RESEARCH REPORT

Institute of Transportation Studies | UNIVERSITY OF CALIFORNIA

Evaluating Transportation Equity Data Dashboards

Claire McGinnis, Master's Student, Transportation Technology and Policy Graduate Group, University of California, Davis
Jesus M. Barajas, Ph.D., Assistant Professor, Department of Environmental Science and Policy, University of California, Davis

September 2024

ITS UCDAVIS Institute of Transportation Studies

Report No.: UC-ITS-2023-02 | DOI: 10.7922/G2ST7N6X

Technical Report Documentation Page

1. Report No. UC-ITS-2023-02	**2. Government Accession No.** N/A	**3. Recipient's Catalog No.** N/A
4. Title and Subtitle Evaluating Transportation Equity Data Dashboards		**5. Report Date** September 2024
		6. Performing Organization Code ITS-Davis
7. Author(s) Claire McGinnis, https://orcid.org/0009-0007-5478-8672 Jesus M. Barajas, Ph.D. https://orcid.org/0000-0001-8966-5778		**8. Performing Organization Report No.** UCD-ITS-RR-24-38
9. Performing Organization Name and Address Institute of Transportation Studies, Davis 1605 Tilia Street Davis, CA 95616		**10. Work Unit No.** N/A
		11. Contract or Grant No. UC-ITS-2023-02
12. Sponsoring Agency Name and Address The University of California Institute of Transportation Studies www.ucits.org		**13. Type of Report and Period Covered** Final Report (October 2022 – September 2023)
		14. Sponsoring Agency Code UC ITS
15. Supplementary Notes DOI: 10.7922/G2ST7N6X		

16. Abstract

The historical impacts of transportation planning and investment have left lasting scars on communities of color and low-income communities. This research evaluates online equity tools that exist as spatial dashboards —i.e., interactive maps in which the parameters of interaction are controlled. Twelve tools ranging from the national to the local level were identified and qualitatively assessed for their ability to address conditions related to transportation equity. The evaluation focused on how each tool defines disadvantaged communities, the outcomes they measure (benefits, burdens, or other), their ease of use, and their ability to guide decisions about equity. The findings show a diversity of methods and metrics in defining disadvantage, with most relying on composite demographic indexes and comparative population thresholds. Tools most commonly provided accessibility metrics to assess transportation benefits, while incorporating a range of environmental and health indicators as burden measures. A minority of tools had integrated features to support planning or project implementation. This study provides examples of promising practices in transportation equity support tools.

17. Key Words Transportation equity, environmental justice, metrics (quantitative assessment), performance measurement, decision making, data dashboards		**18. Distribution Statement** No restrictions.	
19. Security Classification (of this report) Unclassified	**20. Security Classification (of this page)** Unclassified	**21. No. of Pages** 86	**22. Price** N/A

Form Dot F 1700.7 (8-72) Reproduction of completed page authorized

Evaluating Transportation Equity Data Dashboards

Claire McGinnis, Master's Student, Transportation Technology and Policy Graduate Group, University of California, Davis
Jesus M. Barajas, Ph.D., Assistant Professor, Department of Environmental Science and Policy, University of California, Davis

September 2024

UCDAVIS ITS Institute of Transportation Studies

Report No.: UC-ITS-2023-02 | DOI: 10.7922/G2ST7N6X

Table of Contents

About the UC Institute of Transportation Studies

The University of California Institute of Transportation Studies (UC ITS) is a network of faculty, research and administrative staff, and students dedicated to advancing the state of the art in transportation engineering, planning, and policy for the people of California. Established by the Legislature in 1947, ITS has branches at UC Berkeley, UC Davis, UC Irvine, and UCLA.

Acknowledgments

This study was made possible through funding received by the University of California Institute of Transportation Studies from the State of California via the Public Transportation Account and the Road Repair and Accountability Act of 2017 (Senate Bill 1). The authors would like to thank the State of California for its support of university-based research, and especially for the funding received for this project. The authors would also like to thank the attendees of both workshops who provided invaluable insight for this project: Mihaela Babalai, tamika l. butler, Kathryn Canepa, Donald Chase, Darren Conly, Karl Davisson, Jenny Delumo, Annaleigh Ekman, Lauren Elachi, Sequoia Erasmus, David Hosley, Steven Katigbak, Madeline Mattson, Marven Norman, Tristan Osborn, Río Oxas, Nailah Pope-Harden, Rosie Ramos, Faisal Roble, Santos Sanchez, and Paula Zamudio.

Disclaimer

Table of Contents

List of Tables

List of Figures

List of Acronyms

Caltrans	California Department of Transportation
CEJST	Climate and Economic Justice Screening Tool
CES	CalEnviroScreen
EDTM	Efficient Transportation Decision Making
EJ	environmental justice
EQI	Transportation Equity Index (from Caltrans)
EST	Environmental Screening Tool
ETAT	Environmental Technical Advisory Team
ETC	Equitable Transportation Community (from USDOT)
ETDM	Efficient Transportation Decision Making
FDOT	Florida Department of Transportation
IDOT	Illinois Department of Transportation
PD&E	Project Development and Environment
PROWAG	Public Right-of-Way Accessibility Guidelines
SCAG	Southern California Association of Government
STEAP	Screening Tool for Equity Analysis of Projects
USDOT	United States Department of Transportation
VMT	vehicle miles traveled

Executive Summary

Executive Summary

The historical impacts of transportation planning and investment have left lasting scars on communities of color and low-income communities in California. State departments of transportation, metropolitan planning organizations, and local and county governments have begun to address these injustices through plans, policies, and deeper engagement with communities, but the practice is still nascent. There are a variety of data, tools, and metrics from research and practice that measure the distributional equity of transportation planning and projects to help implement equitable solutions. However, there has not yet been a systematic accounting of how effective the tools and indices are across geographic scales and population groups or how they might work together or compete with one another in an effort to advance equity. This review was focused on data, tools, and metrics that can be used in spatial dashboards—i.e., interactive maps in which the parameters of interaction are controlled. This report identifies and evaluates selections from the universe of transportation equity data, tools, and metrics used in research and practice, describing how they identify transportation disadvantage and evaluating the criteria they consider in their equity assessments. This research aims to provide concrete examples of promising practices in transportation equity spatial support tools.

Summary of Methods

To select online tools for further review, we began with an initial scan of tools and found 29 to consider before selecting 12 for in-depth evaluation. Through the initial scan, we evaluated the breadth of each tool's coverage within the following seven categories:

1. infrastructure,
2. travel patterns,
3. funding/investment,
4. access,
5. burdens (health, safety, and economic),
6. neighborhood characteristics, and
7. sociodemographic or socioeconomic factors.

The tools that were selected for an in-depth evaluation covered at least two of the categories, included a map component, and had a stronger focus on transportation equity than on equity in a broader sense or in other specific domains. We selected tools from a various author types, including government, academic, and non-profit organizations. The scan included tools from across the United States, including coverage at the national, state, regional, and local levels, focused on a variety of modes of transportation. The scope of the tools

included support for planning needs, project implementation needs, service needs, and identification of community characteristics. The 12 selected tools are shown in **Table ES 1**

Table ES 1. Summary of Evaluated Tools

Tool Name	Author	Scale
Climate and Economic Justice Screening Tool (CEJST)	Council on Environmental Quality	National
USDOT Equitable Transportation Community (ETC) Explorer	USDOT/FHWA	National
Screening Tool for Equity Analysis of Projects (STEAP)	FHWA Office of Planning	National
Housing and Transportation Affordability Index	The Center for Neighborhood Technology	National
Caltrans Transportation Equity Index (EQI)	Caltrans	State (CA)
Transportation Disparities Mapping Tool	UCLA Center for Neighborhood Knowledge	State (CA)
Illinois Department of Transportation (IDOT) Community Impact Assessment Screener	Center for Neighborhood Technology	State (IL)
Florida Department of Transportation (FDOT) Environmental Screening Tool (EST)	Florida Department of Transportation (FDOT)	State (FL)
Active Transportation Database	Southern California Association of Governments (SCAG)	Metropolitan Region (CA)
TransitCenter Equity Dashboard	TransitCenter	Cities (7 throughout US)
Caltrans Smart Mobility Calculator	Caltrans	Cities (CA)
Sidewalk Explorer	Champaign-Urbana Urbanized Area Transportation Study (CUUATS)	Local (Champaign-Urbana, IL)

We developed a qualitative rubric to evaluate the extent to which each of the selected tools addresses conditions related to transportation equity. We assessed how each tool approaches the designation of priority populations or disadvantaged communities. We identified what outcomes each tool measures—whether addressing transportation benefits, transportation burdens, both benefits and burdens, or neither. We then conducted a thorough assessment of each tool. To determine how comprehensively the tools address equity, we examined whether each tool assessed benefits and burdens in the seven categories above used for the initial scan of tools. Overall ease of use of each tool was qualitatively evaluated based on whether the visualization is easy to understand, and if it is clear to users what the tool is evaluating. Additionally, we evaluated each tool for language accessibility by noting whether the tool or tool tutorials are available in

various languages, and whether the tool uses technical language that would require experience in the transportation industry. Finally, to evaluate the ability of each tool to enable transportation professionals to make decisions about equity, we assessed whether the tool is or could easily be incorporated into transportation professionals' decision-making process, whether the tool has a component to show where current or future transportation investments are directed, and whether the tool has a temporal component so that benefits or burdens could be tracked over time. Overall ease of use and ability to guide decisions to advance transportation equity were also evaluated.

Because the tools serve different audiences and purposes, focusing on different aspects of equity, we did not conduct a comparative ranking for a single "best" tool. Instead, we sought to identify the most promising features relevant to transportation equity analysis.

Summary of Findings

Coverage of Tools

None of the evaluated tools covered all seven categories that were used in the initial scan. All the tools consider demographic, sociodemographic, or socioeconomic factors, even if indirectly through the designation of disadvantaged communities. For example, the Caltrans Smart Mobility Calculator does not directly display factors under this category, but the designation of disadvantaged communities draws on definitions from CalEnviroScreen 4.0, a widely used California environmental justice dashboard. The two categories that were only covered by a few tools were the infrastructure and funding/investment categories.

Methods of Determining Disadvantage

The tools use various methods to identify disadvantaged communities. Some tools show priority areas delineated on the maps, while others show the comparative percentages using graduated colors. The tools varied in their approach to population-level indicators through single variables, composite indices, and comparative thresholds.

Most tools use a combination of indicators to display disadvantage. Most combine multiple indicators, such as demographic, sociodemographic, and socioeconomic information. Several tools draw their definitions from CalEnviroScreen 4.0, which assesses pollution burden and population characteristics to designate disadvantaged communities. It was uncommon for the tools to rely on a set of single indicators; the only one to do so was the Sidewalk Explorer, which defines target populations as people with disabilities and seniors aged 65 or older. All but one tool used relative thresholds to define disadvantaged communities.

Types of Outcomes

We divided the outcomes into the following categories: transportation benefits, burdens, and other. We identified the tools that measured neither benefits nor burdens as focusing primarily on sociodemographic and socioeconomic indicators. We classified these tools as measuring "community vulnerability."

Consistent with existing literature (*1*, *2*), we found that destination accessibility was the primary benefit-based metric used assessing equity in the studied tools. In addition to destination accessibility, some tools considered access to various modes of transportation such as transit, bikeways, and automobiles. We also evaluated tools that considered walkability in their lists of benefits.

The categories of burdens that the tools consider are broader than the benefits. The counterpart to accessibility, or lack of accessibility, was used in some cases to measure transportation insecurity. Many of the burdens that are measured within the tools have to do with environmental factors, such as air pollution, health effects from air pollution, or noise burden from traffic. In addition to environmental factors, several of the tools include health outcomes that could be indicators of environmental burdens, such as asthma, diabetes, heart disease, and low life expectancy. A few tools consider exposure to traffic and traffic noise as burdens. A few tools use cost or "lack of affordability" as a burden.

Two tools that do not measure benefits or burdens primarily focus on population-based metrics that indicate which communities may be disproportionately affected by transportation burdens. We designated this as reporting community vulnerability.

Ease of Use

Overall ease of use of each tool was evaluated based on the clarity of the visualization, the tool's ability to convey its purpose to users, and the ease with which the results or metrics can easily be incorporated into the transportation decision-making process.

The clarity of visualization criterion focused on the ability to present information in a clear and understandable manner, ensuring that users can easily interpret the data. For example, tools such as the CEJST, TransitCenter Equity Dashboard "Equity Communities" view, and Caltrans EQI demonstrate this simplicity by displaying solely disadvantaged communities. This makes it easy for users to immediately pick out which communities should be considered for future investments. Additionally, the simplicity of using an outside tool to measure disadvantage with other metrics, such as the California tools that use CalEnviroScreen, can make the tool simpler to view for California professionals who are familiar with that tool.

Tools that succeeded in conveying the tool's purpose provide clear explanations of their purpose to users. For example, the CEJST presents a description above the map, which is the first item that users see on the webpage.

Ease with which the results or metrics could be integrated was also considered. Some tools, such as the STEAP and IDOT Community Impact Assessment Screener, feature a buffer analysis that allows for easy aggregation of information from census tracts or communities that fall within a given distance of a project.

Decision-making Guidance

Finally, to evaluate the ability of each tool to enable transportation professionals to make decisions about equity, we assessed whether the tool is or could easily be incorporated into transportation professionals'

decision-making process, whether the tool has a component to show where current or future transportation investments are directed, and whether the tool has a temporal component so that transportation benefits or burdens could be tracked over time.

The FDOT EST is already incorporated into the FDOT decision-making process. Because the EST is a required part of the FDOT transportation planning process for every transportation project, the tool can make an impact on equity.

The study authors who developed the IDOT Community Impact Assessment Screener proposed that the tool become a step in the environmental review process in Illinois to ensure that community input is considered. When adopted, the tool could have a greater impact than tools that are not part of the formal transportation decision-making process.

Another factor that we evaluated related to each tool's ability to guide decisions bearing on equity was whether it could display current or future transportation investments. The FDOT EST and the Active Transportation Database were the only tools we reviewed that included such features. The FDOT EST provides information on federally or state-funded projects and makes comments and other data available to the public on the Efficient Transportation Decision Making (ETDM) site. The Active Transportation Database includes a layer to show "Proposed Bikeways by Class."

The presence of a temporal component was also evaluated for each of the tools, as this would allow tracking of transportation benefits or burdens over time and could aid decision-makers in identifying where transportation investments should be directed. Only two tools included a temporal component. The TransitCenter Equity Dashboard shows data on access to various destinations at time points between February 2020 and August 2022. This allows temporal comparisons and can reveal issues that may have been exacerbated by the COVID-19 pandemic. Additionally, the Sidewalk Explorer tool includes compliance scores that can be viewed for various years compared to the base year of 2015, the year of the initial dataset.

Workshops

After our initial evaluation, we held two workshops to gain deeper insight into how these tools are used or could be used. One workshop focused on public agency stakeholders and the other focused on community stakeholders. Attendees of the public agency stakeholder workshop included transportation professionals from metropolitan planning organizations (MPOs) and city and county governments from around the state of California. Attendees of the community needs assessment workshop included members from community-based organizations in California. In the first half of each of the workshops, we presented our findings up to that point on the 12 selected tools. The second half of both workshops consisted of focus group discussions. Both groups provided feedback about the strong components and gaps of the selected tools. The groups also provided feedback on our evaluation, which prompted the inclusion of the following components: noting whether the datasets are open source or downloadable, whether each tool can be edited or altered to include an agency's own datasets or thresholds as a strength, whether technical language that would require

professional experience in the transportation industry is used, and whether trainings are built into the website as a measure of “ease of use.”

Contents

Introduction

The historical impacts of transportation planning and investment have left lasting scars on communities of color and low-income communities in California. State departments of transportation, metropolitan planning organizations (MPOs), and local and county governments have begun to address these injustices through plans, policies, and deeper engagement with communities, but the practice is still nascent. There are a variety of data, tools, and metrics from research and practice that measure the distributional equity of transportation planning and projects to help implement equitable solutions. However, there has not yet been a systematic accounting of how effective the tools and indices are across geographic scales and population groups or how they might work together or compete with one another to advance equity.

This review was focused on data, tools, and metrics that can be used in spatial dashboards—i.e., interactive maps in which the parameters of interaction are controlled. Spatial dashboards to aid in decision-making can be classified as a broader ecosystem of computational tools known as planning support systems (PSS). One vision of PSS tools considers them digital platforms that provide the "information infrastructure" for decision-making, enabling customizable models for specific problems and a platform for collaborative planning (*3*). Early reviews of such systems show a variety of aims, use cases, and designs. The aims include platforms to enhance public participation in planning processes, addressing specific planning needs, and usefulness in public health and environmental planning, and big-picture scenario analysis (*4*, *5*). More recent analysis shows even more variety in the kinds of tools available and their purposes, with equity considerations becoming more common in land use and transportation planning systems (*6*).

Some spatial dashboards are mandated for use in support of policy goals. For example, CalEnviroScreen, a tool that shows indexes of environmental justice vulnerability, is frequently used in California because a certain percentage of climate investment funds must be made in disadvantaged communities as defined by the tool (*7*). Likewise, a new Climate and Environmental Justice Screening Tool, reviewed in this report, operates similarly for certain federal investments mandated by the Justice40 initiative (*8*).

While there is significant potential for PSS tools to improve decision-making through more information, better visualization, and common data platforms for engagement with the public, the uptake in practice is limited. Developers of certain PSS tools and end-users perceive technical limitations to the usability of their platforms. Developers typically see data availability and institutional process barriers as key challenges that prevent the use of some of these tools (*9*, *10*). Likewise, practitioners find institutional policies on planning priorities inhibit the use of tools to guide decisions (*10*). There is often a mismatch between technical improvements in tool development and response to user needs, yielding platforms that lack transparency, relevance, and user-friendliness, particularly in jurisdictions whose staff have limited technical capacity (*6*, *11*).

Increasingly, equity has become a key category relevant for transportation planning and decision-making that could be aided by the use of spatial dashboards. A recent review found that most MPOs use at least one equity-

related metric in their project prioritization process (*12*), while state departments of transportation have more nascent, but evolving, equity practices (*13*). The number of spatial dashboards incorporating transportation equity concerns has also increased recently, but to date there has not been an accounting of the kinds of metrics these tools incorporate and how they differ in their suitability for planning and decision-making.

This report identifies and evaluates transportation equity data, tools, and metrics used in research and practice, describing how they identify transportation disadvantage and evaluating the criteria they consider in their equity assessments. This research aims to provide concrete examples of promising practices in transportation equity spatial support tools.

Tool Evaluation Methods

This section describes the methods used to select tools for evaluation and the results of that evaluation. It then describes how each tool evaluates equity and the thresholds used to define disadvantages or burdens and how each tool visually represents disadvantaged or priority areas. We evaluate each tool regarding its ease of use and how well it could enable transportation professionals to make decisions about equity.

Tool Selection

To select online tools for further review, we began with an initial scan of tools and found 29 to consider before selecting 12 for in-depth evaluation. In the initial scan, we evaluated the breadth of each tool's coverage in the following *categories*: infrastructure, travel patterns, funding and investment, access, burdens (health, safety, or economic), neighborhood characteristics, and sociodemographic or socioeconomic factors. The tools that were selected for an in-depth evaluation covered at least two of the categories, included a map component, and had a stronger—but not necessarily exclusive—focus on transportation equity as opposed to equity in general or in other specific domains. We selected tools from a variety of different author types such as government, academic, and non-profit organizations. The scan included tools from across the United States, including coverage at the national, state, regional, and local levels, focused on a variety of modes of transportation. The scope of the tools included support for planning needs, project implementation needs, service needs, and identification of community characteristics. The list of selected tools along with their authors, audiences, and purposes is shown in **Table 1**

Table 1. Transportation Tools Evaluated

Tool	Author	Target Audience	Scale	Purpose	Reference
Climate and Economic Justice Screening Tool (CEJST)	Council on Environmental Quality	Federal agencies	National	"To help Federal agencies identify disadvantaged communities that could benefit from the Justice40 initiative, which seeks to deliver 40% of the overall benefits of certain Federal investments to disadvantaged communities." (*14*)	(*15*)
USDOT Equitable Transportation Community (ETC) Explorer	USDOT/ FHWA	USDOT and stakeholders	National	"To support the Justice40 initiative. Designed to complement the White House Council on Environmental Quality Climate and Economic Justice Screening Tool (CEJST) by providing users deeper insight into the transportation disadvantage component of the CEJST." (*16*)	(*16*)
Screening Tool for Equity Analysis of Projects (STEAP)	FHWA Office of Planning	FHWA, state DOTs, MPOs, and other local agencies	National	"To provide a rapid screening of potential project locations anywhere in the US to support Title VI, Environmental Justice (EJ), and other socioeconomic data analyses." (*17*)	(*17*)
Housing and Transportation Affordability Index	The Center for Neighborhood Technology	Planners, housing professionals, and policy makers	National	"To measure the true affordability of housing by calculating the transportation costs associated with the location of the home." (*18*)	(*19*)
Caltrans Transportation Equity Index (EQI)	Caltrans	Caltrans	State (CA)	To create a transportation-based index "to identify priority populations at the census block level" with the goal of "informing the Department about how they can best address and mitigate the inequities that are	(*21*)

Tool	Author	Target Audience	Scale	Purpose	Reference
				exacerbated by the existing transportation system." (*20*)	
Transportation Disparities Mapping Tool	UCLA Center for Neighborhood Knowledge	Decision makers, public agencies, community groups	State (CA)	Created to contribute to the California Air Resources Board's (CARB) equity work by "supporting and building on California's efforts to implement the Global Warming Solutions Act of 2006 (AB 32) in a way that equitably benefits all communities." (*22*) The tool is set up as a "database that contains variables and indicators that previous research has documented as being associated with transportation disparities." (*22*)	(*23*)
Illinois Department of Transportation (IDOT) Community Impact Assessment Screener	The Center for Neighborhood Technology	Transportation professionals	State (IL)	To aid in the process of community impact assessment for transportation projects, which is a step in the environmental review process to ensure that community input is considered.	(*24*)
Florida Department of Transportation (FDOT) Environmental Screening Tool	Florida Department of Transportation (FDOT)	Transportation professionals, Environmental Technical Advisory Team	State (FL)	Created to carry out FDOT's Efficient Transportation Decision Making (ETDM) process. The ETDM process was "developed in response to Congress' Environmental Streamlining initiative." (*25*)	(*26*)
Active Transportation Database	Southern California Association of Governments (SCAG)	Transportation professionals	Metropolitan Region (CA)	"Developed to collect and store bicycle, pedestrian, wheelchair, and scooter/skateboard volume counts for infrastructure and planning projects across Southern California. In addition, the platform is designed to assist in planning and data	(*28*)

Tool	Author	Target Audience	Scale	Purpose	Reference
				analysis efforts for active transportation programs and projects." (*27*)	
TransitCenter Equity Dashboard	TransitCenter	Transit practitioners, policy makers, and advocates	Cities (7 throughout US)	"To provide indicators of public transit system performance via a publicly available web dashboard." (*29*) "The dashboard aims to help transit practitioners, policymakers, and advocates make more informed and equitable decisions by providing clear metrics about disparities in transit access and demonstrating how changes to transit networks affect those gaps." (*30*)	(*31*)
Caltrans Smart Mobility Calculator	Caltrans	Practitioners and researchers	Cities (CA)	"To help practitioners and researchers meet planning and design challenges related to corridors, station areas, and complete streets, climate action planning and providing affordable housing near transit in support of active and sustainable travel." (*32*)	(*32*)
Sidewalk Explorer	Champaign Urbana Urbanized Area Transportation Study	Local agencies	Local (Champaign-Urbana, IL)	"To create a database of sidewalk network features within the Champaign Urbana urbanized area. The database was designed to assess and track the condition and Americans with Disabilities Act (ADA) compliance of the sidewalk network." (*33*)	(*34*)

FHWA, Federal Highway Administration; USDOT, United States Department of Transportation

Evaluation Methods

We developed a qualitative rubric to evaluate the extent to which each of the selected tools addresses conditions related to transportation equity. We began by first determining how each tool approaches the analysis of equity-priority communities and relevant measures for transportation equity. We identified the definitions used for disadvantaged communities and what the threshold for disadvantage is based on (i.e., income, race and ethnicity, or other factors). We then identified what outcomes each tool measures—whether addressing transportation benefits, transportation burdens, both benefits and burdens, or neither.

We then conducted a thorough assessment of each tool. We examined how comprehensive the tools are in terms of the benefits and burdens assessed by determining how many categories as defined in the Tool Selection section above were fulfilled. We noted whether there is a threshold against which the indicators in the tools are being measured and whether they are using comparative analyses, percentages, or something else in their evaluation of equity. We also noted how the tools describe equity, whether in place-based or person-based terms. Overall ease of use of each tool was evaluated based on whether the visualization is easy to understand, and whether it is clear to users what the tool is evaluating. Additionally, we evaluated each tool for language accessibility by noting whether the tool or tool tutorials are available in various languages, and whether technical language that would require experience in the transportation industry is used. We also identified whether datasets were open source or available to download for use in other applications. Finally, we assessed whether the tool is or could easily be incorporated into transportation professionals' decision-making process, whether or not the tool has a component to show where current or future transportation investments are directed, and whether or not the tool has a temporal component so that transportation benefits or burdens could be tracked over time.

Because the tools serve different audiences and purposes, focusing on different aspects of equity, we did not conduct a comparative ranking for a single "best" tool. Instead, we sought to identify the most promising features relevant to transportation equity analysis.

Public Agency Stakeholder Needs Assessment Workshop

We held a public agency stakeholder workshop after completing our initial evaluation. Attendees included transportation professionals from MPOs and city and county governments from around the state of California. In the first half of the workshop, we presented our findings up to that point on the 12 selected tools. The second half of the workshop consisted of a focus-group-style discussion, in which we asked the attendees questions about their experience with online equity tools, the strengths of the presented tools, the gaps or limitations of the tools, ease of use of the tools, the ability of the tools to guide decisions to advance transportation equity, and input on our evaluation.

Community Needs Assessment Workshop

A second workshop was held with a focus on community needs. Attendees included members from various community-based organizations in California. In the first half of the workshop, we presented our findings up to that point on the 12 selected tools. The second half of the workshop consisted of a focus-group-style discussion, in which we asked the attendees questions about their experience with online equity tools, the strengths of the presented tools, the gaps or limitations of the tools, input on our evaluation, community involvement, and ease of use of the tools.

Descriptions of Tools

Climate and Economic Justice Screening Tool

Information

- **Author:** Council on Environmental Quality
- **Data Year(s):**
    - 2015-2019 5-Year American Community Survey (ACS) Estimates
    - 2010 Census TIGER files
    - 2016-2019 CDC PLACES: Local Data for Better Health
    - 2010-2015 CDC U.S. Small-area Life Expectancy Estimates Project (USALEEP)
    - 2018 DOE Low-Income Energy Affordability Data (LEAD) Tool
    - 2018 DOI/BIA Land Area Representation
    - 2017 DOI Abandoned Mine Lands Inventory System
    - 2022 DOT Transportation Access Disadvantage
    - 2014-2021 EPA EJScreen
    - 2014-2021 FEMA National Risk Index
    - 2022 First Street Foundation Climate Risk Data Access
    - 1935-1940 HOLC/2021 NCRC Historic Redlining Scores
    - 2014-2018 HUD Comprehensive Housing Affordability Strategy (CHAS)
    - MRLC consortium Percent Developed Imperviousness
    - USACE (2019) Formerly Used Defense Sites
- **Target Audience:** Federal agencies
- **Purpose:** Identify communities eligible for funding under the federal Justice40 initiative
- **Webpage:** Climate and Economic Justice Screening Tool

Tool Evaluation Methods

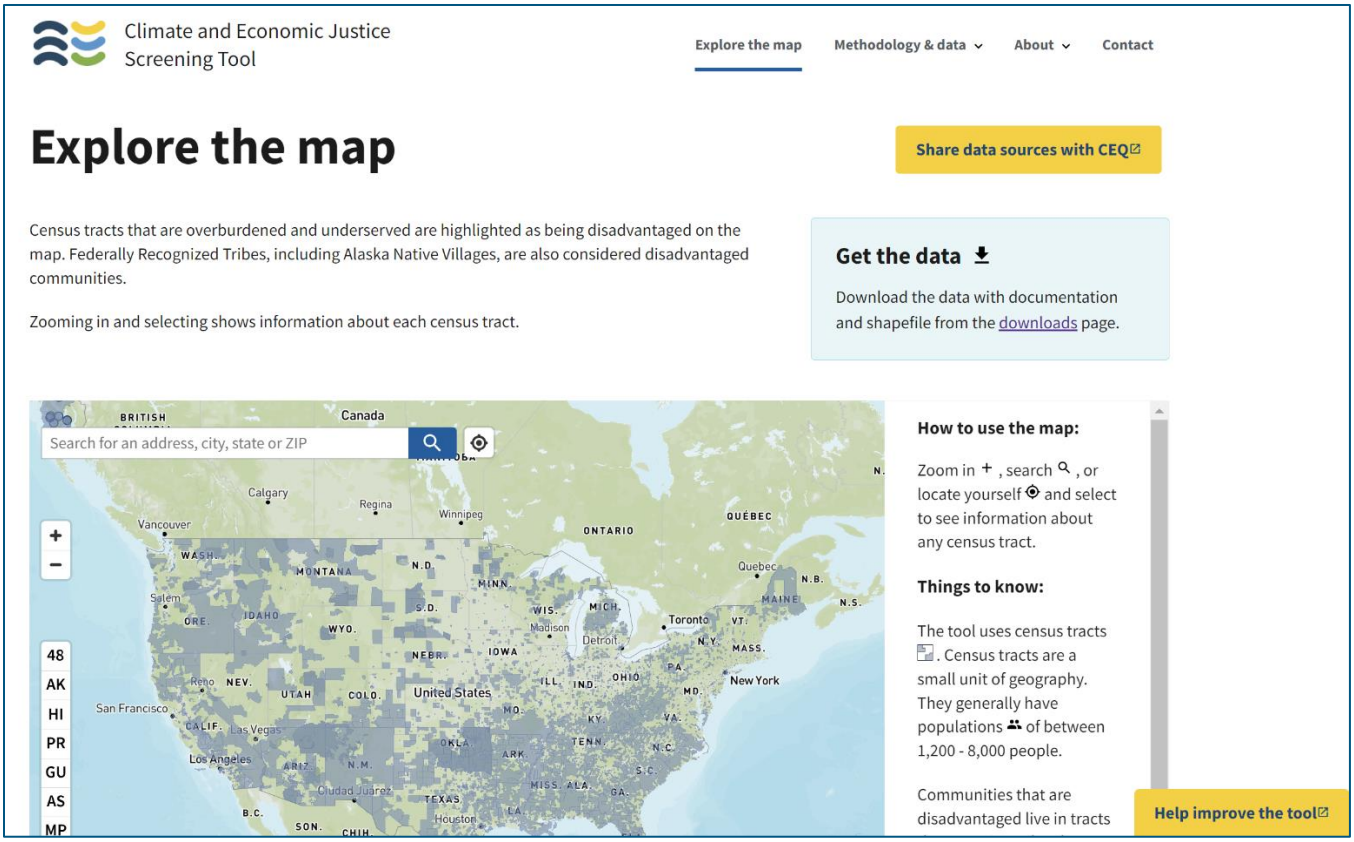

Figure 1. Climate and Economic Justice Screening Tool Home Screen

The CEJST, shown in **Figure 1**, uses multiple datasets to identify disadvantaged communities. The datasets, which are organized into categories as shown in, extracted from the *CEJST Technical Support Document*, "are indicators of burdens that disadvantaged communities face" (*35*). A community is highlighted as disadvantaged on the CEJST map if it is in a census tract that is: "(1) at or above the threshold for one or more environmental, climate, or other burdens, and (2) at or above the threshold for an associated socioeconomic burden. In addition, a census tract that is completely surrounded by disadvantaged communities that meets the burden thresholds and meets an adjusted low-income threshold (≥ 50th percentile), is also considered disadvantaged" (*35*). When household income is used as the measure of socioeconomic burden, "the cutoff for the low-income indicator (< 200% of the Federal poverty line) is at the 65th percentile" (*35*).

The CEJST uses thresholds, or cutoffs, to "account for regional, state, and other geographic differences across the U.S." (*35*). Each of the thresholds is measured independent of one another, and most of the CEJST burdens use percentiles as cutoff values. The tool identifies census tracts in the top 10% for each burden, which allows the tool to identify the most burdened census tracts. The complete list of percentile cutoff values that are used in the CEJST are shown in **Table 2**, extracted from the CEJST Technical Support Document (35).

A feature that is unique to the CEJST is the Historic Underinvestment burden, which was not present in any of the other evaluated tools. This measure highlights census tracts "that experienced historic underinvestment based on redlining maps created by the federal government's Home Owners' Loan Corporation (HOLC) between 1935 and 1940" (*35*). The tool uses the National Community Reinvestment Coalition's (NCRC) methodology for converting boundaries in the HOLC maps to census tracts (*36*). Census tracts meet the threshold when they have a score of 3.25 or more out of 4. This score represents how much of the tract was redlined in the HOLC maps. The NCRC researchers gave a scores of 1, 2, 3, and 4 to neighborhoods graded A ("best"), B ("desirable"), C ("declining"), and D ("hazardous"), respectively, based on the HOLC maps.

When opening the tool, the whole U.S. is visible and disadvantaged census tracts are highlighted in blue. Locations can be selected using the search bar on the map or zoomed in on and selected. Once a census tract is selected, the information panel on the right displays the percentile where the census tract falls for each category listed in **Table 2**.Above the percentile information, tract demographics including race, ethnicity, and age data can be viewed. Additionally, just below the tract demographic information, it lists the question "Identified as disadvantaged?" with an answer of "yes," "no," or "partially." A tract is considered disadvantaged if it is at or above the cutoff values for environmental, climate, and other burdens and the related socioeconomic burdens. A tract is considered partially disadvantaged if lands of federally recognized Tribes cover any portion of the tract. The information panel on the right of the screen, as shown in **Table 2**, highlights the category of burden for which the census tract surpasses the threshold.

Table 2. Overview of methodology used in version 1.0 of the CEJST

Category	Environmental, climate, or other burdens	Socioeconomic burden
Climate change	1. Expected agriculture loss rate ≥ 90th percentile OR 2. Expected building loss rate ≥ 90th percentile OR 3. Expected population loss rate ≥ 90th percentile OR 4. Projected flood risk ≥ 90th percentile OR 5. Projected wildfire risk ≥ 90th percentile	Low income*
Energy	1. Energy cost ≥ 90th percentile OR 2. PM 2.5 in the air ≥ 90th percentile	Low income*
Health	1. Asthma ≥ 90th percentile OR 2. Diabetes ≥ 90th percentile OR 3. Heart disease ≥ 90th percentile OR 4. Low life expectancy ≥ 90th percentile	Low income*
Housing	1. Historic underinvestment = Yes 2. Housing cost ≥ 90th percentile OR 3. Lack of green space ≥ 90th percentile OR 4. Lack of indoor plumbing ≥ 90th percentile OR 5. Lead paint ≥ 90th percentile	Low income*
Legacy pollution	1. Abandoned mine land present = Yes OR 2. Formerly Used Defense Site (FUDS) present = Yes OR 3. Proximity to hazardous waste facilities ≥ 90th percentile OR 4. Proximity to Superfund or National Priorities List (NPL) sites ≥ 90th percentile OR 5. Proximity to Risk Management Plan (RMP) sites ≥ 90th Percentile	Low income*
Transportation	1. Diesel particulate matter ≥ 90th percentile OR 2. Transportation barriers ≥ 90th percentile OR 3. Traffic proximity and volume ≥ 90th percentile	Low income*
Water and wastewater	1. Underground storage tanks and releases ≥ 90th percentile OR 2. Wastewater discharge ≥ 90th percentile	Low income*
Workforce development	1. Linguistic isolation ≥ 90th percentile OR 2. Low median income ≥ 90th percentile OR 3. Poverty ≥ 90th percentile OR 4. Unemployment ≥ 90th percentile	High school education < 10%

Source: (35). * Low Income = 65th percentile or above for census tracts that have people in households whose income is less than or equal to twice the federal poverty level, not including students enrolled in higher education

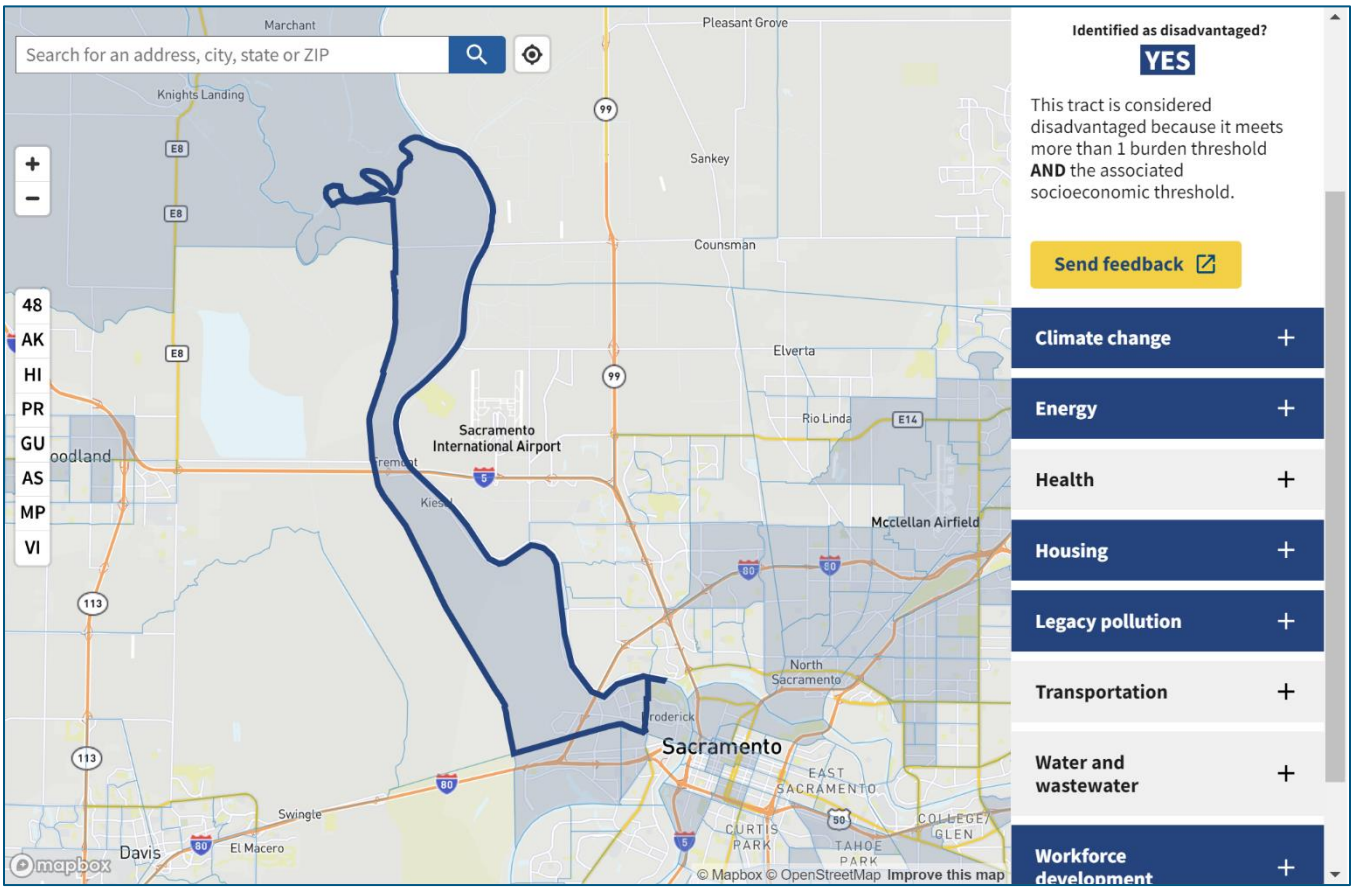

Figure 2. CEJST Highlighted Census Tract and Burdens. Source: (35).

Evaluation of Tool

The CEJST focuses on measuring burdens primarily related to climate change, as the tool was developed to support implementation of Executive Order 14008: Tackling the Climate Crisis at Home and Abroad. Within the context of climate change, the categories that are evaluated for each census tract include those shown in **Table 2**. The data from the tool are downloadable as Geographic Information Systems (GIS) files and could be incorporated into an agency's own decision-making process.

The tool does not include a temporal component to track changes over time, however this is appropriate for the goal of the tool, which is to identify the communities that are currently eligible for Justice40. In the future, it could be useful and informative for the tool to include a temporal component for practitioners to track changes that may happen in communities as they receive more investment from the Justice40 initiative.

Overall, the tool is user-friendly and would enable straightforward decision-making in the allocation of 40% of overall benefits in climate, clean energy, and related areas to disadvantaged communities. An additional strength of the CEJST is that it is the only tool that includes Historic Underinvestment as a data layer.

USDOT Equitable Transportation Community (ETC) Explorer

Information

- **Author:** USDOT/FHWA
- **Data Year(s):**
  - 2015-2020 ACS
  - 2021 EPA Smart Location Database
  - 2022 AAA
  - 2017-2021 NTD
  - 2023 USDOT BCA
  - 2017 BTS LATCH
  - 2020-2021 CES
  - 2020 NHTSA FARS
  - 2022 EPA'S EJScreen
  - 2022 EPA's Facility Registry Service (FRS)
  - 2022 US DOL Mine Data Retrieval System
  - 2023 US DOL Mine Data Retrieval System
  - 2022 USDOT BTS
  - 2022 EPA WSIO
  - 2020 CDC Places
  - 2022 Department of Homeland Security (DHS) Homeland Infrastructure Foundation-Level Data (HIFLD)
  - 2021 FEMA National Risk Index (NRI)
  - 2022 DOI/NOAA CMRA
  - 2019 USGS MRLC NLCD
- **Target Audience:** USDOT and stakeholders
- **Purpose:** To provide additional detail about the transportation disadvantage component of the CEJST
- **Webpage:** USDOT Equitable Transportation Community (ETC) Explorer

Tool Evaluation Methods

The USDOT Transportation Disadvantaged Areas model creates an overall index score. As stated in the ETC, Explorer Technical Documentation, "the index computes cumulative disadvantage by normalizing indicators associated with disadvantage, summing the percentile ranks of these indicators into components, and then summing the percentile ranks of the sums of each component to determine an overall score" (*37*). A graphical representation of the model can be found in **Figure 3**.

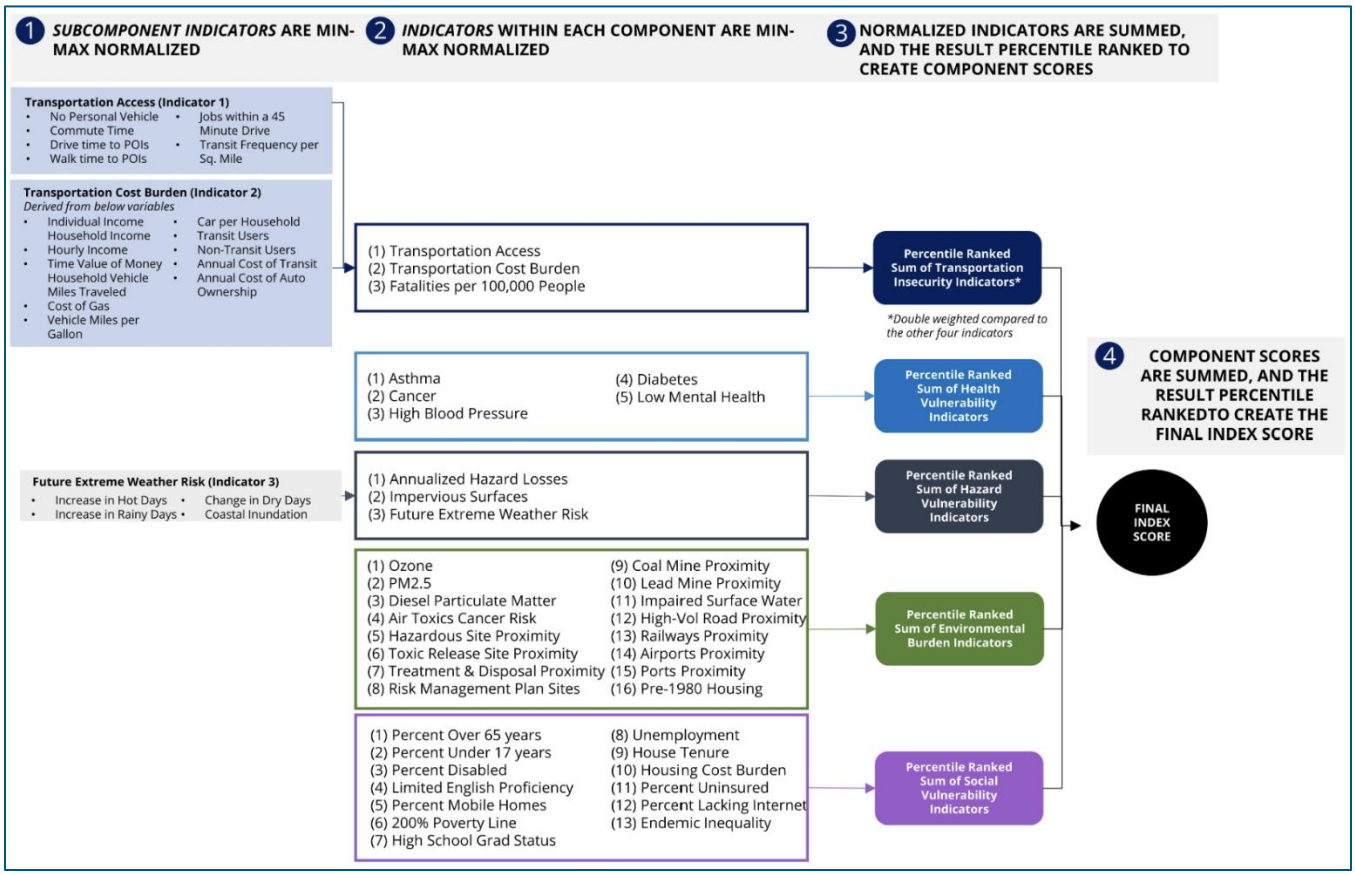

Figure 3. ETC Explorer National Results and State Results Index Methodology (Source: (13))

To allow for comparison and eliminate the effect of different measurement units, the indicators are rescaled using min-max normalization (*37*). The indicators are then ranked and summed to calculate each component. Percentile ranking is then used to determine each composite score. The five components that contribute to the composite score are transportation insecurity, environmental burden, health vulnerability, social vulnerability, and climate and disaster risk burden. Census tracts with final index scores greater than 0.65 (65th percentile) are defined as "burdened" or "disadvantaged." Additionally, the USDOT defines census tracts as "burdened" under individual components if the percentile of that component is greater than 65 (*37*). More detail about the calculation methods can be found in the ETC Explorer Technical Documentation.

When opening the ETC Explorer (**Figure 4**), the top of the screen shows tabs for: ETC Explorer – Homepage; ETC Explorer – National Results; ETC Explorer – State Results; ETC Explorer – Add Your Data (National and State Results); Transportation Insecurity Analysis Tool; and Understanding the Data. The Homepage tab walks users through the background of the tool and offers video tutorials in English and Spanish. The second tab across the top ribbon that can be selected is the National Results tab. When this tab is selected, as has been done in **Figure 4**, a dashboard appears with a map where a census tract or a group of census tracts can be chosen. Shapes can be drawn to select multiple census tracts. The following data is listed just below the map: total population living in the selected project area, total population living in disadvantaged census tracts in the selected project area, and percentage of disadvantaged census tracts in the selected project area. To the right of the map, the percentile ranks for the following overall disadvantage component scores are shown: climate and disaster risk burden, environmental burden, health vulnerability, social vulnerability, and transportation insecurity. Below the overall disadvantage component scores, the individual indicators that feed into each component can be viewed as percentile rankings. The dashboard shows a gray section on each of the bar charts that is labeled "Disadvantaged." The State Results tab looks the same as the National Results tab, but it instead displays how a Census tract experiences disadvantage compared to all other tracts statewide rather than all tracts nationally. The Add Your Data (National and State Results) tab allows users to add their own data to the ETC Explorer National and State Results maps to create custom maps and data views.

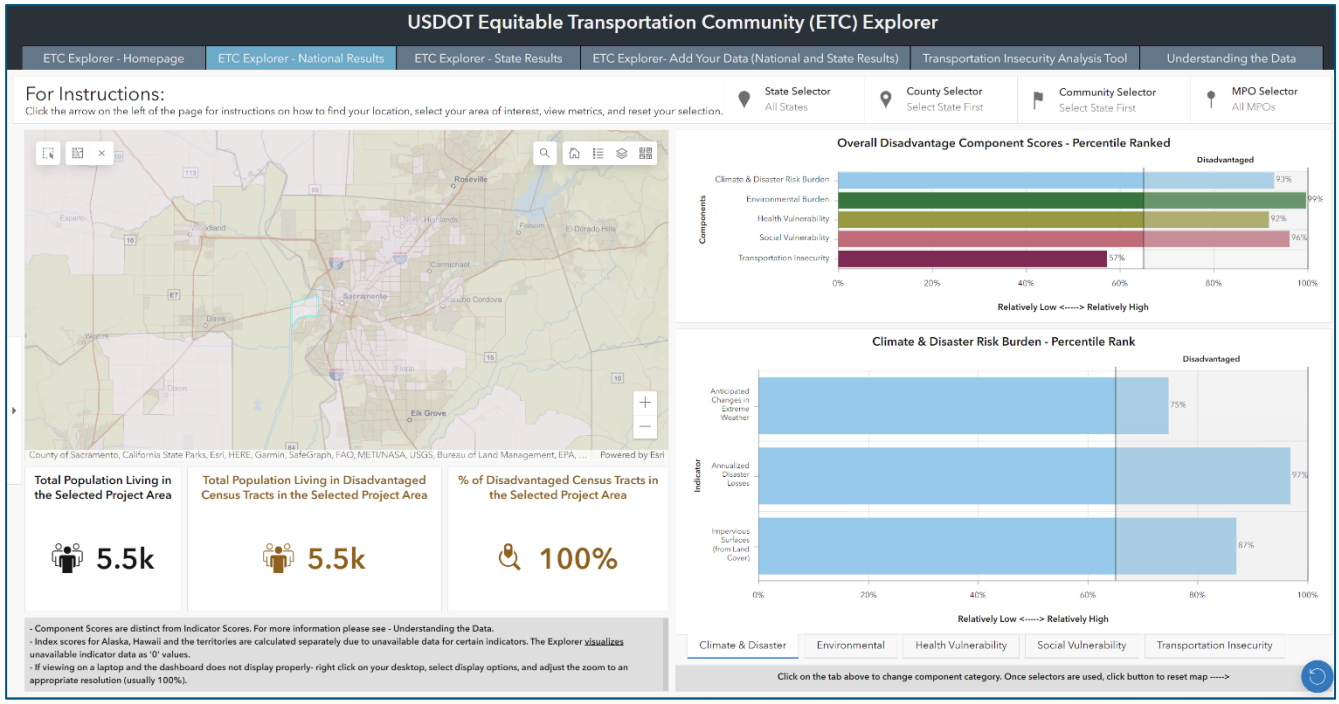

Figure 4. USDOT ETC Explorer National Results Tab

The Transportation Insecurity Analysis Tool tab, shown in **Figure 5**, displays selected transportation insecurity data at the state or national level. Users can filter the data using the preset thresholds or enter their own. The available filters include Urbanized Area, Cost Burden, Access Burden, and Safety. The Urbanized Area filter can be used to define urban areas with 50,000 residents or less, 200,000 residents or less, or 200,000 residents or more. The Cost Burden filters include thresholds related to income, percentage of people transportation cost burdened, estimated cost of transportation, and housing cost. The Access Burden filters include thresholds related to households without vehicles: amount of available transit; drive time and walk time to adult education, grocery stores, medical facilities, and parks; broadband access; and percent of households with no internet. The Safety Filters include thresholds related to motorist fatalities and non-motorist fatalities. Users can select additional layers such as MPO boundaries, alternative fueling stations, safety data, transit routes,

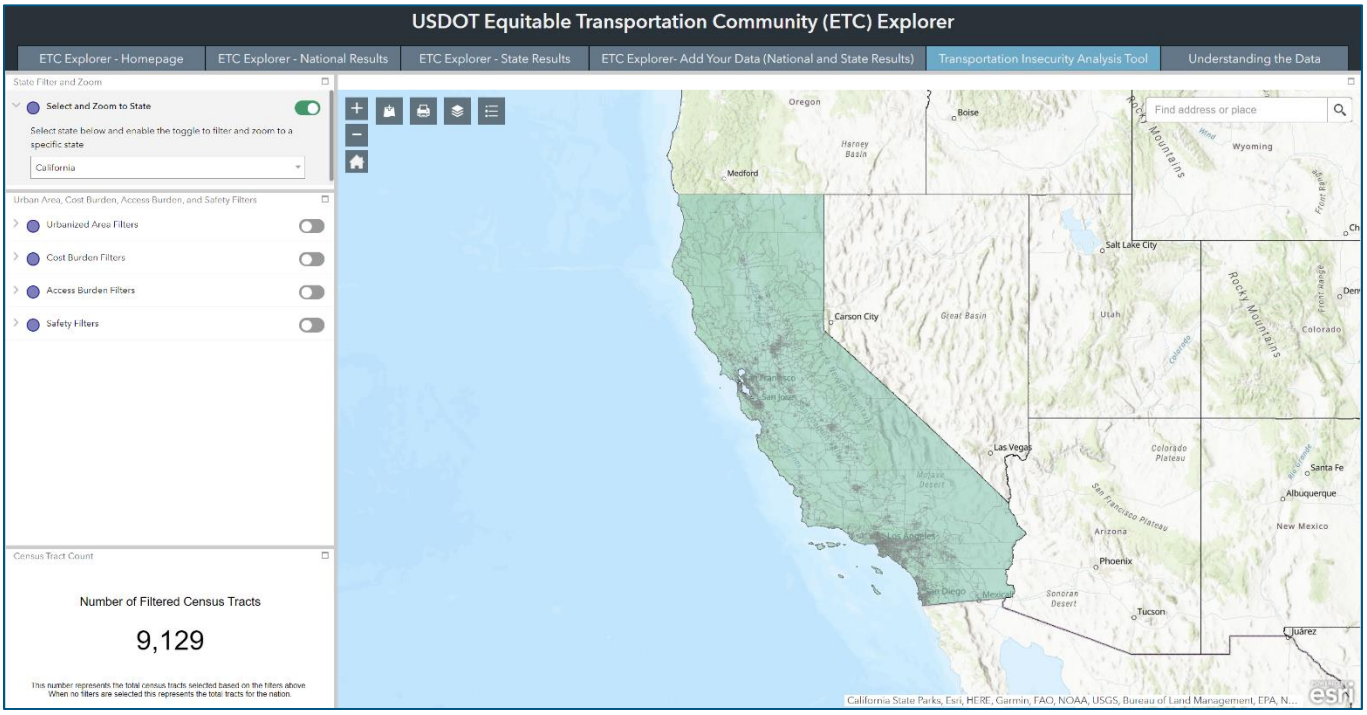

Figure 5. USDOT ETC Explorer – Transportation Insecurity Analysis Tool

intercity bus routes, or any of the five disadvantage components to gain a deeper understanding of the relationship between transportation insecurity and the selected layer.

Finally, the Understanding the Data tab offers more information about each of the components, sub-components, and indicators. Each component has an associated table like the Transportation Insecurity Component table shown in **Figure 6**.

Component	Sub-component	Indicator Description	Units	Data Source	Geographic Granularity
Transportation Insecurity	Transportation Access	Percent of households with no car	Percent households	ACS 2016-2020	Census Tract
		Average commute time to work	Minutes	ACS 2016-2020	Census Tract
		Frequency of Transit Services per Sq Mi	Count/sq mi	EPA Smart Location Database 2021	Census Block Group
		Jobs within a 45-min Drive	Count	EPA Smart Location Database 2021	Census Block Group
		Estimated Average Drive Time to Points of Interest (min)	Minutes	Esri, HIFLD	Census Block Group
		Estimated Average Walk Time to Points of Interest (min)	Minutes	Esri, HIFLD	Census Block Group
	Transportation Cost Burden	Calculated average annual cost of Transportation as percent of household income	Percent of household income towards transportation	Calculated	Census Tract
		Cost of Gas	U.S. Dollar (USD)	EIA 2023	State
		Cost of Transit	USD	NTD 2017-2021	Urbanized Area
		Time Value of Money	USD	USDOT BCA 2023	National
		Time to Work	Minutes	ACS 2016-2020	Census Tract
		Median Income	USD	ACS 2016-2020	Census Tract
		Vehicle Miles Traveled	Miles	BTS LATCH 2017	Census Tract
		Vehicle Finance Charges	USD	CES 2020-2021	Census Division
		Cost of Maintenance	USD	CES 2020-2021	Census Division
		Insurance Costs	USD	CES 2020-20211	Census Division
	Transportation Safety	Traffic Fatalities per 100,000 people	Rate	NHTSA FARS 2020	Point

Figure 6. USDOT ETC Explorer – Transportation Insecurity Indicators (Source: (16))

Evaluation of Tool

The ETC primarily focuses on measuring burdens, as the components on the dashboard include the following: Climate and Disaster Risk Burden, Environmental Burden, Health Vulnerability, Social Vulnerability, and Transportation Insecurity. The Homepage and Understanding the Data tabs offer guidance for users and information about the data without users having to download the associated technical documentation. Additionally, tutorial videos are offered in both English and Spanish, a language accessibility feature that was not present in any other evaluated tools.

In the Transportation Insecurity Analysis Tool tab, users can select the preset thresholds or enter their own thresholds. This tab also provides the Transportation Insecurity Percentile Ranked State Results as a layer that displays the percentile rankings as deciles. Line and shape layers can be viewed at the same time, but multiple shape layers cannot be viewed together if one of the layers does not display with translucency. For example, Transportation Insecurity Percentile and Passenger Rail can be viewed together, but Transportation Insecurity Percentile and CEJST Disadvantaged tracts cannot, because the Transportation Insecurity Percentile layer is opaque.

Though the tool is designed to complement the CEJST by providing deeper insight into the transportation disadvantage component of the CEJST, it is not clear on the main dashboard for 'ETC Explorer – National Results' that any of the components are related to transportation other than the Transportation Insecurity component. The other components include burdens that could be related to transportation burdens such as asthma prevalence or unemployment; however, the connection to transportation is not explicitly stated. Additionally, though the visualization of the percentile ranks of each component score is easy to find, it is difficult to find the final index score.

Screening Tool for Equity Analysis of Projects (STEAP)

Information

- **Author:** FHWA Office of Planning
- **Data Year(s):** 2016-2020 ACS 5-Year Estimates
- **Target Audience:** FHWA, state DOTs, MPOs, and other local agencies
- **Purpose:** To support Title VI and environmental justice analysis near potential transportation project areas
- **Webpage:** Screening Tool for Equity Analysis of Projects (STEAP)

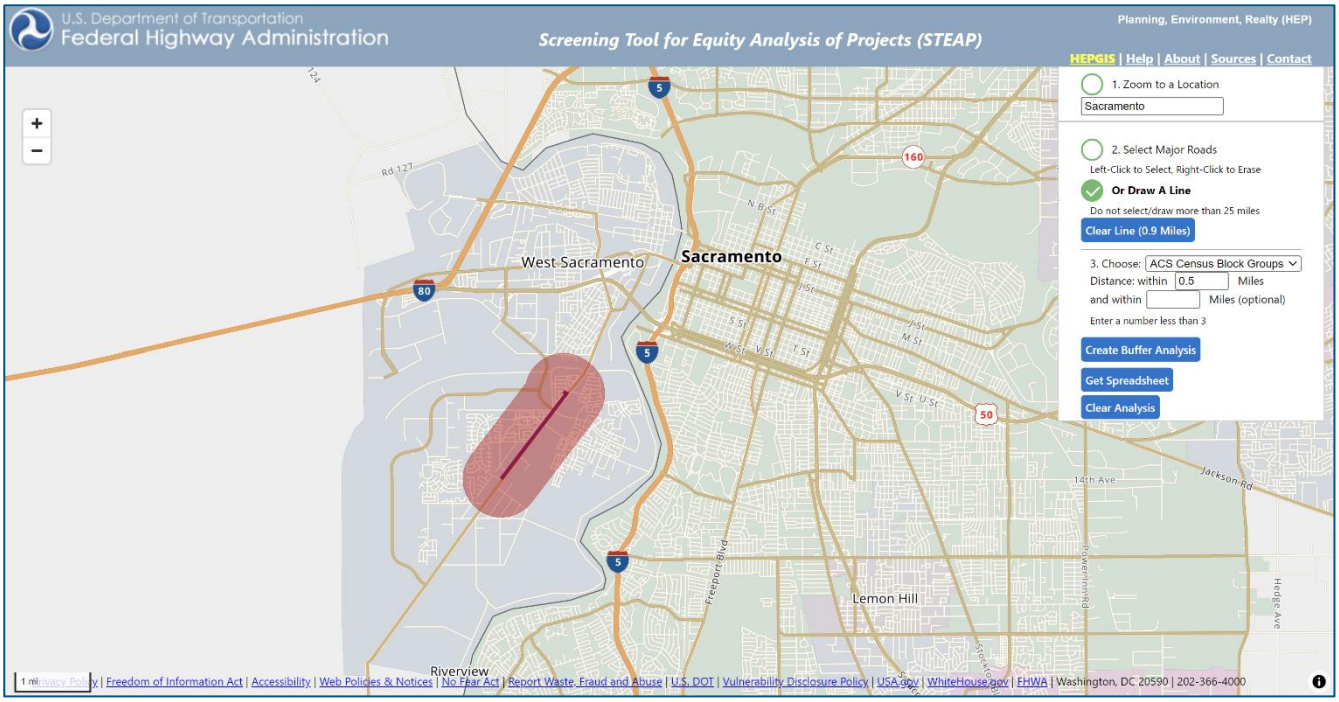

Figure 7. FHWA Screening Tool for Equity Analysis of Projects

Tool Evaluation Methods

The STEAP tool, shown in **Figure 7**, provides estimates of the socioeconomic characteristics of the resident population surrounding a project location based on a simple buffer analysis. The tool creates a downloadable PDF report estimating populations covered by Title VI and environmental justice (EJ), and household characteristics for up to two buffer areas around a project corridor. The demographics are estimated using the Census Block Group layer, which is the most detailed geography for which American Community Survey (ACS) data is available from the Census Bureau. For a project buffer, each Title VI/EJ population and household variable is estimated by summing the contributions from each block group intersecting the buffer. A buffer analysis can be created by selecting major roads or by drawing a line. The buffer analysis provides a summary of various variables such as race, ethnicity, educational attainment, and household income. The summary also provides the values for the city/town, county, and state of the selected location so that the variables can be compared across geographic scales.

Evaluation of Tool

The STEAP tool does not focus on measuring transportation benefits or burdens, as its purpose is to provide a summary of Title VI and EJ variables. The tool provides a summary from a buffer analysis that primarily includes sociodemographic and socioeconomic information. Monthly housing cost is the only indicator that we determined to be a burden measured by the tool.

The tool is user friendly and provides a downloadable PDF of the buffer analysis, which would be easy to incorporate into a project report. The PDF provides summaries of each of the variables for the city/town, county, and state of the selected location, and the variables are clearly organized and easy to understand. This makes it easy to assess how the project area compares to the county and statewide areas for any of the defined Title VI or EJ variables. The tool would be enhanced by an indication of whether the buffer analysis shows a project-specific need for further assessment of community outreach.

Since the tool only provides sociodemographic and socioeconomic information, it is not possible to understand other experiences of the populations surrounding a project area such as access to jobs, schools, parks, grocery stores, or medical facilities. Additionally, the tool shows administrative boundary areas designated by various colors (e.g., red, grey, and green in **Table 7**), but there is no legend to understand what the different colors indicate. The tool does not include a temporal component to see if any changes have happened over time. However, for the tool's purpose, a temporal component may add confusion for a user viewing the printed report. The tool also does not show locations of planned or current projects.

Overall, the tool is user-friendly and could easily be incorporated into a project process evaluating strictly Title VI and EJ variables. However, to assess equity impacts of a project, the tool would require a broader analysis of other variables.

Housing and Transportation (H+T) Affordability Index

Information

- **Author:** The Center for Neighborhood Technology (CNT)
- **Data Year(s):**
    - 2015-2019 ACS 5-Year Estimates
    - 2019 U.S. Census Longitudinal Employment-Household Dynamics (LEHD) Origin-Destination Employment Statistics (LODES)
    - 2019 Consumer Expenditure Survey
    - 2018-2019 Transit schedules
    - 2019 National Transit Database
    - 2018-2020 Odometer Readings from Illinois EPA/DMV
- **Target Audience:** Planners, housing professionals, and policy makers
- **Purpose:** To measure housing affordability accounting for transportation costs
- **Webpage:** Housing and Transportation Affordability Index

Tool Evaluation Methods

The H+T Index, shown in **Figure 8**, estimates a cumulative housing and transportation cost burden. The index considers housing to be affordable when the cost is 30 percent or less of household income, a threshold traditionally accepted by planners, lenders, and most consumers. Based on CNT's research in metro areas ranging from large cities with extensive transit to small metro areas with limited transit options, they "found 15 percent of income to be an attainable goal for transportation affordability." When "combining this 15 percent level with the 30 percent housing affordability standard, the H+T Index recommends a new view of affordability defined as combined housing and transportation costs consuming no more than 45 percent of household income" (*18*).

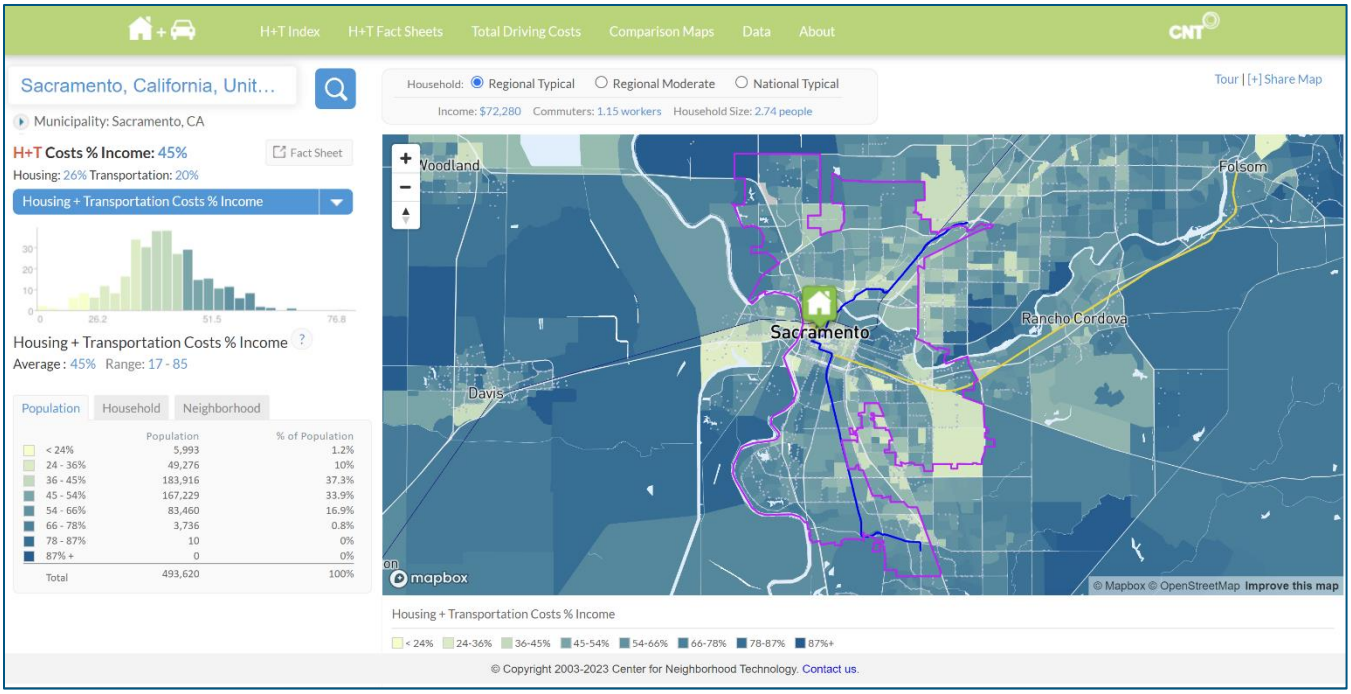

Figure 8. Housing and Transportation Affordability Index

As stated in the H+T methods document: "The H+T Index was constructed using the measured housing cost and the modeled transportation cost. The housing costs were obtained from the American Community Survey 5-year estimates (2019), [by combining] selected monthly ownership cost[s] and gross rent[s], [according to the] relative number of owner and renter occupied households. The transportation model, based on a multidimensional regression analysis, estimates three dependent variables (auto ownership, auto use, and transit use) as functions of 16 independent variables" (*18*). The 16 variables include items such as median household income, gross household density, employment intensity, bus transit connectivity index, and jobs within the transit access shed. The cost of fuel is indirectly included in the auto use variable using the Consumer Expenditure Survey.

The online tool allows users to search different areas by zip code or location name, and it shows the ranges of housing and transportation costs as a percentage of income by census tract. The H+T Index covers all census block groups in US states and the District of Columbia. The ranges of costs as a percentage of income include the following: <24%, 24-36%, 36-45%, 45-54%, 54-66%, 66-78%, 78-87%, and 87%+. The ranges are shown visually on the map with graduated colors. In addition to the combined housing and transportation affordability index, the housing affordability and transportation affordability indices can be viewed separately. The input variables can also be viewed separately and are organized in the following categories: household model outputs, greenhouse gas from household auto use, composite neighborhood scores, environmental characteristics, household characteristics, and housing costs. Other H+T measures that can be viewed include transit access, VMT, auto ownership, and more. Users can see how costs vary by household income and size for three different household types (regional typical, regional moderate, national typical). An overview of the input zip code or location can be viewed and printed by selecting the "Fact Sheet" button next to the "H+T Costs %

Income" overview. The Fact Sheet includes all the metrics that could be selected from the tool's dropdown menu in a downloadable PDF format.

Evaluation of Tool

The H+T Affordability Index tool focuses on the burden of housing and transportation costs. Additionally, it includes a few accessibility metrics such as access to jobs and transit access sheds. The visualization is easy to understand for a first-time user, and it is clear what the tool is evaluating.

The H+T Affordability Index tool provides comparative visualization for the combination of housing and transportation costs that makes it easy to identify affordable and unaffordable areas in specific zip codes or cities. Additionally, the downloadable Fact Sheet is an easy way to view all the metrics in list form and would be easy to add to a report. Though this tool does an effective job of depicting areas burdened by high combined costs of transportation and housing, there is no layer designating census tracts as disadvantaged. With the index alone, some wealthy areas show a high index of housing and transportation costs, which could be misleading to a user who was not familiar with an area or did not also check the median income layer, which cannot be viewed at the same time as the H+T index layer. The tool does not include data over various points in time that would allow users to see how housing and transportation costs have changed. However, in the download feature, the data can be downloaded from 2020 and 2019, as well as the previous 2016 update where 2015 data was used. Another potential barrier of the tool is the potential difficulty for a user to understand some of the scores, such as the job access score, without looking into the technical documentation. Finally, the tool uses eight different percentile ranges, which causes the colors to be more difficult to distinguish from one another than colors separated into quintiles.

Overall, this tool is useful for understanding the housing and transportation affordability patterns in an area. However, because no layer specifically designates disadvantaged census tracts, it would be difficult to make decisions about equity using this tool alone.

Caltrans Transportation Equity Index

Information

- **Author**: California Department of Transportation (Caltrans)
- **Data Year(s):**
    - 2020 Census blocks
    - 2020 ACS 5-Year Estimates
    - Highway Performance Monitoring System (HPMS), no year specified
    - Most-recent five years of data from Transportation Injury Mapping System (TIMS)
- **Target Audience:** California Department of Transportation (Caltrans)

- **Purpose:** To identify priority populations that would allow the department to address and mitigate transportation inequities.

Webpage: Caltrans Transportation Equity Index

Tool Evaluation Methods

The EQI, shown in **Figure 9**, evaluates place-based equity by creating three indicator data sets: demographic indicators, traffic exposure indicators, and access to destination indicators. These indicators were used to create "screens," or screening thresholds to determine equity priority areas as visualized in the web-based map. The three distinct screens are the Traffic Exposure Screen, Access to Destinations Screen, and the Priority Populations Screen. Each screen serves a different use, and all three screening scenarios include demographic indicators of low-income status and race/ethnicity as a "demographic overlay." The relationship between the EQI's indicators, demographic data, and the three screening scenarios are shown in **Figure 10,** extracted from the EQI Documentation (*38*). As stated in the EQI Documentation, "a census block group is designated as a 'low-income' community if either (1) its median household income is at or below 80% of the statewide median household income, or (2) its median household income is at or below the 2022 county low-income limit established by the California Department of Housing and Community Development" (*38*). The blocks were included for further analysis if the income level or the race/ethnicity criteria was met. Additionally, according to the EQI Documentation, "the 2020 ACS data and 2020 Decennial Census data was used to determine whether a block's population was greater than the statewide non-white population percentage (63.4902%). If the percentage of non-white population was greater than or equal to this value, the block was screened for inclusion for the demographic overlay" (*38*).

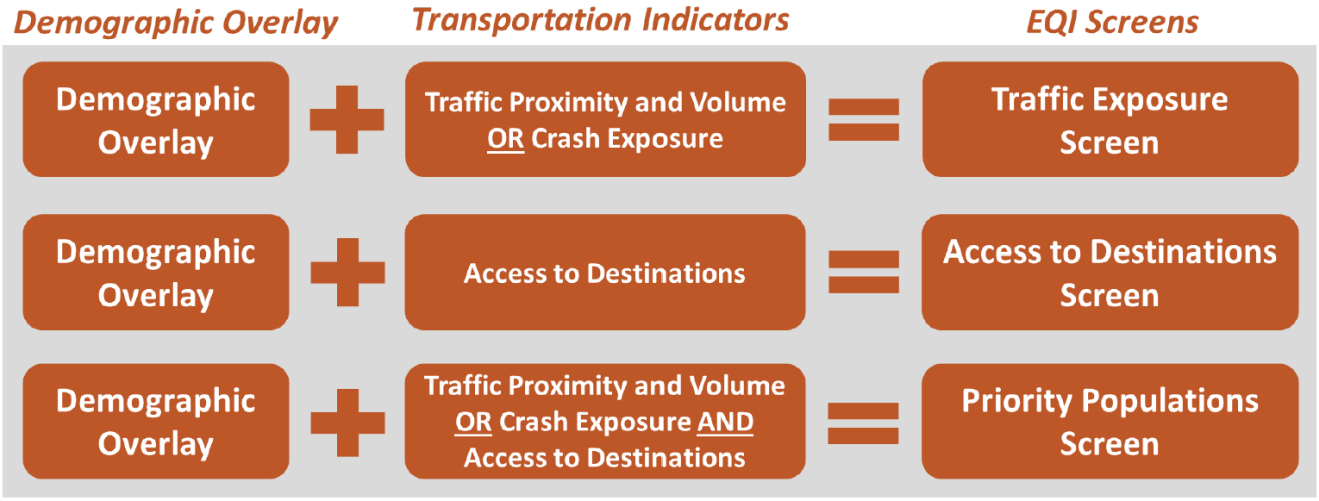

Figure 9. Caltrans EQI Indicators and Screens

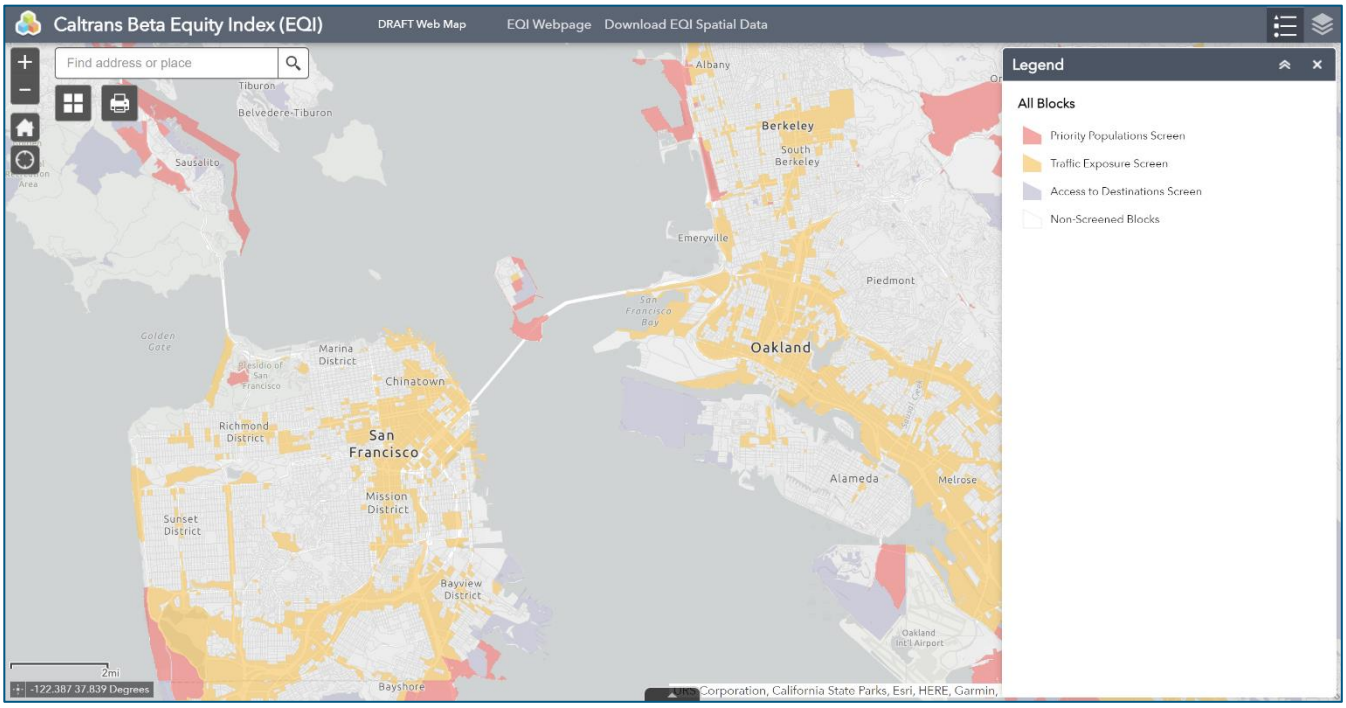

Figure 10. Caltrans Equity Index (Source: (38))

The Traffic Exposure Screen "identifies census blocks for inclusion if the traffic proximity and volume are at or above the 80th percentile for the state, or if the crash exposure score is at or above the 80th percentile for the state" (*38*). The Access to Destinations Screen "identifies census blocks with poor relative multimodal access to destinations" (*38*). Caltrans calculated access to destinations as "the ratio of transit and walking access to destinations compared to auto access to destinations" (*38*). Additionally, the EQI Documentation states that "blocks having a score equal to or less than 0.12 were identified as having poor relative multimodal access to destinations and are included in the screen" (*38*). However, this may be an error in documentation and should be 0.20, as this is consistent with the other thresholds identifying blocks in the 80th percentile or greater for the associated burdens. Also of note for the accessibility analysis, Caltrans ran separate analyses for both work and non-work destinations. If a block met the threshold for either destination type, it was included in the screen. Finally, "the Priority Populations Screen includes both the Traffic Exposure and the Access to Destinations Screens and identifies the priority populations of the state that are the most burdened by traffic exposure and that benefit the least from the multimodal transportation network" (*38*).

The tool is an online ArcGIS map, with the legend showing census blocks within the Priority Populations Screen as red, Traffic Exposure Screen as yellow, and Access to Destinations Screen as gray. Users can click on individual blocks to view various statistics such as median household income, average household size, crash exposure percentile, traffic proximity and volume percentile, work access to destinations ratio, and non-work access to destinations ratio.

Evaluation of Tool

The Caltrans EQI focuses on transportation burdens caused by traffic exposure (traffic crashes, traffic noise, and pollution) and a disproportionately low benefit of accessibility.

A strength of the Caltrans EQI is that the Traffic Exposure Screen does not focus only on crash exposure, but also includes measurements for traffic proximity and volume from the highway system and arterial roads in the state. As stated in the EQI technical documentation, "traffic exposure is used as a proxy for multiple environmental burdens, including diesel particulate matter, diesel exhaust, noise, and traffic safety impacts on communities" (*38*). An additional strength of the EQI is the simplicity that the calculated index can provide to Caltrans employees who need to quickly identify census blocks that are the most impacted by the current transportation system. While other tools may contain more individual indicators to view separately, this tool achieves its goal for its target audience by visually highlighting communities that are disproportionately burdened.

To increase the clarity of the EQI, the tool should emphasize that the Priority Populations Screen may be the most important screen to its users, as the Access to Destinations Screen in some cases highlights blocks that have high median household incomes compared to the listed income threshold. These areas are highlighted due to having less access to multimodal transportation options. However, the higher income blocks indicate that they are not being disproportionately burdened by poor access to opportunities such as jobs. Additionally, the Access to Destinations Screen is calculated as the ratio of transit and walking access to destinations compared to auto access to destinations. Additionally, it is not clear what types of destinations are considered. The technical documentation lists work and non-work destinations, but it would be more informative if the tool or documentation described these destinations in more detail. Since the Priority Populations Screen includes both the Traffic Exposure and the Access to Destinations Screens and identifies the priority populations of the state that are the most burdened by traffic exposure and that benefit the least from the multimodal transportation network, it may make more sense to highlight only this Screen.

The tool has the potential to aid Caltrans employees in easily identifying communities that are disproportionately impacted by transportation burdens. However, an obstacle of the tool is that unless someone reads the technical documentation, it is unclear by the name of the Access to Destinations Screen what is being measured (poor relative multimodal access to destinations). It could be more helpful for Caltrans employees if the tool included a layer to view the locations of future projects, as projects are planned years in advance and disparities in future projects may be mitigated by the use of this tool.

Though the tool is still in its testing phase as of this writing, and therefore does not include data over various points in time, it would be useful for the tool to track changes in census tracts that are designated under the Priority Populations Screen.

California Transportation Disparities Mapping Tool

Information

- **Author:** UCLA Center for Neighborhood Knowledge
- **Data Year(s):** Varies based on dataset 2014-2022
- **Target Audience:** Decision makers, public agencies, community groups
- **Purpose:** To contribute to the California Air Resources Board's (CARB) equity work by supporting equitable implementation of the Global Warming Solutions Act of 2006 (AB 32)
- **Webpage:** California Transportation Disparities Mapping Tool

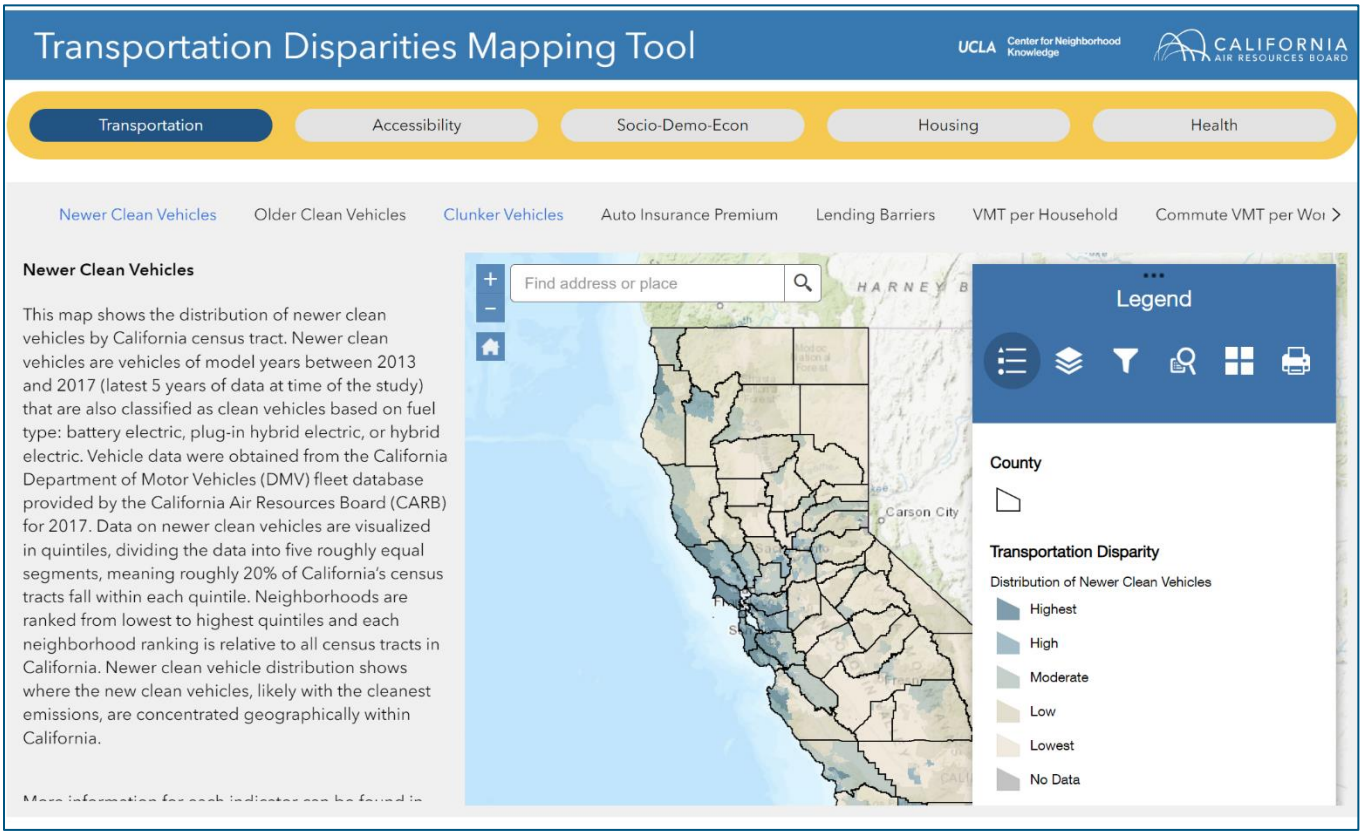

Figure 11. Transportation Disparities Mapping Tool

Tool Evaluation Methods

The Transportation Disparities Mapping Tool, shown in **Figure 11**, contains 40 indicators, each shown separately in the tool. Of the 40 indicators, 17 were created by the UCLA Center for Neighborhood Knowledge (CNK), and 13 were constructed specifically for this project. The 23 indicators that were not created by CNK are from other sources (*22*).

The 40 indicators are all separately reported as decile rankings or numerical values. The indicators that are reported in decile rankings are visualized in the tool as quintiles. However, there are certain indicators where the observations could not be evenly distributed into deciles due to clusters of observations at the top or bottom. In these cases, some of the indicators are reported as rankings. As stated in the report associated with this tool, the following categories are used to group indicators: "(1) 'Transportation' refers to vehicle-related characteristics; (2) 'Accessibility' refers to spatial access to opportunities and amenities; (3) 'Housing' refers to the characteristics of the housing stock and inhabitants; (4) 'Socio-Demo-Economic' refers to social, demographic, and economic characteristics of the population; and (5) 'Health' refers to the health-related characteristics of the population or neighborhood" (*22*).

The tool contains an option on each separate indicator map to view Senate Bill (SB) SB 535 disadvantaged communities. These are census tracts that are designated as disadvantaged according to SB 535, which required the state to identify disadvantaged communities for funding prioritization from the Greenhouse Gas Reduction Fund. Under SB 535, disadvantaged communities are defined as: "1) Census tracts receiving the highest 25 percent of overall scores in CalEnviroScreen 4.0, 2) Census tracts lacking overall scores in CalEnviroScreen 4.0 due to data gaps, but receiving the highest 5 percent of CalEnviroScreen 4.0 cumulative pollution burden scores, 3) Census tracts identified in the 2017 DAC designation as disadvantaged, regardless of their scores in CalEnviroScreen 4.0, [or] 4) Lands under the control of federally recognized Tribes" *(39)*.

We also performed a distributional analysis to identify trends and patterns in transportation disparities among different neighborhoods (defined as census tracts; the two terms are used interchangeably). To accomplish this, the team used census tract median incomes relative to the regional average, and then compared lower-income neighborhoods with wealthier ones (*22*). This distributional analysis was done with just a portion of the indicators included in the tool, to provide an example of one way interested parties could use the data contained within the tool.

Evaluation of Tool

The Transportation Disparities Mapping Tool includes 40 indicators that it describes as "being associated with the causes, characteristics, and consequences of transportation access disparity based on existing literature and previous research" (*22*).

The tool includes a wide variety of indicators containing both benefits and burdens of transportation. Rather than including only a subset of census tracts, the tool displays all census tracts across the state of California and displays each of the indicators ranked visually by quintiles. It is clear what each map in the tool is evaluating and the visualization is also clear.

Though the tool contains a multitude of informational layers, a difficulty that users may face is that each map layer is on a different tab and must be viewed separately, making it difficult to understand how the different indicators may relate to each other or interact. Additionally, although there are indicators of current housing conditions, there are no forecasting indicators such as displacement and gentrification indicators (*6*). The tool

does not display data over different years, which could be helpful in tracking changes in any of the indicators over time.

The tool is useful for informational purposes for the various indicators. However, transportation professionals would likely find it difficult to synthesize and make decisions based on multiple indicators as they are each displayed on a different map.

IDOT Community Impact Assessment Screener

Information

- **Author:** Center for Neighborhood Technology
- **Data Year(s):** 2017-2021 ACS 5-Year Estimates
- **Target Audience:** Transportation professionals
- **Purpose:** The purpose of the IDOT Community Impact Assessment Screener is to aid in the process of community impact assessment for transportation projects, which is a step in the environmental review process to ensure that community input is considered.
- **Webpage:** IDOT Community Impact Assessment Screener

Tool Evaluation Methods

The Screener, shown in **Figure 12**, is a tool with both quantitative and qualitative components to help transportation professionals determine whether a community impact assessment is justified for a project. The quantitative component consists of sociodemographic data from the American Community Survey. The qualitative component consists of prompts to examine key community resources, displacement potential, complex community impacts, and community engagement processes that result from a project implementation process.

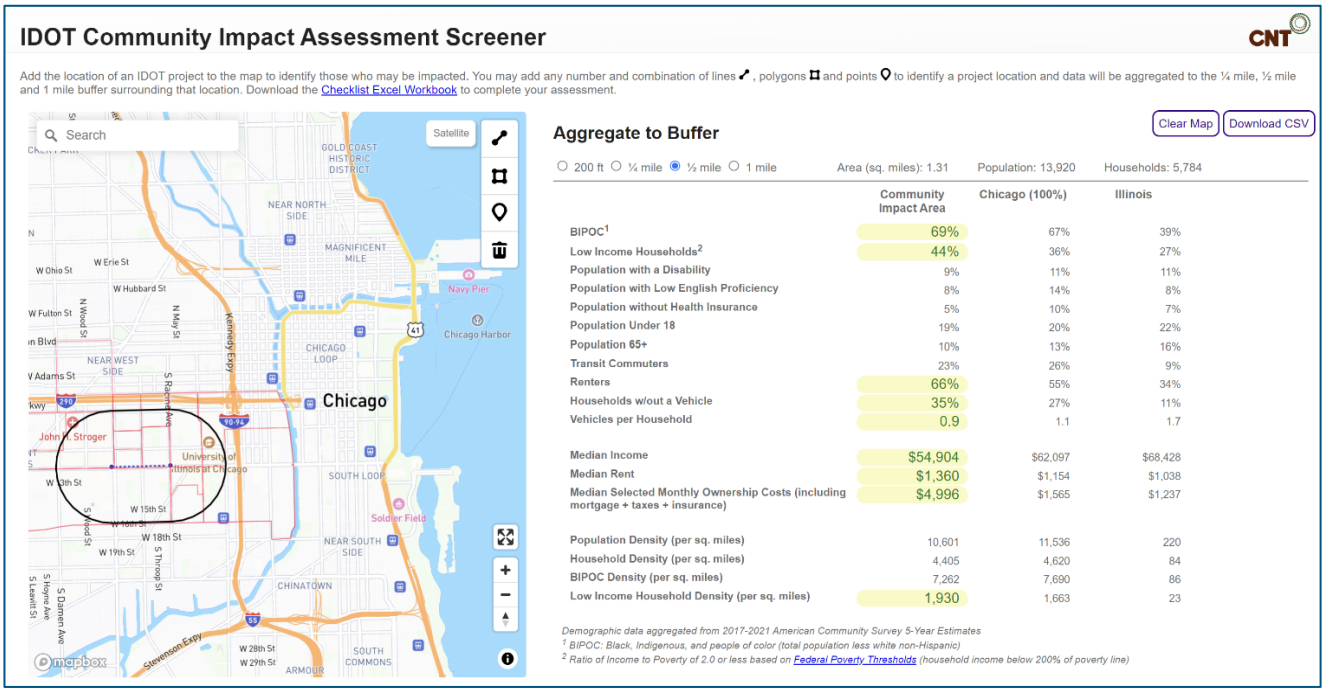

Figure 12. IDOT Community Impact Assessment Screener

The IDOT Community Impact Assessment Screener uses lines, polygons, and points to identify a project location and aggregate the quantitative data to the ¼ mile, ½ mile and 1 mile buffer surrounding that location. After a project location is chosen, an Excel spreadsheet may be downloaded that shows how the percentages of each of the metrics compares to the County of the project location, and the state of Illinois. The demographic data is aggregated from the 2017-2021 American Community Survey 5-Year Estimates. Low-income households are defined as having a ratio of income to poverty of 2.0 or less based on federal poverty thresholds (household income below 200% of poverty line). The Excel workbook includes "Quantitative," "Qualitative," "Engagement," and "Review of Results" tabs for users to fill in to determine whether a community impact assessment is necessary.

Evaluation of Tool

The IDOT Community Impact Assessment Screener focuses primarily on neighborhood characteristics and sociodemographic data. A line, polygon, or point can be placed on the map at a project location and then an

Excel spreadsheet can be downloaded that shows how the area compares to the county and state in the listed metrics. This process is clear and user-friendly for a first-time user, and the provided data is easy to understand.

The study authors who developed the IDOT Community Impact Assessment Screener proposed that the tool become a step in the environmental review process to ensure that community input is considered. The tool being a required part of the planning process in the transportation industry in Illinois would allow it to have a greater impact than other tools that exist outside of the transportation decision-making process. The impact of tools that exist outside of the decision-making process requires transportation professionals to have a prior awareness of and willingness to use them. Another strength of the IDOT Community Impact Assessment Screener is its qualitative component, which assesses community involvement and distinguishes it from all other tools examined in this study.

The tool, while providing useful information, does not include a variety of transportation burdens or benefits, as it focuses primarily on sociodemographic information. It does, however, include a few neighborhood metrics such as median rent, household density, and low-income household density. Additionally, the tool includes only one metric under the travel patterns category—transit users. While it is important to understand how many people are using transit in an area, measuring vehicle use could help to indicate areas where multimodal options are not available, and could aid in planning for more sustainable transportation options.

FDOT Environmental Screening Tool

Information

- **Author:** Florida Department of Transportation (FDOT)
- **Data Year(s):**
    - Project Data: 2023
    - Supplemental layers: varies by layer
- **Target Audience:** Transportation professionals, Environmental Technical Advisory Team (representatives from MPOs/TPOs, federal and state agencies, and participating Native American Tribes)
- **Purpose:** The Florida Department of Transportation (FDOT) Environmental Screening Tool (EST) was created to carry out FDOT's Efficient Transportation Decision Making (ETDM) process. The ETDM process was "developed in response to Congress' Environmental Streamlining initiative" (*25*).
- **Webpage:** FDOT Environmental Screening Tool

Tool Evaluation Methods

As stated on FDOT's Office of Environmental Management EST Overview webpage, the "EST is a geo-relational database of ETDM projects, over 550 environmental resource GIS data layers, an automated and standardized

GIS-based environmental screening analysis application, and numerous tools for data entry, review, and reporting throughout the ETDM Process" (*25*).

The EST is used throughout the ETDM Process, and one of the groups that uses the tool to identify potential project effects is the Environmental Technical Advisory Team (ETAT). The ETAT is a group of members from MPOs/TPOs, federal and state agencies, and participating Native American Tribes (*40*). There is a different ETAT for each FDOT district in the state (*40*). However, it is unclear from the ETDM manual how this group is selected. The ETAT also uses the EST to make comments on projects and submit them to the project sponsors during the planning stage. The EST provides access for ETAT members to view project information and "data about natural, physical, social, and cultural resources in the project area" (*40*). The ETDM Overview PDF that can be found on the tool's website states, "ETDM projects may originate from a variety of FDOT, MPO/TPO, or local government programs and plans. The project sponsor (FDOT or MPO/TPO) selects qualifying projects and then enters project information into the EST" (*41*). The comments and other project information are made available to the public on the ETDM Public Access Site.

As stated in the ETDM Manual, the Planning Screen segment of the ETDM process integrates federal directives regarding environmental streamlining (*40*). This establishes a link between the Transportation Planning phase and the Project Development and Environment (PD&E) phase by "giving early consideration to natural, physical, social, and cultural resources" (*40*). Additionally, the ETDM Manual states, "the Planning Screen reviews help to:

- Consider the feasibility of proposed projects.
- Focus topics to be addressed during the Programming Screen.
- Allow for early identification of potential avoidance, minimization, and mitigation opportunities.
- Identify potential direct and indirect effects on communities through information gathering, analysis, and consideration of sociocultural effects.
- Generate documentation and support information which may be carried forward into subsequent project phases" (*40*).

Based on this description, it seems that for any equity concerns to be considered, they would have to be part of the Planning phase of the ETDM. Our overview of the ETDM process also indicates that the ETAT members are crucial to considering equity concerns in the early phases of a project.

A diagram of the Planning Screen and the Programming Screen is shown in **Figure 13** (*41*). The EDTM process occurs throughout both Screens. The Planning Screen of a project occurs when the projects are being considered for inclusion in a Long Range Transportation Plan (LRTP). Whereas "the Programming Screen occurs during the development of the FDOT Five Year Work Program" (*41*).

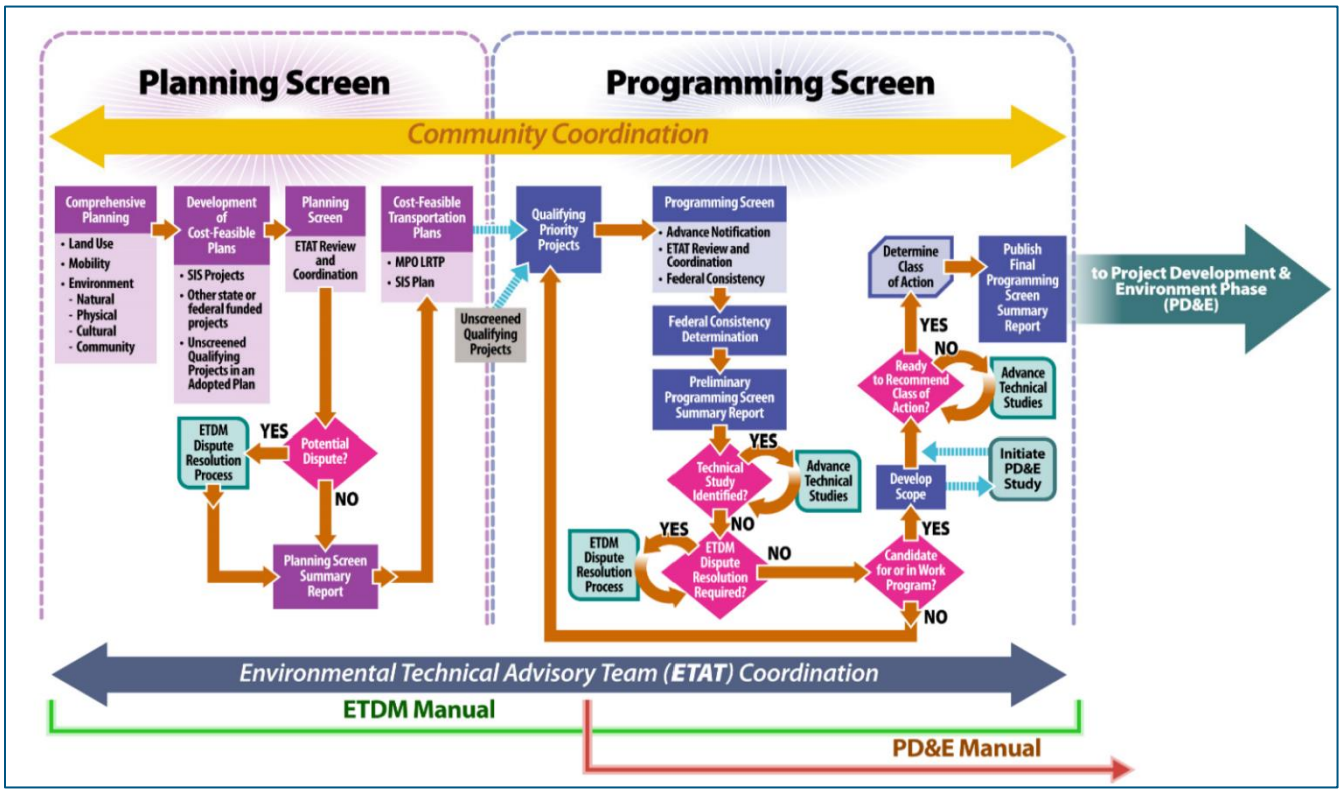

Figure 13. Diagram of ETDM Process (Source: (40))

Part of the EST includes an interactive map, shown in **Figure 14**. Current and planned projects are all automatically displayed when first opening the map. Many layers of information can be toggled on and viewed along with the projects layer. The categories for the layers include the following: social and economic, cultural and tribal, natural, physical, special designations, administrative/boundaries, and resilience. Though the EST does not specifically evaluate transportation equity, it does include layers for Justice40 and indigenous land in the interactive map portion.

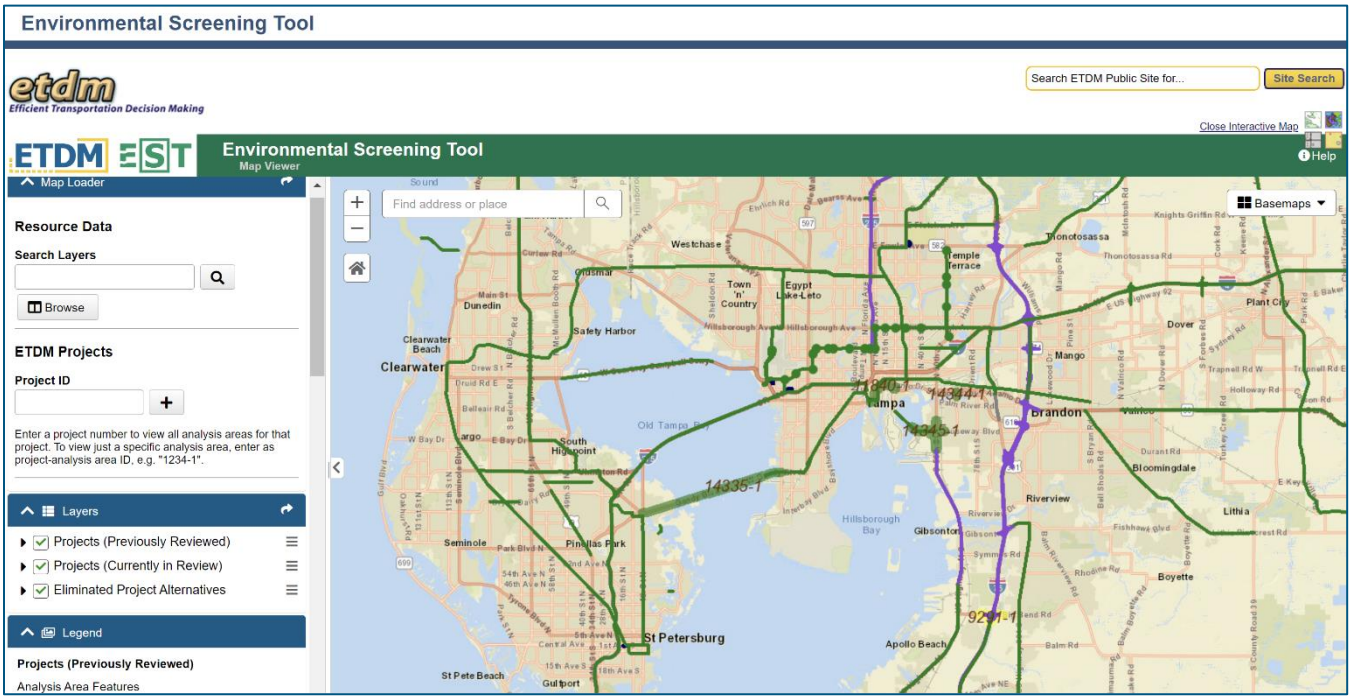

Figure 14. FDOT Environmental Screening Tool Interactive Map

Evaluation of Tool

Overall, the goal of the EST is to carry out FDOT's ETDM Process, and does not specifically evaluate equity. However, a strength of the EST is that by being a required part of the transportation planning process, it has the opportunity to make an impact by forcing every transportation project to undergo this process. The tool is also one of the few that we evaluated that shows locations for current and future transportation investments. Additionally, the comments by the ETAT and other information are made available to the public on the ETDM Public Access Site.

An assessment of equity for a given project would require the ETAT team to add the appropriate layers on the interactive map to view and assess equity impacts of a given project. The tool provides layers that can be toggled on, which provide a wide range of information. However, these layers do not include any measures of access or travel patterns. It also seems that in the ETDM process, it is up to the ETAT to make decisions or comments about equity, and it is not clear from the documentation how members of the ETAT are chosen. The focus of the ETAT team may end up not being transportation equity at all, as this is not listed as one of the specific the goals of the tool.

Though this tool is useful and has some strengths, it is not very user-friendly. Though a lot of information is publicly available, the tool's lack of user-friendliness would act as a barrier to many. There is no technical documentation associated with the tool; there is just the ETDM Manual which provides detail about the Efficient Transportation Decision Making process as a whole, but not about the EST. Additionally, the

interactive map is not in an obvious place on the homepage, and therefore could be easily missed. In this study, we were only able to access the EST from the public perspective and were therefore not able to evaluate this tool from the perspective of the ETAT making equity-based decisions or comments. Another limitation of this tool is that it is difficult to tell what the various projects shown on the initial view of the map are (bridge, highway, active transportation, transit, etc.), as the legend only designates them in terms of where they fall in the review process. Overall, it would be difficult to make decisions about equity based on this tool alone.

Active Transportation Database

Information

- **Author:** Southern California Association of Governments (SCAG)
- **Data Year(s):**
    - Count data: Varies by location
    - Supplemental layers: Varies by layer
- **Target Audience:** Transportation professionals
- **Purpose:** Identify active transportation counts for infrastructure and planning projects in the SCAG region.
- **Webpage:** Active Transportation Database

Tool Evaluation Methods

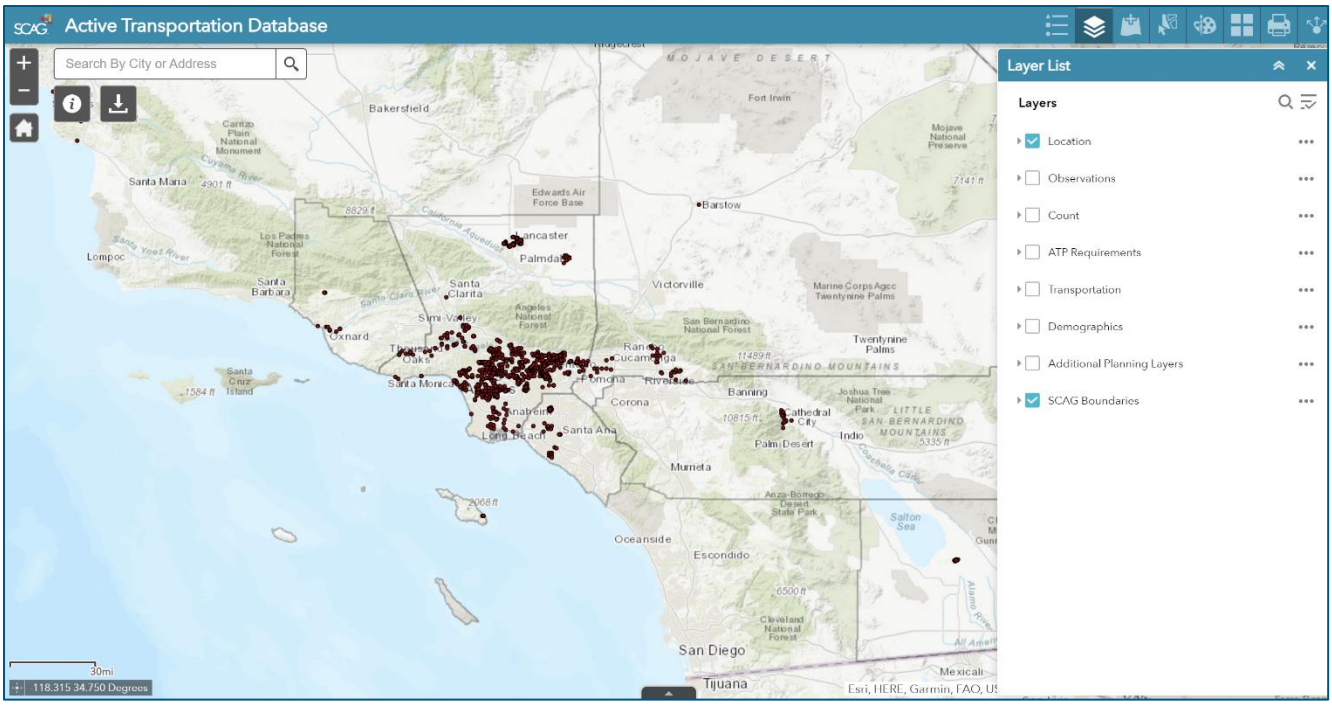

Figure 15. Active Transportation Database

The Active Transportation Database, shown in **Figure 15**, does not assess equity specifically and does not use the included data sets to perform analysis. However, it includes many informative layers, some of which highlight disadvantaged communities, such as Environmental Justice Areas, Communities of Concern, and CalEnviroScreen 3.0 Scores by Census Tract. The database also includes layers in other categories such as access, infrastructure, and other demographic information that can be viewed together with the count data.

Evaluation of Tool

The goal of the Active Transportation Database is "to store bicycle, pedestrian, wheelchair, and scooter/skateboard counts for infrastructure planning projects across Southern California. It is also designed to assist in planning and data analysis efforts for active transportation programs and projects." (*27*). Although the tool is not designed to specifically assess equity, it incorporates equity-focused layers into its database. It provides options to overlay various layers including EJ areas, Communities of Concern, and CalEnviroScreen 3.0 Scores by Census Tract. Additionally, the tool depicts burdens using the following layers: CalEnviroScreen 3.0 Scores by Census Tract, Environmental Justice Areas, Healthy Places Index total percentile ranking, Traffic Density, and Tree Canopy Coverage. Another strength of this tool is that in addition to showing count locations, it also has the option to turn on a layer for proposed bikeways by class. It would be possible for a user to view proposed bikeways by class while also viewing a layer for disadvantaged communities, and therefore view any disparity of investment into active transportation infrastructure that may exist.

While this tool has the potential to aid active transportation planners in making equitable decisions, there is no obvious signal to users that this should be considered. Additionally, the tool does not include any temporal component other than showing planned projects and dates associated with various counts. Users cannot see the dates of the counts unless they click on each one individually, making it difficult to assess whether some counts may be out of date.

With all of the informational layers available, staff working on active transportation projects could make decisions about equity using this tool. However, as noted above, if there is no signal or directive for staff to use the informational equity layers within the database, they may not know to use them.

TransitCenter Equity Dashboard

Information

- **Author:** TransitCenter
- **Data Year(s):** February 2020 – August 2022
- **Target Audience:** Transit practitioners, policy makers, and advocates
- **Purpose:** The purpose of the TransitCenter Equity Dashboard is "to provide indicators of public transit system performance via a publicly available web dashboard." (*29*) "The dashboard aims to help transit practitioners, policymakers, and advocates make more informed and equitable decisions by providing clear metrics about disparities in transit access and demonstrating how changes to transit networks affect those gaps." (*30*)
- **Webpage:** TransitCenter Equity Dashboard

Tool Evaluation Methods

The primary aim of the TransitCenter Equity dashboard is to "track the equity of transit service over time in seven US cities" (*29*), which are Boston, Chicago, Los Angeles (LA), New York, Philadelphia, San Francisco-Oakland, and Washington, DC. This tool offers visual representations and evaluations of transit-focused metrics such as changes in accessibility, transit service intensity, and transit reliability (delay) (*29*). The tool also "evaluates transit accessibility measures relative to car access to provide an indication of differences in access for different mode users" (*29*).

Each of the seven US regions has three options for users to click on via the landing page as shown in **Figure 16**: Story, Map, and Data. **Table 3**, extracted from the TransitCenter Equity Dashboard: Technical Documentation (*29*), shows the parameters that can be used to modify the map. The dashboard's Story page includes equity indicators, including population-weighted accessibility and transit service intensity for people of color (based on race and ethnicity), people from households living below the poverty level, essential workers at their place of residence, and female single-parent households. The location of each of these populations is also available as

a demographic overlay in the map view by displaying a dot for every 100 people of the chosen demographic group. The analysis boundaries that can be selected include metropolitan statistical areas (MSA), economic activity regions, urban cores, and equity neighborhoods. As stated in the Technical Documentation, "equity neighborhoods are areas that local transit advocates and TransitCenter identified as meriting additional resources for transit improvements due to past disinvestments or marginalization in planning decisions" (*29*), which are based on existing databases or definitions, with the exception of one that was based on qualitative local knowledge. Because each region varied in how they identified equity neighborhoods, the thresholds cannot be easily compared between regions. For example, the highlighted Equity Neighborhoods in LA were defined by LA Metro's definition for Equity Focus Communities, and can be seen in **Figure 17**.

Each access to opportunity metric is disaggregated by race, income, and other socioeconomic characteristics that are shown on the Story page. Each of the access metrics is evaluated in each region for multiple time periods (weekday morning peak, weekday evening, weekend morning), travel modes (fare-constrained transit, fare-unconstrained transit, auto), and dates (monthly from February 2020 through February 2021, periodically from February 2021 onward).

This tool defines people living in poverty as those whose household incomes are below the federal poverty line, according to the 2018 five-year U.S. Census American Community Survey. Jobs with low wages pay no more than $12,500 in annual wages, according to 2017 U.S. Census Longitudinal Employer-Household Dynamics data.

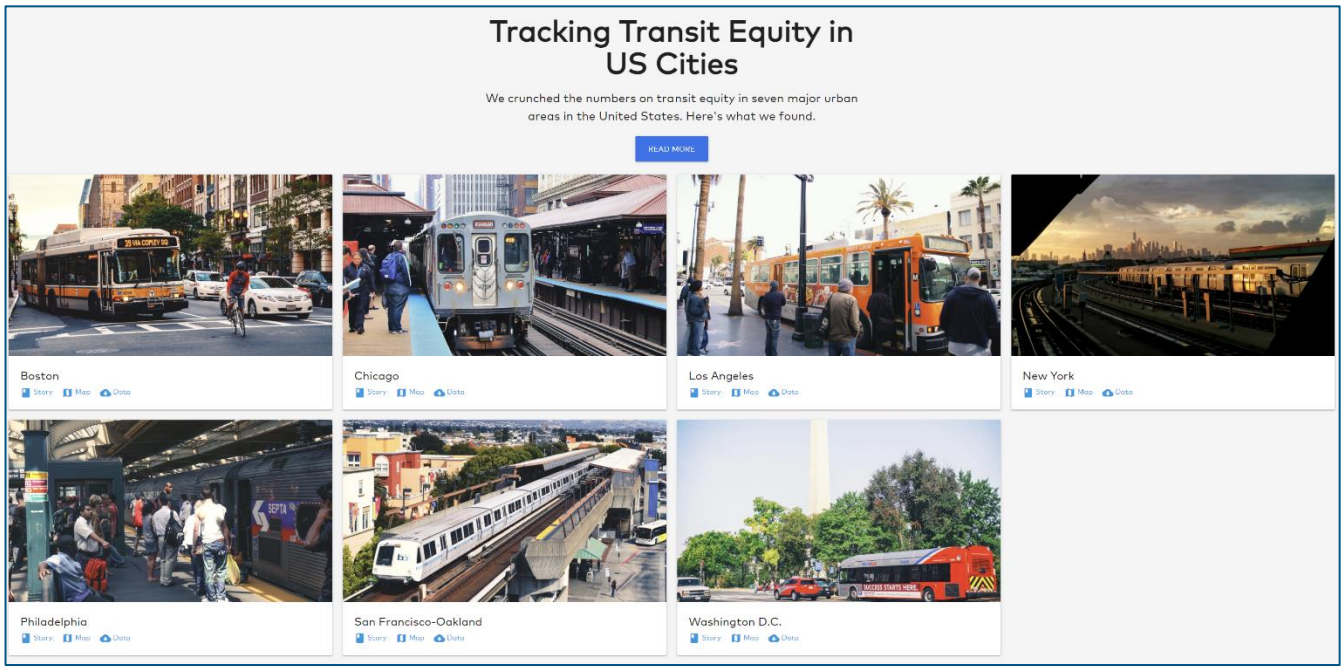

Figure 16. TransitCenter Equity Dashboard

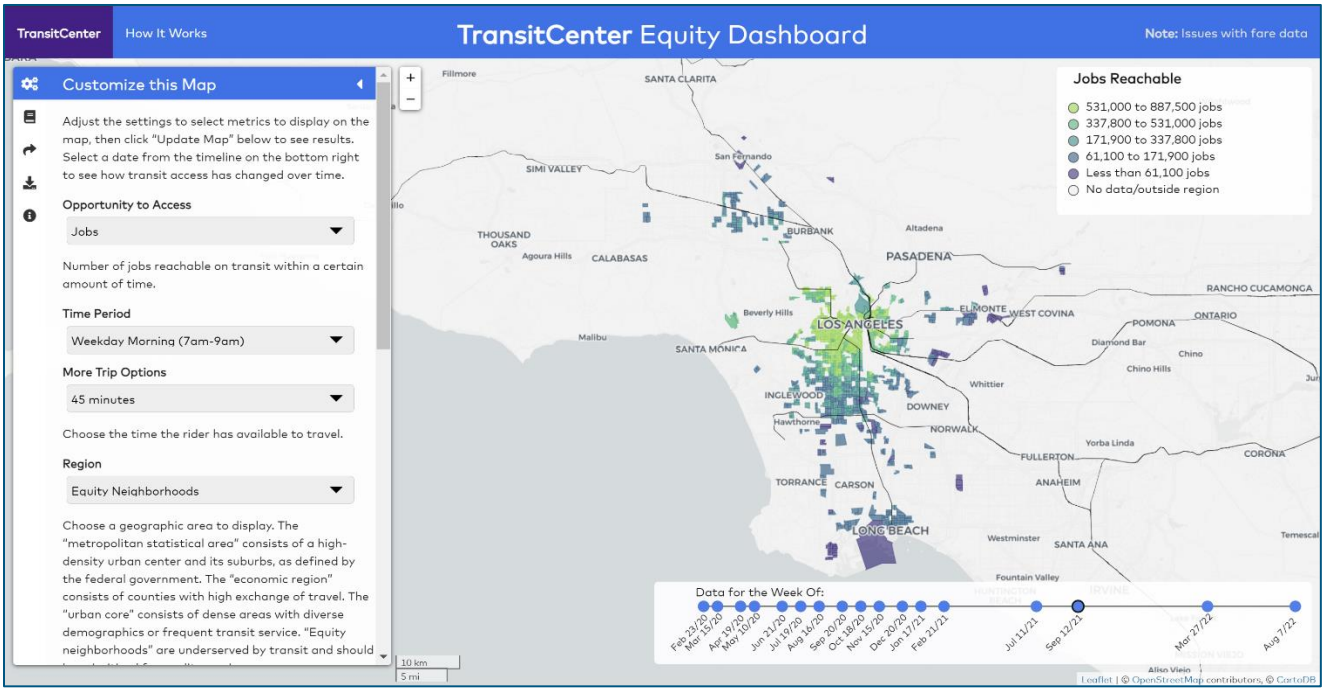

Figure 17. TransitCenter Equity Dashboard – Map Example

Table 3. Transit Center dashboard map parameters and user options (Source: (*29*))

Parameter		Options	
Analysis boundary		metropolitan statistical area (MSA) economic activity region urban core equity neighborhoods	
Performance measure	Accessibility	Travel mode	transit ratio of transit to auto
		Destination type	jobs low-wage jobs grocery stores and supermarkets hospitals urgent care pharmacies parks and greenspace colleges and universities transit service intensity

Parameter		Options	
		Measure type	Depends on destination type: cumulative opportunities in X minutes minimum time to reach X facilities gravity measure (data download only)
		Fare	Fare limited No fare limit
		Time of day/week	weekday morning (7 to 9 am) weekday night (10 pm to 12 am) weekend day (Saturday 10 am to 12 pm)
	Equity	Population overlay	Asian and Pacific Islander Black Hispanic/Latinx White Living at or below poverty level Essential workers (at their place of residence) Single-mother households No car households
Date slider		~monthly 2/20 to 2/21, less frequently 2/21 onward	
Units		Percentiles Transit: Auto ratio	

Evaluation of Tool

This tool focuses primarily on transportation benefits, by showing the opportunities to access various destinations. These destinations include jobs, low-wage jobs, parks, grocery stores, hospitals, urgent care facilities, pharmacies, colleges and universities, and transit service. This is the only tool reviewed in this study that has the advantage of distinguishing between jobs and low-wage jobs. Another strength of this tool is a temporal component, so that opportunities to access these various destinations can be viewed and compared between February 2020 and August 2022, as more data is added to the tool.

Though this tool includes many strengths, a few areas for potential improvement were noted. While there is an option to show a dot-density map for racial groups (100 dots per person), there is no layer on the dashboard to indicate disadvantaged communities. There is also a demographic option to show a dot for every 50 essential workers, single-mother households, and no-car households. This could be useful to view densities of low-income areas, or areas that show a racial disparity among the opportunities available, but it could also be more difficult to make decisions about which communities or census tracts to invest in as it is difficult to highlight or designate specific areas. Additionally, the dots are small and difficult to see in some cases, especially when overlayed on the darker areas which show fewer opportunities available. The different demographic groups

also must be viewed individually, so it is difficult to understand any relationships that exist between the different demographic options such as people living below the poverty line and any particular race or ethnicity.

Another limitation of this tool is that it only has maps available for the seven cities that are shown on its homepage. However, the Python scripts that they used to create their maps are available for download, so that the analysis can be re-created for any city. While this could be useful to many cities or agencies, it could be a barrier to smaller cities that do not have the staff resources for this type of effort.

Additionally, the tool could readily assist in making decisions regarding public transit. However, it would be difficult to make decisions about other modes of transportation.

Caltrans Smart Mobility Calculator

Information

- **Author:** California Department of Transportation (Caltrans)
- **Data Year(s):**
    - EPA Smart Location Mapping dataset: 2014-2018 ACS 5 Year Estimates
    - 2017 Employment Data
    - 2018 Protected Areas Database
    - 2020 GTFS Data
    - HUD Location Affordability Index: 2012-2016 ACS Data
- **Target Audience:** Practitioners and researchers
- **Purpose:** "To help practitioners and researchers meet planning and design challenges related to corridors, station areas, and complete streets, climate action planning and providing affordable housing near transit in support of active and sustainable travel" (*32*).
- **Webpage:** Caltrans Smart Mobility Calculator

Tool Evaluation Methods

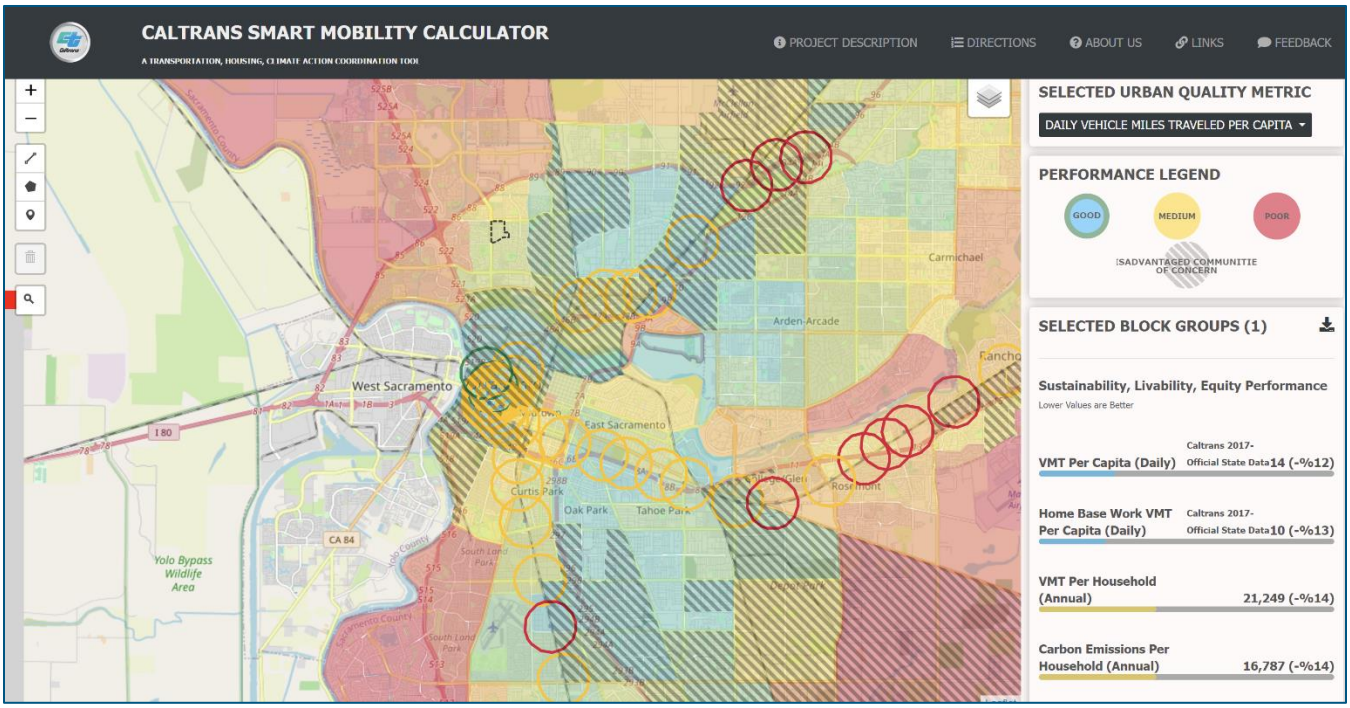

Figure 18. Caltrans Smart Mobility Calculator

The Smart Mobility Calculator, shown in **Figure 18** as stated under the project description, "builds on the work of The Handbook for Building Livable Transit Corridors and the associated Livability Calculator, sponsored by the National Academies of Sciences' Transportation Research Board" (*32*). The Handbook for Building Livable Transit Corridors offers a definition for transit corridor livability and offers a five-step process with methods, metrics, and strategies to enhance this livability (*42*). An associated Transit Livability Calculator is also available. The related research involved quantitative analysis of 350 U.S. transit corridors and qualitative analysis of 17 case study corridors to determine effective livability metrics and strategies (*42*). The data for the Caltrans Smart Mobility Calculator comes from the EPA Smart Location Mapping Dataset and the HUD Location Affordability Index.

The tool displays two categories of metrics: Sustainability/Livability/Equity Performance and Urban Form/Livability Opportunities. Lower scores are better for the Sustainability/Livability/Equity Performance metrics, whereas higher scores are better for the Urban Form/Livability Opportunities. These categories include multiple individual indicators related to vehicle miles traveled (VMT), emissions, housing and transportation affordability, health indicators, density, access, and walkability. Geographic areas (census block groups or transit catchment areas) are color coded according to performance on a selected indicator.

When opening the Calculator, users are instructed to select a state and a county within the state. As of this writing, only California and counties within the largest metro areas are available. The default layer visualized indicates average daily VMT per capita. Blue and green areas show low VMT per household, and red, orange,

and yellow areas show areas of higher VMT. Gray and white hatched areas highlight disadvantaged communities of concern overlayed on the colors. The layer in the tool for disadvantaged communities of concern is based on the definitions specified in Senate Bill (SB) 535. Other urban quality metrics can be selected from a dropdown menu and viewed on the map. A dashboard on the right side of the screen shows how metrics change as the mouse is hovered over different block groups, as well as the negative or positive percent difference compared to the regional average of the selected county. Circles on the map "show half mile catchment areas around transit stations using the high (green), medium (yellow), low (red) smart growth performance typology, based on a national study of urban quality of the National Academies (*43*)" (*32*).

Users can select multiple block groups for analysis using drawing tools for areas, polylines, and points, the last two of which select block groups within a half mile of the shape. A spreadsheet with the following metrics summarized for each census block group can then be downloaded: Home Base Work VMT per Capita, VMT per Household (Annual), Housing Affordability, Transportation Affordability, Cardiovascular Disease, Obesity, Population Density, Jobs Density, Dwelling Density, Jobs Accessible via Transit, Jobs Accessible via Auto, Pedestrian Environment (Walkability), and WalkScore.

Evaluation of Tool

The Caltrans Smart Mobility Calculator measures transportation benefits and burdens at the census block group level. Transportation benefits include accessibility metrics such as jobs density (jobs per acre), jobs accessibility by both automobile and transit, and walkability scores. Burdens include pedestrian collisions per 100,000 walkers, obesity, cardiovascular disease, housing affordability, and transportation affordability. The tool also measures travel outcomes such as annual carbon emissions per household, daily VMT per capita, and walk percent.

Although the color overlay can only display one metric at a time on the map, values and percentage difference from regional averages for all performance metrics can be viewed simultaneously on the dashboard on the right side of the screen. This is helpful for understanding how the metrics differ relative to each other. For example, in areas that transportation affordability decreases, the housing affordability may increase. Another strength of this tool is that video tutorials along with instructions are available under the Directions tab of the menu.

Several limitations were identified in the Caltrans Smart Mobility Calculator. The accessibility to jobs by both automobile and transit does not delineate the time shed that the jobs are available within. Additionally, the spreadsheet that can be downloaded with the metrics does not identify which tracts are disadvantaged. A practitioner would have to have the map tool open while looking at the spreadsheet, which could be a barrier in making decisions about equity. The tool is also limited to the following counties: Alameda, Contra Costa, Los Angeles, Orange, Sacramento, San Diego, San Francisco, San Mateo, and Santa Clara.

The goal of the tool is to help transportation practitioners and researchers meet a variety of planning and design challenges related to transportation, housing, and climate action coordination. Overall, the tool may be useful in making decisions related to these categories, but it may be difficult to make decisions specifically related to transportation equity, as the main indicator of disadvantaged communities is the thresholds under

SB 535, which focuses mainly on environmental burdens and does not take other benefits or burdens into account, such as access to opportunities or traffic impacts.

Sidewalk Explorer

Information

- **Author:** Champaign Urbana Urbanized Area Transportation Study (CUUATS)
- **Data Year(s):** 2015-2023
- **Target Audience:** Local agencies
- **Purpose:** To track sidewalk accessibility features to maintain compliance with the Americans with Disabilities Act (ADA)
- **Webpage:** Sidewalk Explorer

Tool Evaluation Methods

The Sidewalk Explorer tool uses Compliance Scores which are calculated with weighted criteria. The weights are assigned according to the importance of each component to overall accessibility (*33*). Each feature type (i.e. sidewalks, curb ramps, crosswalks, and pedestrian signals), has an overall Compliance Score, which is calculated using the assigned weights of each component of the features. The Compliance Scores of each component are then combined for the overall Compliance Score. For example, the Compliance Score for sidewalks considers the four following criteria representing the Public Right-of-Way Accessibility Guidelines (PROWAG) standards as shown in **Table 4,** extracted from the technical documentation (*33*). The Sidewalk Compliance Score uses equal weights for maximum cross slope, largest vertical fault, number of obstruction types, and sidewalk width, as the technical documentation states that "any of these factors could severely reduce the mobility and safety of individuals with disabilities" (*33*).

Table 4. Sidewalk Compliance Weights
Source: (*33*)

Variable	Weight
Maximum cross slope	25 %
Largest vertical fault	25 %
Number of obstruction types	25 %
Sidewalk width	25 %

The Curb Ramp Compliance Score includes 13 criteria based on Public Right-of-Way Accessibility Guidelines (PROWAG) standards which cover six categories as listed in **Table 5,** extracted from the technical

documentation (*33*). The Compliance Score for curb ramps was calculated by weighting the scores for compliance criteria as shown in **Table 5**.

Table 5. Curb Ramp Compliance Weights
Source: (*33*)

Variable	Weight
Ramp geometry	**25 %**
Ramp width	5 %
Ramp cross slope	10 %
Ramp running slope	10 %
Detectable warning surface	**15 %**
Detectable warning surface type	10 %
Detectable warning surface width	5 %
Gutter	**10 %**
Gutter cross slope	5 %
Gutter counter slope	5 %
Landing	**20 %**
Landing dimensions	10 %
Landing slope	10 %
Approaches and flares	**10 %**
Approach cross slope	5 %
Flare slope	5 %
Hazards	**20 %**
Vertical faults	10 %
Obstructions	10 %

The crosswalk Compliance Score includes two criteria based on PROWAG standards that are equally weighted in the calculation of the Compliance Score as shown **Table 6,** extracted from the technical documentation (*33*).

Table 6. Crosswalk Compliance Weights
Source: (*33*)

Variable	Weight
Crosswalk width	25 %
Cross slope	25 %

The pedestrian signals Compliance Score includes four ADA and Manual on Uniform Traffic Control Devices criteria that are weighted as shown in **Table 7,** extracted from the technical documentation (*33*), in the calculation of the Compliance Score.

Table 7. Pedestrian Signal Compliance Weights

Source: (*33*)

Variable	Weight (with button)	Weight (without button)
Maximum cross slope	20 %	--
Largest vertical fault	20 %	--
Number of obstruction types	30 %	--
Sidewalk width	30 %	100 %

The next value that was evaluated in the Sidewalk Network Inventory and Assessment was the Condition Index. The Condition Index assesses condition factors that are not covered by PROWAG (*33*). As stated in the technical documentation, "scores for the index are based on the distribution of values observed in the inventory. Crosswalks and pedestrian signals are not evaluated using the index because structured condition data were not collected for these feature types." (*33*). The combined Condition Score for sidewalks and curb ramps was calculated by equally weighting each of the three compliance criteria as shown in **Table 8,** extracted from the technical documentation (*33*).

Table 8. Condition Weights

Source: (*33*)

Variable	Weight
Surface condition	33.4 %
Frequency of vertical faults	33.3 %
Number of cracked panels	33.3 %

In addition to the indices and scores that were calculated for the online tool, priority areas were identified within the technical report associated with the tool. The target populations in this study were designated as people with disabilities and those of age 65 and over, as these populations are the most impacted by poor sidewalk infrastructure. Data from the Champaign-Urbana Mass Transit District and the U.S. Census Bureau was used to identify areas where the target populations are concentrated. Pedestrian trip generators were also taken into account in determining priority areas. The individual factors were aggregated using the weights shown in **Table 9,** extracted from the technical documentation (*33*).

Table 9. Priority Area Analysis Variable Weights

Source: (*33*)

Variable	Weight
Target populations	**50 %**
People with disabilities	30 %
Seniors	20 %
Pedestrian trip generators	**50 %**

Variable	Weight
Schools and public facilities	15 %
Transit connectivity	15 %
Retail businesses	10 %
Housing density	10 %

The combined results were then used to identify high-, medium-, and low-priority zones for improvements, and listed within the technical documentation (*33*).

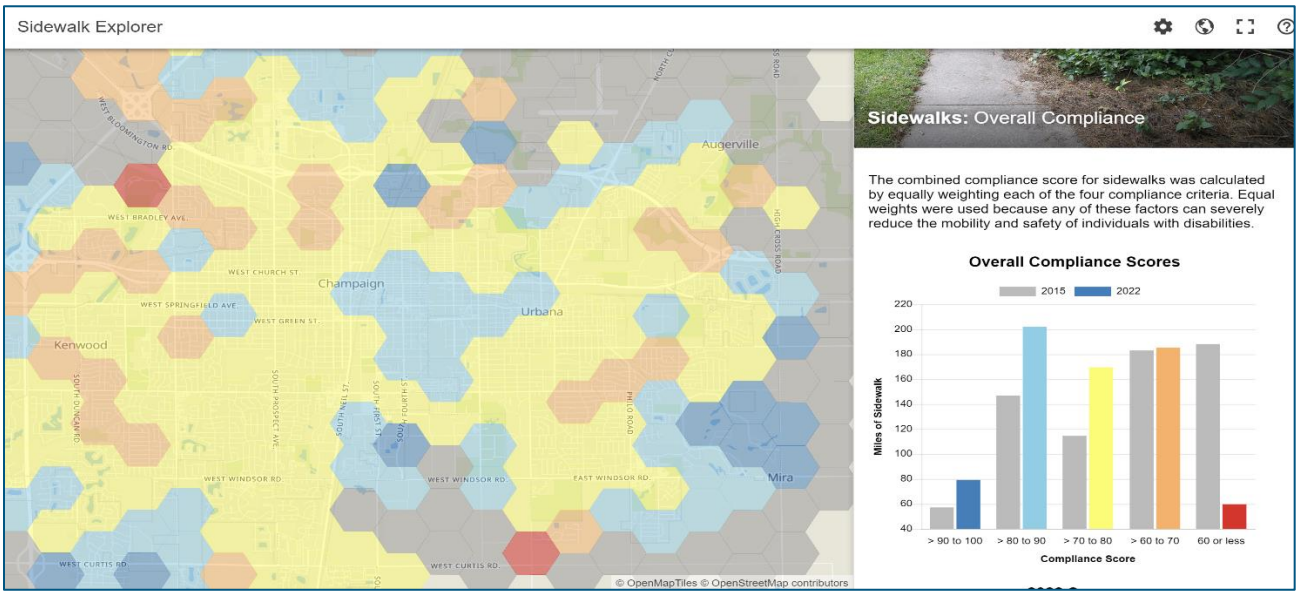

Figure 19. Sidewalk Explorer

The online tool shows hexagons that are color coded (**Figure 19)**, to show five different levels of Compliance Score ranges. The colors of the hexagon are based on the average Compliance Score of each half-mile wide zone. As noted in the technical documentation, "zones containing fewer than five features are excluded from the map in order to avoid placing undue weight on the scores for any one feature" (*33*).

Evaluation of Tool

The sidewalk tool is the most detailed example of a tool that evaluates infrastructure conditions. By evaluating the specific conditions of sidewalks, we considered the tool to measure a benefit, as better sidewalk infrastructure improves walkability.

Aside from being the most detailed infrastructure tool, an additional strength is that it includes a temporal component, so that the sidewalk infrastructure condition can be tracked over time. The compliance scores can be viewed for various years compared to the base year of 2015, the year of the initial dataset. The hexagons on the website make it easy to identify areas where sidewalk improvements are most needed. However, it would be useful if the tool included a layer for the priority areas that were included in the technical documentation.

Otherwise, it is difficult to tell from the tool alone whether there is a large portion of the target population living in an area with poor sidewalk conditions. Additionally, in the technical documentation, it is difficult to distinguish whether there is a difference between a "score" and an "index." Based on the tool's webpage and the language used in the technical documentation, the terms appear to be used interchangeably.

Overall, the goal of the tool is to focus on the conditions of a specific type of infrastructure, which the tool accomplishes. It is difficult to identify priority areas without the priority populations being highlighted in the online tool. However, transportation practitioners focused on ADA compliance could still make decisions about where to improve sidewalk infrastructure using this tool.

Summary of Evaluation of Tools

Coverage of Tools

Table 10 shows the coverage of each of the 12 tools across the categories for which we selected in the initial scan of tools. None of the evaluated tools cover all seven categories. All of the tools consider sociodemographic or socioeconomic factors, even if indirectly through the designation of disadvantaged communities via other tools. For example, the Caltrans Smart Mobility Calculator does not directly display factors under this category, but the designation of disadvantaged communities uses CalEnviroScreen data, which does evaluate factors under this category. Additionally, under sociodemographic factors, the only two tools to consider gender were the STEAP tool and the TransitCenter Equity Dashboard. The two categories that were covered only by a few tools were the infrastructure and funding/investment categories.

Methods of Determining Disadvantage

Table 11 displays each tool's method of determining which communities are highlighted as disadvantaged or as priority populations. Some tools show priority areas delineated on the maps, while others show the comparative percentages using graduated colors. The tools varied in their approach to population-level indicators by using single variables, composite indices, and comparative thresholds.

Most tools use a combination of indicators to display disadvantage. For example, the STEAP tool uses both single indicators and comparative thresholds by providing a summary of Title VI and EJ variables from a buffer analysis that primarily includes demographic, sociodemographic, and socioeconomic information. The buffer analysis provides a summary with each variable shown for the selected project area, and the city or town, county, and state of the selected location. Additionally, several of the California tools (i.e., Caltrans Smart Mobility Calculator, Transportation Disparities Mapping Tool, and Active Transportation Database) use data from CalEnviroScreen 4.0, another spatial tool that was developed by the California Environmental Protection Agency (CalEPA) as a result of California Senate Bill 535 to identify disadvantaged communities to target for investment of proceeds from the state's cap-and-trade program. CalEnviroScreen (CES) 4.0 uses around 20 indicators based on pollution burden and population characteristics to calculate a "CES score" for each census tract in the state. The census tracts that have scores within the top 25% are then designated as disadvantaged

communities. Communities are also designated as disadvantaged if they are under the control of federally recognized tribes, which we accounted for in the table as a single indicator.

It was uncommon for the tools to rely on a set of single indicators; the only one to do so was the Sidewalk Explorer. This tool defines target populations as people with disabilities and seniors aged 65 or older. Areas with high concentrations of the target populations are identified within the report that is associate with this tool. However, the online tool does not provide an option to view these areas. More commonly, other tools used single indicators in combination with composite indices and threshold comparisons. Several tools contained data on Indigenous populations along with a composite indicator of disadvantage.

The USDOT ETC Explorer is an example of a tool that uses an overall index score with relative thresholds. The index computes cumulative disadvantage by normalizing indicators associated with disadvantage, summing the percentile ranks of these indicators into components, and then summing the percentile ranks of the sums of each component to determine an overall score. The final score is displayed in the index and dashboard as a percentile rank. Communities are defined as "burdened" in a component if their component-specific percentile score is greater than 0.65 (65th percentile) in that area.

The only tool evaluated that uses an absolute threshold is the TransitCenter Equity Dashboard for the Los Angeles map. We defined an *absolute threshold* as a specific threshold or number that was used to designate disadvantaged communities that was not part of a larger calculation such as an index. For example, in LA, TransitCenter applied LA Metro's definition for Equity Focus Communities, which includes the following thresholds: census tracts with at least 40% low-income households, at least 10% zero-car households, and at least 80% residents of color. In certain other locations, areas were identified qualitatively.

Many of the tools use comparative thresholds to evaluate disadvantage in an entire area, but highlight only the communities that fall within the highest percentiles of the chosen metrics. For example, CEJST displays communities as disadvantaged if they are above the threshold for one or more of environmental, climate, or other burden and at or above the threshold for an associated socioeconomic burden. The threshold for most burdens considered in this tool is for communities that are above the 90th percentile. In addition, a census tract that is completely surrounded by disadvantaged communities that meet the burden thresholds and meets an adjusted low-income threshold (≥ 50th percentile) is also considered disadvantaged. The general cutoff for the low-income indicator (< 200% of the Federal poverty line) is at or above the 65th percentile.

Types of Outcomes

Table 12 displays the types of outcomes shown by each tool. We divided the outcomes into the following categories: transportation benefits, burdens, and other. We identified the tools that measured neither benefits nor burdens as focusing primarily on demographic, sociodemographic, and socioeconomic indicators. We classified these tools as measuring "community vulnerability." These outcomes are discussed in more detail in the subsequent sections.

Benefits

Consistent with existing literature (*1*, *2*), we found that most tools identify destination accessibility as a metric for assessing transportation benefits with respect to equity. In addition to destination accessibility, access to various modes of transportation such as transit, bikeways, and automobiles were considered by some of the tools. We also evaluated tools that considered walkability and the walkability index in their lists of benefits.

Two of the evaluated tools examined only benefits as transportation outcomes against which to measure equity: the TransitCenter Equity Dashboard and the Sidewalk Explorer. The TransitCenter Equity Dashboard focuses on transportation benefits by showing the opportunities to access various destinations. We considered the Sidewalk Explorer tool to measure walkability, as better sidewalk infrastructure improves walkability, though poor sidewalk infrastructure can also be identified with this tool.

Four of the tools measured both benefits and burdens of transportation; we discuss the benefits in this section. The benefits measured in Housing and Transportation Affordability Index include five composite indicators at the block group level, which provide a job access score, a transit performance and access score, an employment mix index, a transit connectivity index, and a score measuring neighborhood compactness. The tool also provides absolute values for employment access, the transit access shed, jobs accessible in a 30-minute transit ride, and available transit trips per week.

The Caltrans Smart Mobility Calculator measures both transportation benefits and burdens at the census block group level. The tool displays two categories of metrics: Sustainability/Livability/Equity Performance and Urban Form/Livability Opportunities. Transportation benefits measured in this tool include accessibility metrics such as jobs density, jobs accessibility by both automobile and transit, and walkability scores.

The Transportation Disparities Mapping Tool includes 40 indicators that it describes as being associated with the causes, characteristics, and consequences of transportation access disparity based on existing literature and previous research. Benefit layers include items such as access to transit and jobs, availability of bikeways and public parks, jobs-housing fit, job density, and walkability index.

Though the goal of the Active Transportation Database is to store bicycle, pedestrian, wheelchair, and scooter/skateboard counts for infrastructure planning projects across Southern California, it is also designed to assist in planning and data analysis efforts for active transportation programs and projects. This tool provides options to overlay various layers. The layers within this tool that measure benefits include indicators for high quality transit areas, automobile access, retail density, supermarket access, park access, and employment density.

Burdens

The categories of burdens that the tools consider are broader than the benefits. The counterpart to accessibility, or lack of accessibility, was used in some cases to measure transportation insecurity. For example, in the USDOT ETC Explorer uses the National Walkability Index within its calculation of the Transportation Access Disadvantage Indicator, and the Caltrans EQI uses lack of access within the calculation of its Access to

Destinations Screen. The Access to Destinations indicator provides a ratio of the multimodal access to destinations (transit and walking) to automobile access to destinations. Census blocks with an Access to Destinations score less than or equal to 0.2 (in the lowest 20%) for either work or non-work destinations are screened as having poor relative multimodal access to destinations.

Many of the burdens that are measured within the tools have to do with environmental factors and related health outcomes. For example, the CEJST is designed to help practitioners easily identify census tracts that can benefit from programs included in the Justice40 initiative, which seeks to deliver 40% of the overall benefits in climate, clean energy, and related areas to disadvantaged communities. The CEJST focuses on measuring burdens primarily related to climate change, as the tool was developed as a result of Executive Order 14008: Tackling the Climate Crisis at Home and Abroad. Within the context of climate change, the metrics that are evaluated for each census tract include the following: projected flood risk, projected wildfire risk, and airborne fine particulate matter (PM2.5). The USDOT ETC Explorer provides pre-1960 housing (lead paint indicator), diesel PM level in air, air toxics cancer risk, air toxics respiratory hazard index, ozone level in air, and PM2.5 level in air. While CalEnviroScreen 4.0 was not one of the tools that was evaluated, we included the burdens that it uses to calculate its "CES score" because three of the California tools (Caltrans Smart Mobility Calculator, Transportation Disparities Mapping Tool, and Active Transportation Database) use the score as part of their map components. The CalEnviroScreen 4.0 pollution burdens include exposures to ozone concentrations, PM2.5 concentrations, diesel PM emissions, drinking water contaminants, children's lead risk from housing, pesticide use, toxic releases from facilities, cleanup sites, groundwater threats, hazardous waste, impaired water bodies, and solid waste sites and facilities. The FDOT EST interactive map includes layers for contamination and waste, and NOAA sea level rise.

A few tools consider exposure to traffic and traffic noise as burdens, which we categorized under the Environmental category in **Table 12**. The CEJST and Caltrans EQI use traffic proximity and volume, and the FDOT EST uses noise barriers and noise sensitive sites. CalEnviroScreen 4.0 also includes a Traffic Impacts indicator, which is calculated as the sum of traffic volumes adjusted by road segment length divided by total road length within 150 meters of the census tract.

The Housing and Transportation Affordability Index uses other environmental metrics that can be used to determine the overall burden and which populations are contributing more greenhouse gas (GHG) emissions. These metrics include annual GHG per household and annual GHG per acre. Similarly, the Caltrans Smart Mobility Calculator uses annual carbon emissions per household, daily carbon emissions (pounds per person), and daily carbon emissions (pounds per employee).

In addition to environmental factors, several of the tools include health outcomes that could be indicators of environmental burdens. The CEJST tool uses asthma, diabetes, heart disease, and short life expectancy. The Caltrans Smart Mobility calculator uses obesity and cardiovascular disease. In addition to also using asthma prevalence, cardiovascular disease prevalence, and life expectancy, the Transportation Disparities mapping tool uses non-person-based health related metrics such as no health insurance, Medicaid health insurance, and

primary care shortage areas. CalEnviroScreen4.0 uses population characteristics that include emergency department visits for asthma, for heart attacks, and percentage of low birth-weight infants.

Several of the tools also use safety metrics such as pedestrian collisions per 100,000 walkers in the Caltrans Smart Mobility calculator; Signal 4 Crash data, a web-based system designed to support crash mapping and analysis needs in the FDOT EST; and a crash exposure screen in the Caltrans EQI. The Caltrans EQI uses crash data to calculate a crash exposure indicator. The weighted crash values for all crashes occurring in the block and surrounding 250-foot buffer are summed and divided by the area of the census block (in square miles) to calculate a density score for every census block in the state. Lastly, a percentile rank is calculated for every census block with a land area greater than zero and a demographic overlay score. Blocks at or above the 80th percentile were screened for inclusion in the map.

A few tools use cost or "lack of affordability" as a burden. The CEJST uses energy cost as a burden in conjunction with the low-income threshold. The CEJST also calculates transportation barriers as the average relative cost and time spent on transportation relative to all other tracts. This indicator is also used in conjunction with the low-income threshold. The Housing and Transportation Affordability Index includes layers that show annual transportation cost, annual auto ownership cost, annual vehicle miles traveled (VMT) cost, and annual transit cost of all census blocks relative to each other. The Transportation Disparities Mapping tool uses households paying 30-49% and households paying 50% or more for housing as their metrics for cost-burden.

Community Vulnerability

Two tools that do not measure benefits or burdens are the STEAP and the IDOT Community Impact Screener. They primarily focus on population-based metrics that indicate communities that may be disproportionately affected by transportation burdens, which we designated as community vulnerability.

The STEAP provides estimates of the socioeconomic characteristics of the resident population surrounding a project location. The tool does not focus on measuring transportation benefits or burdens, as its purpose is to provide a summary of Title VI and EJ variables.

The IDOT Community Impact Screener is a tool with both quantitative and qualitative components to help transportation professionals determine whether a community impact assessment is justified in the project process. The quantitative component consists of sociodemographic data from the American Community Survey. The qualitative component consists of prompts to examine key community resources, displacement potential, complex community impacts, and community engagement processes that result from a project implementation process.

In addition to these two tools, a few of the other tools considered community vulnerability in addition to benefits and burdens. In these cases, community vulnerability overlaps with definitions of transportation disadvantaged, as described above. These tools include those that use CalEnviroScreen scores (Caltrans Smart Mobility Calculator, Transportation Disparities Mapping Tool, and Active Transportation Database), and the

FDOT EST. CalEnviroScreen includes socioeconomic factors like educational attainment, housing burdened, low-income, linguistic isolation, poverty, and unemployment in the calculation of its CES Score.

Ease of Use

Overall ease of use of each tool was evaluated based on the clarity of the visualization, the tool's ability to convey its purpose to users, and the ease with which the results or metrics can be incorporated into the transportation decision-making process.

The clarity of visualization criterion focused on the ability to present information in a clear and understandable manner, ensuring that users can easily interpret the data. For example, tools like the CEJST, TransitCenter Equity Dashboard "Equity Communities" view, and Caltrans EQI demonstrate this simplicity by displaying solely disadvantaged communities. This makes it easy for users to immediately pick out which communities should be considered for future investments. Additionally, the simplicity of using an outside tool to measure disadvantage with other metrics, such as the California tools that use CalEnviroScreen, can make the tool easier to view for California professionals who are familiar with that tool. The use of quintiles for displaying graduated colors in the Transportation Disparities Mapping Tool and the TransitCenter Equity Dashboard allow for users to easily distinguish the different ranges of each metric. However, we determined that when the graduated colors represent more than five divisions (i.e., quintiles), it is more difficult to distinguish the differences in color on the map. Another example of a tool that uses clear visualization is the Sidewalk Explorer, which uses hexagons in the zoomed-out map view, effectively indicating areas in need of sidewalk infrastructure improvement without the distortion of variably sized census geographies.

Tools that succeeded in conveying their purpose provide clear explanations to users. For example, the CEJST presents a description above the map, which is the first item that users see on the webpage. Additionally, the USDOT ETC Explorer webpage opens to a homepage that explains what each tab contains. The Transportation Disparities Mapping Tool includes a description for each of the 40 metrics on their respective separate tabs. The STEAP tool provides an explanation of the map on its "About" tab, but also clearly shows text on the right side of the screen instructing users to zoom to a location or type a city name, select major roads or draw a line, and then to choose the scale of the buffer analysis such as census block groups, and a distance for the buffer analysis. Similarly, the IDOT tool includes clear instructions. Buffer analysis in STEAP and IDOT Community Impact Assessment Screener makes it easy to aggregate information from census tracts or communities that overlap with a project area.

Ease with which the results or metrics could be integrated was also considered. Some tools, such as the STEAP and IDOT Community Impact Assessment Screener, feature a buffer analysis that allows for easy aggregation of information from census tracts or communities that fall within a given distance of a project. Additionally, tools like the STEAP and IDOT Community Impact Assessment Screener provide downloadable PDFs or Excel spreadsheets, which would help incorporate of the data into reports.

Decision-making Guidance

Finally, to evaluate the ability of each tool to enable transportation professionals to make decisions about equity, we assessed whether the tool is or could easily be incorporated into transportation professionals' decision-making process, whether or not the tool has a component to show where current or future transportation investments are directed, and whether or not the tool has a temporal component so that transportation benefits or burdens could be tracked over time.

The FDOT EST is already incorporated into the FDOT decision-making process. However, the goal of the EST is to carry out FDOT's Efficient Transportation Decision Making (ETDM) Process. The EST provides access for ETAT members to project information and data about natural, physical, social, and cultural resources in the project area. The comments and other information are made available to the public. An assessment of equity for a given project would require the ETAT team to add the appropriate layers on the interactive map portion of the EST. The tool provides over 50 layers that can be toggled on, which provide information for categories such as social and economic, cultural and tribal, infrastructure, contamination, and environmental elements. Because the EST is a required part of every federal or state-funded transportation project process, it has the opportunity to make an impact on equity by requiring every transportation project to undergo this process.

The study authors that developed the IDOT Screener proposed that the tool become a step in the environmental review process in Illinois to ensure that community input is considered. When adopted, the tool would have a greater impact than tools outside the formal transportation decision making process. Another strength of the IDOT Community Impact Assessment Screener is that it is the only tool evaluated in this report that included a qualitative component regarding community involvement.

Another factor that we evaluated related to each tool's ability to guide decisions about equity was whether it can display current or future transportation investments. The FDOT EST and the Active Transportation Database were the only tools we reviewed that included such layers. The FDOT EST provides information on federally or state-funded projects and makes comments and other data available to the public on the ETDM site. The Active Transportation Database includes a layer to show "Proposed Bikeways by Class."

The presence of a temporal component was also evaluated for each of the tools, as having this would allow for the tracking of transportation benefits or burdens over time and could aid decision-makers in easily identifying where transportation investments should be directed. Only two tools included a temporal component. The TransitCenter Equity Dashboard shows data for various points in time so that opportunities to access the various destinations can be viewed and compared at various dates between February 2020 and August 2022, to understand issues that may have been exacerbated by the COVID-19 pandemic. Additionally, the Sidewalk Explorer tool includes compliance scores that can be viewed for various years compared to the base year of 2015, the year of the initial dataset.

Overall Evaluation

Table 13 and this online spread sheet display the summary matrix with the various aspects that we considered in our evaluation. If the answer to the listed question was “yes”, we display “Y” and if the answer was “no” we display “N”. We first note whether each tool evaluates place-based equity, person-based equity, or both. We then note the following items under decision making guidance: whether the tool is required as part of the transportation planning process, whether it provides the option to view current/future transportation investments, whether it includes a temporal component, and whether it has a qualitative component. We note the following items under ease of use: whether instructions are present, whether technical documentation is provided, whether it is clear what the tool is evaluating, whether instructions or tutorials are present in various languages, and whether the language that is used could be easily understood by someone without professional experience in the transportation industry. We marked “clear visualization” with “N” if the tool did not include a legend or if the legend was difficult to find, or if the tool displayed graduated colors in more sections than quintiles. We noted under data access and availability if the data sets are referenced and if the data sets are open source.

Table 10. Coverage of Tools

Tool	Infrastructure	Travel Patterns	Funding/ Investment	Access	Health/ Safety/ Economic	Neighborhood Characteristics	Sociodemographic/ Socioeconomic
Climate and Economic Justice Screening Tool			X	X	X	X	X
USDOT ETC Explorer		X		X	X	X	X
Screening Tool for Equity Analysis of Projects (STEAP)						X	X
Housing and Transportation Affordability Index	X	X		X	X	X	X
Caltrans Transportation Equity Index				X	X		X
Transportation Disparities Mapping Tool		X		X	X	X	X
IDOT Community Impact Assessment Screener		X				X	X
FDOT Environmental Screening Tool	X		X		X	X	X
Active Transportation Database	X	X	X	X	X		X
TransitCenter Equity Dashboard		X		X			X
Caltrans Smart Mobility Calculator		X		X	X	X	X
Sidewalk Explorer	X			X			X

Table 11. Methods of Determining Disadvantage

	Single Indicators			Indices			Thresholds		
Tool	**Title VI**	**EJ**	**Indigenous Land**	**Age**	**Disability Status**	**Percentile Ranked**	**Composite**	**Relative/ Comparative**	**Absolute**
Climate and Economic Justice Screening Tool								X	
USDOT ETC Explorer						X		X	
Screening Tool for Equity Analysis of Projects (STEAP)	X	X						X	
Housing and Transportation Affordability Index								X	
Caltrans Transportation Equity Index (EQI)							X		
Transportation Disparities Mapping Tool			X				X	X	
IDOT Community Impact Assessment Screener								X	
FDOT Environmental Screening Tool			X					X	
Active Transportation Database			X				X	X	
TransitCenter Equity Dashboard									X
Caltrans Smart Mobility Calculator			X				X	X	
Sidewalk Explorer				X	X				

Table 12. Types of Outcomes

	Benefits		Burdens						Other
Tool	Access-ibility	Walk-ability	Lack of Access	Environ-mental	Health	Safety	Costs	Historic Under-investment	Community Vulnerability
Climate and Economic Justice Screening Tool				X	X		X	X	
USDOT ETC Explorer			X	X	X		X		
Screening Tool for Equity Analysis of Projects (STEAP)									X
Housing and Transportation Affordability Index	X			X			X		
Caltrans Transportation Equity Index			X		X	X			
Transportation Disparities Mapping Tool	X			X	X	X	X		X
IDOT Community Impact Assessment Screener									X
FDOT Environmental Screening Tool				X	X		X		X
Active Transportation Database	X			X	X	X			X
TransitCenter Equity Dashboard	X								
Caltrans Smart Mobility Calculator	X			X	X	X			X
Sidewalk Explorer		X							

Table 13. Evaluation Matrix

Tool	Granularity	Place-based or Person-based equity	Decision Making Guidance			
			Required as part of planning process?	Displays current/ future transportation investments?	Temporal Component?	Qualitative Component?
Climate and Economic Justice Screening Tool	Census Tracts	place	N	N	N	N
USDOT ETC Explorer	Point to national	both	N	N	N	N
Screening Tool for Equity Analysis of Projects (STEAP)	Census Block groups or Census Blocks	person	N	N	N	N
Housing and Transportation Affordability Index	Census Blocks	both	N	N	Y	N
Caltrans Transportation Equity Index (EQI)	Census Blocks	place	N	N	N	N
Transportation Disparities Mapping Tool	Census Tracts	both	N	N	N	N
IDOT Community Impact Assessment Screener	1/4 mile, 1/2 mile, and 1 mile buffer surrounding location (aggregates block groups)	person	N	N	N	Y
FDOT Environmental Screening Tool	Dependent on informational layer - Justice40 layer is by Census Tract	place	Y	Y	N	N
Active Transportation Database	Individual count locations	both	N	Y	N	N
TransitCenter Equity Dashboard	Block groups	both	N	N	Y	N
Caltrans Smart Mobility Calculator	Block groups	place	N	N	N	N
Sidewalk Explorer	Hexagons/Can zoom in to individual facilities	place	N	N	Y	N

Table 13. Evaluation Matrix (continued [additional headings])

Tool	Ease of Use						Data Access and Availability	
					Language Accessibility			
	Instructions present?	Technical Documentation provided?	Clear what tool is evaluating?	Clear visualization?	Various Languages?	Understandable to non-transportation professionals?	Data sets referenced?	Data sets open source?
Climate and Economic Justice Screening Tool	Y	Y	Y	Y	N	Y	Y	Y
USDOT ETC Explorer	Y	Y	Y	N	Y	Y	Y	N
Screening Tool for Equity Analysis of Projects (STEAP)	Y	N	Y	N	N	N	Y	N
Housing and Transportation Affordability Index	Y	Y	Y	N	N	Y	N	Y
Caltrans Transportation Equity Index (EQI)	N	Y	Y	Y	N	N	Y	N
Transportation Disparities Mapping Tool	N	Y	Y	Y	N	N	Y	N
IDOT Community Impact Assessment Screener	Y	Y	Y	Y	N	Y	Y	Y
FDOT Environmental Screening Tool	N	N	N	Y	N	N	Y	N

Tool	Ease of Use						Data Access and Availability	
					Language Accessibility			
	Instructions present?	Technical Documentation provided?	Clear what tool is evaluating?	Clear visualization?	Various Languages?	Understandable to non-transportation professionals?	Data sets referenced?	Data sets open source?
Active Transportation Database	N	Y	Y	Y	N	N	Y	Y
TransitCenter Equity Dashboard	Y	Y	Y	Y	N	Y	N	Y
Caltrans Smart Mobility Calculator	Y	Y	N	N	N	N	Y	Y
Sidewalk Explorer	N	Y	Y	Y	N	N	Y	N

Public Agency Stakeholder Needs Assessment Workshop

The following are the key takeaways from the first workshop.

- Local knowledge is important in the use of these tools as the data may not always be reflective of actual conditions. For example, the tools that include access to grocery stores as a metric may designate a gas station with an attached convenience store as an available grocery store. Additionally, the data does not always accurately represent the communities, and there is variation that is not captured by some of the tools.
- Making sure that data sources stay up-to-date and maintaining these tools are a cost that needs to be considered. Additionally, the community's expectations about the recentness of the data should be met. In some cases, the community input process is not defined for some agencies, which creates an additional barrier to meeting the community's expectations.
- The scale of each tool relative to that tool's goals are important to note. For example, census tracts may be too large of a scale when examining rural areas, and census blocks may be a better fit. Participants noted that the tools should complement a broader story rather than serve as the sole source of information.
- Overall, transportation is just one part of equity in communities that we are examining. True equity is a much bigger issue than the specific goals of transportation equity.

The group identified the following additional elements to consider in the tool evaluations:

- Noting whether the datasets are open source or downloadable.
- Noting whether each tool can be edited or altered to include an agency's own datasets or thresholds as a strength.

Community Needs Assessment Workshop

The key takeaways from the second workshop are described below.

- Though the target audiences of many of the evaluated tools are transportation professionals, ensuring that the tools remain accessible to the general public is important. Trainings could be built into the websites, and the role of community-based organizations in training community members to use the tools should be considered.
- Language accessibility is an important ease-of-use factor in the tools. This refers not just to English/non-English language accessibility, but to the use of technical terms that non-transportation professionals may not easily understand.

- As in the government stakeholder workshop, the issue of maintenance and up-to-date information was discussed.
- Many of the tools do not contain a section for community input. Only the CEJST includes a tab for the general public to give input about missing data sources in the tool. Additionally, there may be a difference in boundaries between communities as identified in the tools and how the communities think of themselves. Several ideas for outreach were discussed by agencies, non-profit groups, and journalists. The role of advocacy in community-focused tools was highlighted, with participants suggesting that tools should not only provide data but also support communities in advocating for change.
- Different place types—rural, suburban, urban—should be distinguished by the tools. For example, in a rural place car access matters more than it does in cities.
- More intersectional issues should be considered by the tools. For example, understanding areas vulnerable to extreme heat together with transit use is important for ensuring adequate shade at bus stops in hot climates.

The group identified the following additional elements to consider in the tool evaluations:

- Noting whether technical language that would require experience as a professional in the transportation industry is used in any of the evaluated tools.
- Noting whether trainings are built into the website as a measure of "Ease of Use."

Discussion and Conclusion

The evaluation of transportation equity data, metrics, and tools presented in this report provides insights into the current landscape of resources available to transportation professionals for guiding decision-making to advance equity. Through a qualitative analysis of 12 selected tools, we assessed the comprehensiveness, clarity of visualization, the ease of use of each tool, and their ability to guide decisions related to transportation equity.

We found range of methods for defining disadvantaged communities. While some tools use comparative thresholds to highlight communities that fall within the highest percentiles of chosen metrics, others rely on absolute thresholds, single indicators, or a combination of methods. Income was a common metric that is used in many of the tools' definitions of disadvantage. Some use the Federal poverty threshold (household income below 200% of the federal poverty line), while some use a specific state's median income as the threshold. For example, the Transportation Disparities Mapping Tool grouped tracts based on their median income relative to their region's median income and considered tracts with 80% of the median income or less to be low-income. Many of the tools use comparative thresholds but with different methods. For example, the CEJST highlights a community as disadvantaged if it is over the 90th percentile threshold for one of the considered burdens and at or above the threshold for its associate socioeconomic burden, which is income in most cases. On the other

hand, the USDOT ETC first calculates index scores using transportation insecurity, environmental burden, health vulnerability, social vulnerability, and climate and disaster risk burden categories. The tool then highlights a census tract as "disadvantaged" if it has a Final Index Score greater than 0.65 (65th percentile).

The evaluation of outcomes revealed a focus on accessibility as a primary benefit in transportation equity analysis. Many of the tools assessed burdens related to environmental factors and health outcomes, indicating the significance of addressing the impacts of transportation on air quality and public health. However, several tools included additional burdens such as lack of access, safety, and costs. Historic underinvestment was found in only the CEJST but is important for understanding communities that are not only currently overburdened and underserved, but have also historically been underserved or subject to systematic disinvestment. Additionally, the tools that are more specific in their metrics are also more useful. For example, the safety metric of pedestrian collisions per 100,000 walkers in the Caltrans Smart Mobility calculator makes it easier to assess whether there might be insufficient or unsafe pedestrian infrastructure where it is needed, rather than just "traffic collisions," which would require more information to understand infrastructure needs. We found that several tools go beyond place-based definitions of equity by considering demographic, socio-demographic, and socio-economic indicators. We considered this in **Table 12** that shows the various types of outcomes as "Other – Community Vulnerability."

Our assessment of ease of use highlighted the features in each tool that contribute to their clear visualization and user-friendliness. Showing solely communities that are designated as disadvantaged can be helpful for users to quickly understand where transportation investments should be directed. Additionally, using quintiles rather than more subdivisions for graduated color schemes aids in simplifying the visualization of metrics.

The tools vary in their potential to guide decisions about transportation equity. While the FDOT EST is already integrated into the transportation decision-making process, the remainder are not. For tools that exist outside of the decision-making process, awareness and use by transportation professionals is essential for the tool to guide their decisions around transportation equity. Additionally, the inclusion of current or future transportation projects or investments, as well as a temporal component to track changes over time were identified as features that could further aid in decision-making.

Transportation equity is a multifaceted and complex issue. Due to the diversity of audiences and purposes served by the evaluated tools, we did not conduct a comparative ranking. Instead, our focus was on identifying the most promising features relevant to transportation equity analysis. No single tool can comprehensively address all aspects of equity, and an approach that combines the strengths of multiple tools is necessary in advancing equity.

References

1. Golub, A., and K. Martens. Using Principles of Justice to Assess the Modal Equity of Regional Transportation Plans. *Journal of Transport Geography*, Vol. 41, 2014, pp. 10–20. https://doi.org/10.1016/j.jtrangeo.2014.07.014.
2. Karner, A. Assessing Public Transit Service Equity Using Route-Level Accessibility Measures and Public Data. *Journal of Transport Geography*, Vol. 67, 2018, pp. 24–32. https://doi.org/10.1016/j.jtrangeo.2018.01.005.
3. Klosterman, R. E. Planning Support Systems: A New Perspective on Computer-Aided Planning. *Journal of Planning Education and Research*, Vol. 17, No. 1, 1997, pp. 45–54. https://doi.org/10.1177/0739456X9701700105.
4. Geertman, S., and J. Stillwell. Planning Support Systems: An Inventory of Current Practice. *Computers, Environment and Urban Systems*, Vol. 28, No. 4, 2004, pp. 291–310. https://doi.org/10.1016/S0198-9715(03)00024-3.
5. Geertman, S., and J. C. H. Stillwell, Eds. *Planning Support Systems Best Practice and New Methods*. Springer, Dordrecht, 2009.
6. Nguyen, P., and J. M. Barajas. *Tools and Best Practices for Land Use Efficiency and Equity in Cities*. National Center for Sustainable Transportation, Davis, CA, 2023.
7. Truong, V. Addressing Poverty and Pollution: California's SB 535 Greenhouse Gas Reduction Fund. *Harvard Civil Rights-Civil Liberties Law Review*, Vol. 49, 2014, p. 493.
8. The White House. Justice40 Initiative. *The White House*. https://www.whitehouse.gov/environmentaljustice/justice40/. Accessed Jul. 31, 2023.
9. Papa, E., C. Silva, M. te Brömmelstroet, and A. Hull. Accessibility Instruments for Planning Practice: A Review of European Experiences. *Journal of Transport and Land Use*, Vol. 9, No. 3, 2016, pp. 57–75.
10. Silva, C., L. Bertolini, M. te Brömmelstroet, D. Milakis, and E. Papa. Accessibility Instruments in Planning Practice: Bridging the Implementation Gap. *Transport Policy*, Vol. 53, 2017, pp. 135–145. https://doi.org/10.1016/j.tranpol.2016.09.006.
11. te Brömmelstroet, M. Equip the Warrior Instead of Manning the Equipment: Land Use and Transport Planning Support in the Netherlands. *Journal of Transport and Land Use*, Vol. 3, No. 1, 2010, pp. 25–41.
12. Krapp, A., J. M. Barajas, and A. Wennink. Equity-Oriented Criteria for Project Prioritization in Regional Transportation Planning. *Transportation Research Record*, Vol. 2675, No. 9, 2021, pp. 182–195. https://doi.org/10.1177/03611981211001072.
13. 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*. University of California Institute of Transportation Studies, 2022.
14. About - Climate & Economic Justice Screening Tool. https://screeningtool.geoplatform.gov/en/about#3/33.47/-97.5. Accessed Jan. 25, 2024.

15. Council on Environmental Quality. *Climate and Economic Justice Screening Tool*. https://screeningtool.geoplatform.gov.
16. United States Department of Transportation (USDOT). *USDOT Equitable Transportation Community (ETC) Explorer*. https://experience.arcgis.com/experience/0920984aa80a4362b8778d779b090723/page/Homepage/.
17. United States Department of Transportation (USDOT). *Screening Tool for Equity Analysis of Projects (STEAP)*. https://hepgis.fhwa.dot.gov/fhwagis/buffertool/.
18. Center for Neighborhood Technology. H + T Index Methods. Nov, 2022.
19. Center for Neighborhood Technology (CNT). *Housing + Transportation Affordability Index*. https://cnt.org/tools/housing-and-transportation-affordability-index.
20. California Department of Transportation (Caltrans). Caltrans Transportation Equity Index (EQI) Documentation. 2023.
21. California Department of Transportation (Caltrans). *Caltrans Beta Transportation Equity Index (EQI) Draft Web Map*. https://caltrans.maps.arcgis.com/apps/webappviewer/index.html?id=8ff3d27cdc1a4e8da0ae09c6b076a253.
22. Pech, W. C., J. Pascual, S. R. González, J. Ong, and G. Pierce. Screening Method and Map for Evaluating Transportation Access Disparities and Other Built Environment-Related Determinants of Health.
23. UCLA Center for Neighborhood Knowledge. *CA Transportation Disparities Mapping Tool*. https://knowledge.luskin.ucla.edu/2541-2/.
24. Center for Neighborhood Technology (CNT). *IDOT Community Impact Assessment Screener*. https://apps.cnt.org/idot-cia/.
25. Environmental Screening Tool Overview. *FDOT*. https://www.fdot.gov/environment/est-overview.shtm. Accessed Jan. 25, 2024.
26. Florida Department of Transportatoin (FDOT). *Efficient Transportation Decision Making (ETDM)*. https://etdmpub.fla-etat.org/est/library.jsp?categoryList=85.
27. Southern California Association of Governments (SCAG). Active Transportation Database (ATDB) Data Dictionary. Jun 18, 2018.
28. Southern California Association of Governments (SCAG). *Active Transportation Database*. https://maps.scag.ca.gov/atdb/.
29. Sustainable Systems Research, LLC, SF2 Enterprises Inc, Klumpentown Consulting, University of Vermont. TransitCenter Equity Dashboard: Technical Documentation. Jun, 2021.
30. Home - TransitCenter Equity Dashboard. https://dashboard.transitcenter.org/#readmore. Accessed Jan. 25, 2024.
31. TransitCenter. *TransitCenter Equity Dashboard*. https://dashboard.transitcenter.org/.
32. California Department of Transportation (Caltrans). *Smart Mobility Calculator*. https://smartmobilitycalculator.netlify.app/.
33. Champaign Urbana Urbanized Area Transportation Study (CUUATS). Sidewalk Network Inventory and Assessment for the Champaign Urbana Urbanized Area. 2016.

34. Champaign County Regional Planning Commission. *Sidewalk Explorer*. https://ccrpc.gitlab.io/sidewalk-explorer/.
35. White House Council on Environmental Quality. Climate and Economic Justice Screening Tool Technical Support Document. Nov, 2022.
36. Meier, Helen C.S., and Mitchell, Bruce C. Historic Redlining Scores for 2010 and 2020 US Census Tracts. Oct 15, 2021.
37. United States Department of Transportation Office of the Secretary (OST). Equitable Transportation Community Explorer (ETCE) Technical Documentation. Feb, 2023.
38. Caltrans Transportation Equity Index (EQI) Documentation.
39. SB 535 Disadvantaged Communities | OEHHA. https://oehha.ca.gov/calenviroscreen/sb535. Accessed Jan. 31, 2024.
40. Florida Department of Transportation (FDOT). ETDM Manual. https://www.fdot.gov/environment/pubs/etdm/etdmmanual.shtm. 2021.
41. Florida Department of Transportation (FDOT). Efficient Transportation Decision Making. https://etdmpub.fla-etat.org/est/. Accessed Feb. 1, 2024.
42. Ferrell, C. E., B. S. Appleyard, M. Taecker, C. Allen, C. Armusewicz, C. Schroder, Transit Cooperative Research Program, Transportation Research Board, and National Academies of Sciences, Engineering, and Medicine. *Livable Transit Corridors: Methods, Metrics, and Strategies*. Transportation Research Board, Washington, D.C., 2016.
43. Appleyard, B. S., A. R. Frost, and C. Allen. Are All Transit Stations Equal and Equitable? Calculating Sustainability, Livability, Health, & Equity Performance of Smart Growth & Transit-Oriented-Development (TOD). *Journal of Transport & Health*, Vol. 14, 2019, p. 100584. https://doi.org/10.1016/j.jth.2019.100584.

Data Summary

Data Access and Sharing

The spreadsheet is available at the following URL: https://docs.google.com/spreadsheets/d/1Tpq-2jq3FwVdP2RtJL43SWskhPnRrhevzaSq7JSc6-w/edit#gid=555531915