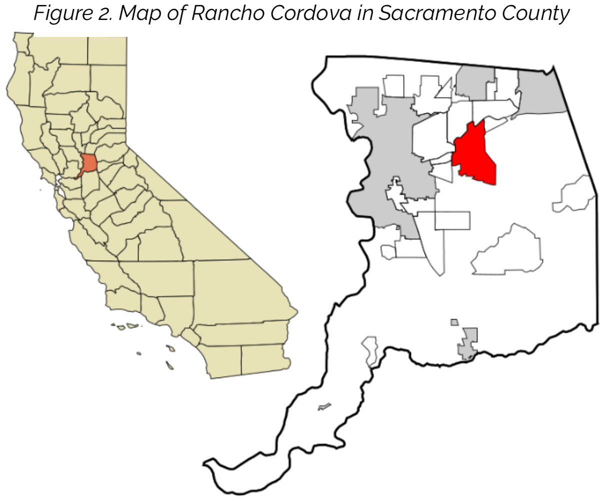
Economic Analysis for Project-Level Adaptation Planning and Guidance Implementation sections for more information on how to approach similar types of project-level assessments.

Extreme Heat and Transit Stop Pilot

Figure 2. Map of Rancho Cordova in Sacramento County



Source: Map by Arkyan, creative commons license.

Summary

This pilot analyzed the impacts of extreme heat to transit users at a bus stop in Rancho Cordova in Sacramento County, as shown Figure 2. The case study uses the ADAP steps to exemplify possible decision-making processes and compare costs and benefits of different adaptation alternatives.

The bus stop selected for analysis is the Zinfandel Plaza stop (#658), at Zinfandel Drive and Ross Parking Lot in Rancho Cordova. Rancho Cordova is situated in northeastern Sacramento County, approximately 20 to 30 minutes east of downtown Sacramento. A community survey completed for the *Capital Region Urban Heat Island (UHI) Mitigation Project* collected information on community priorities around the Capital Region related to heat vulnerability. The Zinfandel Plaza stop was selected following a review of 30 bus stops where survey results reported a lack of shade, benches, and other forms of shelter. The bus stop currently has a single shade canopy but does not have shade options available outside of this small shelter. The stop is also in the middle of a parking lot and idling vehicles could additionally exacerbate heat pollution in this area.

The study reviewed existing conditions at the site, including population characteristics, site conditions, and bus operations. Next, the study compiled and reviewed future changes in temperature, extreme heat, and the Urban Heat Island (UHI) effect at the site. Temperature data was compiled from the past SACOG *Vulnerability and Criticality Assessment*, the California Heat Assessment Tool (CHAT), and the *Capital Region UHI Mitigation Project.* The study attempted to assess the performance of the facility under current temperature conditions, but this was challenging given limited data and resources to quantify performance. The study also qualitatively discussed potential impacts to ridership and revenue due to temperature rise, but this was also difficult to quantify.

In addition, the study compiled a shortlist of potential adaptation measures to apply at the Zinfandel stop, along with information surrounding their effectiveness, costs, co-benefits, and challenges. The most cost-effective options were identified based upon this information, but an economic analysis was not performed. Finally, the study evaluated additional considerations at the site and presented a set of recommended approaches to adaptation. Given available information, we recommend that Sacramento Regional Transit (SacRT) and SACOG consider the following strategies to reduce exposure to Heat Health Events (HHEs) at Zinfandel Plaza:

- Install a water fountain
- Install a high-pressure water mister

- Install a cool wall shelter
- Develop a list of shade trees adapted to future climate through a partnership with the Sacramento Tree Foundation

SacRT and SACOG may also want to consider:

- Installing benches
- Planting shade trees
- Installing permeable/green pavement at the site (could be on the concrete pad the shelter sits on)

Lessons Learned/Considerations for Similar Assessments

- This assessment was different then the "typical" ADAP assessment because it focused exclusively on impacts to riders, not a piece of infrastructure. Conducting this assessment took some flexibility.
  - Changed some of the approaches to the ADAP steps:
    - During Steps 1 and 2 it was important to consider how a rider would experience the bus stop. This information cannot be collected by looking at designs and blueprints, but by examining population characteristics, ridership, location, etc.
    - Step 5 was not possible with the information available. More information was needed on how the public experiences the stop and would need to conduct some follow-up surveys to collect feedback on adaptation measures.
    - Steps 7 and 8 changed somewhat as there are many combinations of adaptation measures that could be applied to reduce heat stress to riders. Not just one or two. It did not seem appropriate to narrow down to 1-2 concrete suggestions.
      - The study provided several recommendations and scenarios for applying them.
      - The cost-effectiveness of these measures may be hard to quantify in an economic analysis.
    - The facility management plan (Step 11) is also non-traditional. It instead needs to focus on maintenance requirements and monitoring the performance of adaptation measures through performance indicators like customer satisfaction.
- There were many additional considerations to include in Step 9, especially when dealing with impacts to public health. Disadvantaged/heat-vulnerable communities are a major consideration. Rider acceptance of an adaptation option (e.g., additional shading) is important, because the ridership is likely to experience that adaptation option directly and tangibly.

Key Takeaways

- Temperatures are rising across the SACOG region and the number of HHEs and overall public health impacts are expected to increase.
- Transit users may be disproportionately vulnerable, especially if they are transit dependent, represent a heat vulnerable population, and/or are waiting for their bus during the hottest times of the day (as they would at this stop).
- Collecting rider feedback is an important way to understand current site conditions, develop goals for the site, and evaluate performance after making changes.
- There are many options available to reduce heat impacts at bus stops. In addition, local/regional policies and goals are supportive of reducing heat pollution and impacts. The challenges tend to lie with implementation (permitting, ADA compliance, construction, maintenance, utility access, etc.). These barriers can be significant for transit agencies and will need to be addressed/removed to move forward with adaptation measures.

Extreme Heat and Pavement

Summary

This case study is a theoretical example of assessing the performance grade binder for an asphalt roadway under increasing heat stress due to climate change. Asphalt pavement is generally built over a base and subbase course, usually a gravel or stone material, as shown on Figure 3.[5] The sublayers provide foundational support to prevent the pavement from becoming deformed from the vehicles loads. The asphalt binding agent in a roadway is essentially the "cement" that keeps the aggregate together. The performance grade (PG) asphalt binder choice is determined by the 7-day maximum pavement temperature (˚C) and 1-day minimum pavement temperature (˚C) values (i.e., annotated as: PG ##H - ##L [where ##H relates to high pavement design temperature under an average 7-day maximum and is intended to protect against rutting and shoving, and ##L relates to low pavement design temperature for the 1 day minimum and is intended to protect against thermal cracking]).

[5] A course is a material layer. Combining all the layers creates the pavement structure.