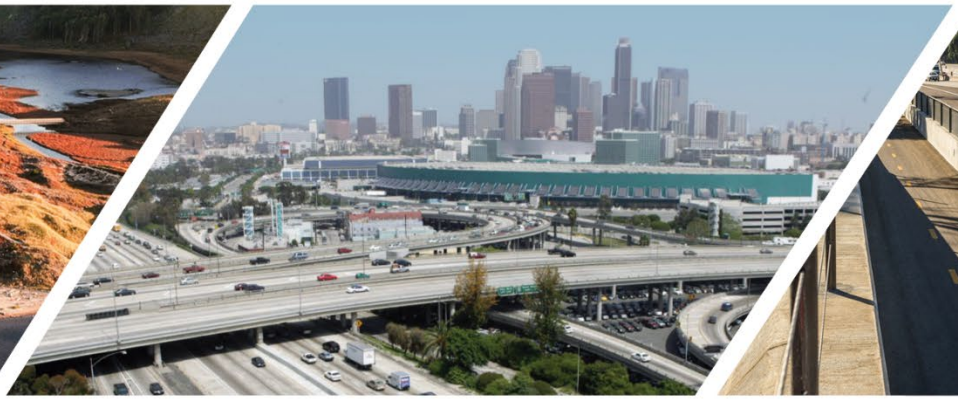
CALIFORNIA DEPARTMENT OF TRANSPORTATION

CLIMATE CHANGE
COMMUNICATION GUIDE



U.S. Department of Transportation
Federal Highway Administration

Caltrans

Contents

Executive Summary 1
Purpose and Goal 2
Background 2
Who Can Use This Guide? 3
Who Does Caltrans Communicate With? 4
How to Use This Guide 5
Best Practices for Communicating with Caltrans Staff and Partners 6
- Clearly define your goals. 6
- Develop and align your messages with your goals. 6
- Be consistent with your message. 7
- Understand your unique audiences 8
- Conduct frequent, two-way engagement. 8
- Measure your success. 10

Best Practices for Communicating with the Public 12
- Simplify your message. 12
- Understand your unique audiences 13
- Tailor your message. 13
- Focus on framing. 13
- Focus on local impacts. 14
- Tell real stories 14
- Use effective visualizations. 15

Recommended Communication Channels 17
Best Practices in Action: Closing the Communication Loop 19
Appendix A: Assessment of the Current Situation 22
Appendix B: Survey Instrument and Interview Scripts 29
Appendix C: Suggested Climate Change Data Sources 34
Appendix D: Climate Change Communication Resources 35
Appendix E: Memo: Best Practices for Communicating Climate Change 48

Notice: This report was developed by the California Department of Transportation in accordance with a grant from the Federal Highway Administration (FHWA). The statements, findings, conclusions, and recommendations are those of the authors and do not necessarily reflect the views of FHWA or the U.S. Department of Transportation.

Technical Report Documentation

1.Report No.	2.Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle California Department of Transportation Climate Change Communication Guide		**5. Report Date** March 2020 **6. Performing Organization Code**
7. Author(s) California Department of Transportation Eastern Research Group, Inc.		**8. Performing Organization Report No.**
9. Performing Organization Name and Address Climate Change Branch, Division of Transportation Planning, California Department of Transportation 1120 N Street Sacramento, CA 95818		**10. Work Unit No.** **11. Contract or Grant No.**
12. Sponsoring Agency Name and Address Federal Highway Administration, 1200 New Jersey Avenue, SE Washington, DC 20590		**13. Type of Report and Period** Pilot Final Report **14. Sponsoring Agency Code**
15. Supplementary Notes		

16. Abstract

This Climate Change Communication Guide articulates best practices that the California Department of Transportation (Caltrans) can use to educate, inform, and strengthen collaboration within Caltrans, among external partners, and with the public on the topic of climate change. Because different audiences have different communication needs, the guide presents two distinct (though similar) sets of tools:

- Strategies for communicating with internal staff and partner agencies
- Strategies for communicating with the broader public

Each section presents a sample checklist, descriptions, and examples drawn from published literature and from Caltrans' own project portfolio. The guide also recommends specific communication channels and presents a set of diagrams to illustrate effective communication in action.

This guide is one component of Caltrans' broader work on climate change. Caltrans is proactively identifying potential climate change impacts to the state highway system while advancing adaptation and greenhouse gas mitigation efforts. As the Department develops new climate change tools and guidance, this guide will help facilitate the conversation on climate change efforts internally and externally to enhance climate change consideration and integration throughout Caltrans.

17. Key Words	18. Distribution Statement
Climate change, resiliency, adaptation, mitigation, communication, transportation	No restrictions.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	55 pages	

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

Executive Summary

California is vulnerable to nearly every climate change stressor and extreme weather threat. Increasing temperatures, larger wildfires, heavier rainstorms, extended periods of drought, and rising sea levels and storm surges pose a significant risk to California's natural and human resources and to the state's transportation infrastructure. As the steward of this infrastructure, the California Department of Transportation (Caltrans) has taken many steps to integrate climate change considerations into project planning and implementation. However, support for technical integration is just part of the solution. Caltrans also faces the difficult task of communicating about climate change—explaining climate science, risks, and resilience concepts to inform constituents, engage with partner organizations, and achieve a common understanding among its own staff.

Communicators face many challenges when dealing with climate change. Climate science is complex, yet the explanations that scientists and engineers tend to rely on may not be understood—or may be misunderstood—by a general audience. Some people naturally have difficulty understanding or acknowledging the realities of climate change when the impacts may be hard to see, gradual (e.g., sea level rise of a few millimeters per year), geographically distant, or seemingly far in the future. This difficulty is compounded by widespread misinformation and the way in which scientific issues have become politicized.

Fortunately, many well-documented best practices are available to help organizations such as Caltrans overcome the challenges inherent in communicating about climate change. This guide presents many such strategies. Because different audiences have different communication needs, the guide presents two distinct (though similar) sets of tools:

- Strategies for communicating with internal staff and partner agencies
- Strategies for communicating with the broader public

Each section presents a sample checklist, descriptions, and examples drawn from published literature and from Caltrans' own project portfolio. The guide also recommends specific communication channels and presents a set of diagrams to illustrate effective communication in action.

Many people contributed input and ideas to this guide, including Caltrans staff from Headquarters and all 12 districts, and representatives from key partner agencies. An appendix to the guide captures the strengths, challenges, and concerns they shared through interviews and surveys. Their input helped the authors select a focused set of strategies for this guide—strategies that can help Caltrans address the unique challenges of communicating about climate change in a state as geographically, politically, and culturally diverse as California. As the Department develops new climate change tools and guidance, the hope is that this guide will help facilitate the conversation on climate change efforts internally and externally to enhance climate change consideration and integration throughout Caltrans.

Purpose and Goal

This Climate Change Communication Guide articulates best practices that the California Department of Transportation (Caltrans) can use to educate, inform, and strengthen collaboration within Caltrans, among external partners, and with the public on the topic of climate change. Caltrans received a Federal Highway Administration (FHWA) Resilience and Durability to Extreme Weather Pilot Program grant to develop the guide, which includes strategies to communicate the results of vulnerability and/or risk assessments to support integration of resilience into Caltrans practices.

Caltrans is proactively identifying potential climate change impacts to the state highway system while advancing adaptation and greenhouse gas mitigation efforts. These efforts include but are not limited to the recently completed District Climate Change Vulnerability Assessment Reports, upcoming District Adaptation Priorities Reports, the soon-to-be released Caltrans Climate Change Adaptation Strategy Report, and this Climate Change Communication Guide. As the Department develops new climate change tools and guidance, this guide will help facilitate the conversation on climate change efforts internally and externally to enhance climate change consideration and integration throughout Caltrans.

Background

California is vulnerable to nearly every climate change stressor and extreme weather threat. Increasing temperatures, larger wildfires, heavier rainstorms, extended periods of drought, and rising sea levels and storm surges pose a significant risk to California's natural and human resources and to the state's transportation infrastructure. In response to this threat, Caltrans can plan proactively and incorporate mitigation and resilience into its planning, design, maintenance, programming, and operations.

At the state level, multiple policies help guide Caltrans' climate change mitigation and adaptation efforts, including:

- **Executive Order (EO) B-30-15**: Requires that all state investment decisions consider climate change, and that state agencies prioritize adaptation actions that also reduce greenhouse gas emissions, consider the most vulnerable populations, prioritize natural infrastructure solutions, and use flexible approaches where possible.
- **EO S-13-08**: Directs state agencies to plan for sea level rise for construction projects having design lives extending to 2050 and/or 2100.
- **EO N-19-19**: Requires state to redouble efforts to reduce greenhouse gas emissions and mitigate climate change impacts while building a sustainable, inclusive economy.
- **Senate Bill (SB) 1:** Requires that transportation funding be used, where feasible, to promote adaptation actions that make assets more resilient to climate change impacts.
- **Assembly Bill (AB) 2800:** Requires state agencies to take climate change impacts into account during all infrastructure planning, design, construction, investments, operations, and maintenance.
- **AB 1482:** Requires all state agencies and departments to prepare for climate change impacts through continued collection of climate data, state investments, and reliable transportation strategies.

Within Caltrans itself, the Climate Change Branch recently led a series of statewide vulnerability assessments in the Department's 12 districts. The vulnerability assessments identified climate change vulnerabilities along the state highway system, as well as potential impacts from changes in temperature, sea level rise, storm surge, cliff retreat, precipitation, and increased wildfires. These assessments provide an important tool for communicating climate vulnerabilities within the Department, with the Department's external partners, and with the public. Caltrans is using the vulnerability assessment findings to inform adaptation plans customized for each district to increase highway resilience and foster climate adaptation strategies for communities and ecosystems more broadly.

To supplement these efforts, Caltrans has developed this Climate Change Communication Guide, which provides best practices for communicating climate change-related information both internally and externally. The recommendations in this guide are based on findings from in-depth stakeholder research (refer to Appendix A and Appendix B for more information), including a scoping survey of district and Headquarters staff, internal interviews with district planners and representatives from other functional units, and external interviews with partners—including metropolitan planning organizations (MPOs), the California Air Resources Board, the California Coastal Commission, the California Environmental Protection Agency, and the California Natural Resources Agency.

Cover of District 2's Climate Change Vulnerability Assessment Summary Report. (credit: Caltrans District 2)

The best practices in this guide are also informed by a growing body of social science research on climate change communication, which provides insights into the way people understand the topic based on their different ways of thinking, experiences, and world views. See Appendix D for an annotated list of climate change communication resources.

Who Can Use This Guide?

Climate change communication is a Department-wide responsibility. As such, all staff at Caltrans, from Headquarters to the districts, can benefit from using this guide. Moreover, although the Climate Change Communication Guide is based on research specific to Caltrans, it contains best practices that apply to—and can be adapted by—agencies, organizations, and others engaged in climate change communication across the country.

The Mud Creek Slide in Caltrans District 5 demonstrates how this stretch of Highway 1 is vulnerable to changing rainfall patterns. The slide occurred days after heavy rainfall during one of the wettest winters in a century for the area. (credit: Caltrans District 5)

Who Does Caltrans Communicate With?

Caltrans communicates climate change information with both internal and external audiences, including Caltrans staff, Caltrans partners, and members of the public. Table 1 describes each of these main audiences in more detail.

Table 1. Caltrans Audiences

Type	Audience	Description
Internal	Caltrans staff	Employees in all divisions and all 12 districts.
External	Partners	MPOs, state agencies, cities/counties, tribal partners, regional transportation planning agencies, federal agencies, and permitting agencies Caltrans relies on and works with to accomplish overlapping environmental/land use planning goals.
External	Public	Homeowners or renters, recreational groups, real estate agencies, housing managers, schools and educators, vulnerable subpopulations, and more.

How to Use This Guide

This Climate Change Communication Guide presents two sets of key best practices. The first set highlights best practices for communicating with partner organizations and staff who are already familiar with climate change information and need communications that help them make informed decisions about adaptation and mitigation. The second set describes best practices for communicating with members of the public, who may have heard the term "climate change," but are not necessarily familiar with the underlying science or importance of taking action to address impacts. Many of the second set of best practices are also helpful for communications with Caltrans staff who are less familiar with climate change.

Throughout this guide, you will also find "Best Practice" call-out boxes that highlight issues of special consideration in more detail. Following the best practices, this guide describes some recommended communication channels for sharing climate change information with staff, partners, and the public. The guide also includes flow charts that illustrate key best practices in action, using the example of Caltrans' recent climate change vulnerability assessments.

The LACBC, pictured here at a Caltrans Bike To Work Event, is an example of a public audience. (credit: "LACBC tabling yet another bike event!" by Umberto Brayj, CC BY 2.0)

Best Practices for Communicating with Caltrans Staff and Partners

Best Practices at a Glance: Caltrans Staff and Partners

- ☐ Clearly define your goals:
  - Identify your desired outcomes.
- ☐ Develop your messages and align them with your goals.
- ☐ Be consistent with your message:
  - Deliver the same message multiple times through multiple channels.
- ☐ Understand your unique audiences:
  - Customize your messages according to their needs.
- ☐ Conduct frequent, two-way engagement:
  - Provide opportunities for collaboration and perspective sharing.
- ☐ Measure your success:
  - Ask evaluation questions.
  - Develop metrics and collect data.

Clearly define your goals.

To successfully communicate climate change information, it is important to first clearly define your goals. What are you trying to achieve? What outcomes do you want to see? Clearly defined goals will help you tailor your messaging to achieve them. For example, Caltrans may have the following communication goals for internal staff and external partners:

- **Caltrans staff:** Provide information that motivates staff from all Caltrans divisions to work together—from project initiation to completion—to incorporate resilience measures into Department practices.
- **Partners:** Inform partners that California's state highway system is vulnerable to climate change impacts, describe Caltrans' role in addressing vulnerabilities, and work together to make the state more resilient.

Caltrans Districts 8 and 12 staff at SB1 Forum in 2017. (credit: Caltrans District 8 Twitter)

Develop and align your messages with your goals.

Once you have determined your goals, it is useful to strategically consider how you will achieve those goals through your messaging. Messaging is what you want to communicate to your stakeholders, and it should consider both the information that you want to convey and how you want people to respond to or act upon that information.

Table 2 presents sample messages corresponding to the goals defined above.

Table 2. Sample Climate Change Messages

Goal	Sample Messages
Caltrans staff: Provide information that motivates staff from all Caltrans divisions to work together to incorporate resilience measures into Department practices.	• We all have a role to play in designing and maintaining a state highway system that is resilient to climate change. • Climate resilience work goes beyond planning to project delivery and the full project life cycle.
Partners: Inform partners that the state highway system is vulnerable to climate change impacts, describe Caltrans' role, and work together to make the state more resilient.	• Caltrans can be counted on to do its part to consider and integrate climate change mitigation and adaptation strategies into its decisions and activities. • Caltrans is an engaged partner that will meet its commitments and deadlines. • By working collaboratively, we can create a more resilient transportation system.

Be consistent with your message.

Consistent messaging will help build trust and credibility in Caltrans' commitment to climate change action. Social science research consistently reveals that people need to hear messages multiple times through multiple channels for them to notice, remember, and eventually act upon them.

- **Caltrans staff:** Consistent messaging enables all districts and divisions to understand where the Department stands on different climate change issues. This is critically important, as district staff handle many climate change considerations at the project level on a case-by-case basis. As projects move from planning and environmental review to permitting, design, and eventually completion, resilience measures sometimes get removed or scaled back if their value to the project is not consistently reinforced. Consistent messaging can help prevent this by providing a reliable guideline that staff can use to align their decisions and actions accordingly.
- **Partners:** Consistency also ensures that partners hear the same information regardless of which division or staff member within Caltrans provides the communication. This will reinforce the outside perception that the entire Department views climate change as a priority.

Understand your unique audiences.

Understanding the different groups or segments that make up your audiences will help you customize your messaging to meet their needs. Climate change communication requires more than a "one-size-fits-all" approach. For maximum impact, be sure to speak to your audiences' interests.

Best Practice: Continually Educate Staff

Climate change is an ever-evolving science. As such, continual education to keep staff abreast of the latest trends, projections, and findings is key to ensuring they understand the implications and applicability of climate change to their projects and practices. Internal webinars, training sessions, email lists, and newsletters are examples of methods you can use to keep staff informed and equip them to confidently discuss climate change with colleagues and partners.

- **Caltrans staff:** Staff work in multiple divisions at Headquarters and the 12 districts, representing various roles, populations, geographies, and climate change concerns. For example, staff in inland and desert districts might not feel their needs are addressed by messaging that focuses on sea level rise impacts to coastal cities. Design and maintenance engineers might respond more to messaging that quantifies impacts to specific stretches of road, backed by specific data.
- **Partners:** Caltrans partners include a range of agencies and organizations, some of which are already actively involved in adaptation and resilience planning. As such, they require messaging backed by actionable information that supports strategic decision-making, such as priority infrastructure areas in need of adaptation, costs of different adaptation strategies, and potential funding sources.

Conduct frequent, two-way engagement.

Regular collaboration with staff and partners is a great way to share lessons learned, solve pressing problems, and make decisions regarding climate change topics of mutual interest.

- **Caltrans staff:** Two-way engagement between Headquarters and the districts will enable staff at all levels to talk about climate change, share their unique perspectives and concerns, and remain invested. It will also facilitate more cross-divisional collaboration. Meetings and workshops provide opportunities for districts to share climate change-related efforts in their area and for Headquarters to share updates about the latest climate change policy and science, discuss current and upcoming Caltrans work, and answer district questions. Lessons learned at these engagements could also be used to customize climate change messages for maximum impact.
- **Partners:** Proactive engagement with partners will help build trust, strengthen working relationships, and advance state policy. It is important to ensure that partners fully understand the scope of Caltrans' adaptation and vulnerability projects, as some Caltrans projects overlap with what partners are doing and represent opportunities to leverage and complement funding. It is also a best practice to consult with partners before conducting climate change-related assessments and to give them ample time to review and comment on these efforts. Finally, it is important to work with partners to publicize joint successes and encourage them to share Caltrans climate change-related activities in their own communications—thus amplifying your messages to an even broader audience.

Best Practice: Share Lessons Learned from Adaptation Planning Projects

Caltrans and its partners across the state are implementing a range of projects that apply best practices in equitable, stakeholder-driven transportation and adaptation planning. Through SB1 Adaptation Planning Grants, Caltrans has provided direct funding for municipalities and partner organizations to implement such projects. Caltrans and its grantee organizations have a strong desire to share lessons learned from these projects to ensure that all groups leverage one another's successes.

For example, several MPOs have received SB1 grants to work with stakeholders (including Caltrans) on integrating climate considerations into long-term regional transportation plans. By sharing lessons learned along the way, MPOs and stakeholders can help one another refine their planning processes.

Open dialogue can also provide opportunities to better align climate change messaging and guidance provided by different funding sources. For example, grantees working on a multijurisdictional shoreline adaptation project may encounter conflicting guidance. Being open and transparent about these differences creates the opportunity to troubleshoot and resolve these issues.

The Capitol Corridor Joint Powers Authority has received an SB1 Adaptation Planning Grant to support the "Alviso Wetland Railroad Adaptation Alternatives Study." The study will evaluate possible adaptation alternatives for railroad infrastructure in the area, following the broad objectives of increased resilience, increased train capacity, minimized environmental disturbance, natural habitat restoration, and protected/endangered species preservation. (credit : "Coast Starlight passing Alviso Marina County Park, June 2017" by DonFB, CC BY-SA 4.0).

Measure your success.

When you establish goals for your climate change communication effort, it is important to consider how you will measure the successful achievement of those goals. Table 3 revisits the goals discussed earlier and presents some questions and sample qualitative and quantitative metrics you can use to evaluate whether you have successfully achieved these goals. You can collect data on metrics using surveys, feedback/response forms, digital analytics, interviews, focus groups, and other methods.

Table 3. Sample Questions and Metrics for Evaluating Climate Change Communication Success*

Goal	Evaluation Questions	Metrics
Caltrans staff: Provide information that motivates staff from all Caltrans divisions to work together to incorporate resilience measures into Department practices.	• Did Caltrans reach and inform staff in all districts/divisions? • Did staff understand the information provided enough to make decisions? • Did cross-divisional collaboration on climate change issues increase? • Did staff incorporate more resilience measures into projects?	• Feedback and responses received • Number of projects that have incorporated resilience measures since the communication • Click-through/read-through rates for newsletters and emails • Number of attendees at trainings/webinars, meetings, and other events • Number of internal downloads of documents
Partners: Inform partners that the state highway system is vulnerable to climate change impacts, describe Caltrans' role, and work together to make the state more resilient.	• Did Caltrans reach and inform all partner organizations? • Do partners understand Caltrans' role in climate change planning? • Did the communication lead to increased collaboration on statewide climate change planning? • Did Caltrans and partners better align their efforts?	• Feedback and responses received • Number of partners who attended Caltrans-hosted meetings and other events • Invitations Caltrans received from partners to participate in planning sessions or contribute to a project or media event • Mentions of Caltrans' work in partners' communications

** Note: The evaluation questions and metrics you measure will depend on your specific climate change communication goals and channels.*

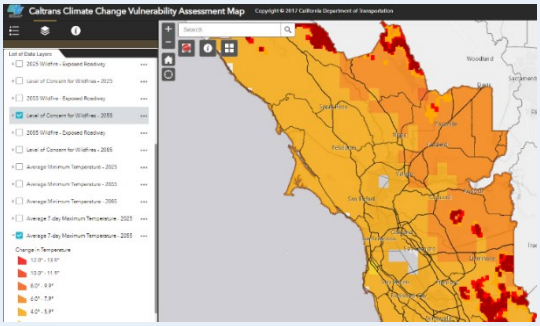
Best Practice: Building a Central Data Hub

Transportation officials, planners, and engineers need access to trustworthy, high-resolution data on observed climate change impacts and projected future conditions. For example, those designing new infrastructure or communicating climate-related risks to stakeholders must consider variables such as rainfall, streamflow, and flooding potential; projected temperature extremes; magnitude and frequency of high winds; and sea level rise and the risk it poses to coastal infrastructure.

Finding useful data can pose a challenge. With so many organizations publishing information, it can be hard to know where to start or who to trust. Interpreting the data can also be difficult for those who are not steeped in the nuances of climate change science. Transportation departments can help address these challenges by compiling "data hubs"—collections of the best available climate data, curated for quality and relevance to transportation issues and linked from a central portal. (Refer to Appendix C for widely respected climate data sources to draw from when developing a hub.)

Useful Steps

- **Determine the purpose and target audience.** One key consideration is whether to store all the data in a central database or just compile links to external sources. The former can lead to more consistent formatting and retrievability, but the latter can be a more efficient way to provide access without duplicating effort.
- **Define the scope.** What topics should the hub include? Must all data be mappable? Should the hub focus on historical observations, future projections, or both? Should it be expanded to a "resource hub" with policies, sample messaging, and other information?
- **Collect and catalog data.** For each source, catalog data attributes that could support searching or filtering in a web-based data tool. For example, users might want to search by topic, date range, or spatial coverage. Prepare language to help users select and apply the appropriate variable to their inquiries.
- **Curate the list.** To avoid presenting users with too many options and having to maintain a massive compilation, it can be useful to narrow the list to a smaller group of data sets representing the best available sources. You can determine this objectively by applying criteria (e.g., credible government/peer-reviewed sources, freely accessible data, high likelihood of future data updates) and prioritizing sources that provide the strongest spatial and temporal coverage and resolution.
- **Make a maintenance plan.** A data hub can become outdated as external data sources are updated, moved, or perhaps discontinued. Consider committing to a periodic review for accuracy and working links. Soliciting user suggestions can help to "crowdsource" upkeep.



An example of a data portal: the Caltrans Climate Change Vulnerability Assessment Map allows users to zoom into components of the highway system that could not be specifically discussed in a printed vulnerability assessment report. As Caltrans staff assess risks to specific components of the state highway system, they might need higher resolution data.

Best Practices for Communicating with the Public

Best Practices at a Glance: The Public

- ☐ Simplify the message and provide context or explanation where needed:
  - Avoid scientific jargon.
  - Use metaphors and analogies.
- ☐ Focus on framing:
  - Depoliticize the message.
  - Focus on positive messaging.
  - Correct misconceptions.
- ☐ Tailor your message to your audience:
  - Be sensitive of cultural, educational, and political backgrounds.
- ☐ Focus on local impacts.
- ☐ Tell real stories:
  - Use both experiential and statistical evidence.
- ☐ Use effective visualizations:
  - Depict a hopeful future.
  - Avoid cliché images.

Simplify your message.

Climate change involves complex scientific concepts and principles that are difficult for those without a scientific background to understand. Presenting climate change research in a simple, clear, relatable way is imperative to preventing the spread of misperceptions and the creation of opposing narratives. One way to simplify the message is by avoiding scientific jargon—that is, words that are well understood in the scientific community but might be unfamiliar or have different meanings to non-scientists. Examples of commonly misunderstood terms and better alternatives (adapted from Somerville and Hassol, 2011) include:

- "Values"—to many, this means ethical or monetary values. When talking about data, consider saying "numbers" instead.
- "Error" or "uncertainty"—non-scientists might incorrectly infer that the data are inaccurate or mistakes (errors) were made. Instead, consider "difference from exact true number" or provide a range of possible numbers.
- "Anomaly"—this suggests an abnormal occurrence, whereas you could achieve your intended meaning by saying "difference or change compared with the long-term average."

Another strategy is to use metaphors and analogies to provide a familiar point of reference for the audience. Keep your message clear and concise, and make sure it conveys impactful information that will be understandable to those who do not have much familiarity with climate change—yet also useful to those who do.

Understand your unique audiences.

Commuters boarding VTA light rail in downtown San Jose. (credit: "Busy light rail" by Richard Masoner, CC BY 2.0)

Keep in mind that you are not just communicating with a "general public" where everyone behaves and responds the same way. Rather, your audience likely comprises several different groups or segments, each with their own characteristics and needs. Therefore, it is important to consider a variety of factors when communicating climate change to the public—particularly in a state as populous and diverse as California. For example, what is the educational and cultural background of the people you are trying to reach? Do they have any unique characteristics (e.g., linguistically isolated or economically disadvantaged) that could make them more vulnerable to the impacts of climate change, influence their perceptions, or create communication challenges? Are there any barriers to buy-in (e.g., political views)? It is best to conduct actual research to identify these audience segments and their characteristics, as opposed to making assumptions about them.

Tailor your message.

Once you understand your audiences' needs, it is a best practice to tailor your messaging accordingly. For example, people with different worldviews or political perspectives tend to prioritize different values, so it helps to tailor your climate change messaging to the values that will resonate most with your particular audiences. Examples could include economic security, fiscal responsibility, a duty to help others who are less fortunate, or obligations to future generations, among others. Ensure you reach diverse audiences by providing information in a variety of common languages of the state. Depending on education level, you might have to correct ingrained misconceptions by starting from the beginning and presenting climate change basics in a clear, easily digestible format.

Focus on framing.

The way you frame the scientific facts behind climate change is important for reaching a wider audience. For example, research has shown that more people are motivated to take action on climate change when it is framed as a public health issue with economic implications—not just an environmental issue. To further depoliticize the message, be sure to consistently convey Caltrans' perspective on climate change as an organization, and do not impart your personal views on organizational work. Focus on positive messaging instead of worst-case scenarios by combining discussion of worrisome climate impacts with positive solutions and actionable behaviors. Also, correct the misconception that scientists disagree about whether climate change is happening and whether it is human-caused; reframe the discussion of climate change not as a debate, but as a settled scientific fact.

Focus on local impacts.

People feel more responsible and motivated to take action when presented with specific and visible impacts to their communities. In recent years, California has experienced record water shortages, devastating wildfires, floods, and landslides. Discussing how climate change is directly related to the frequency and increased severity of these events helps to put the threat of climate change into immediate, emotionally relevant terms for the public.

The Helena Fire in August and September 2017 burned the area around SR 299 in Trinity County. (credit: Caltrans District 2)

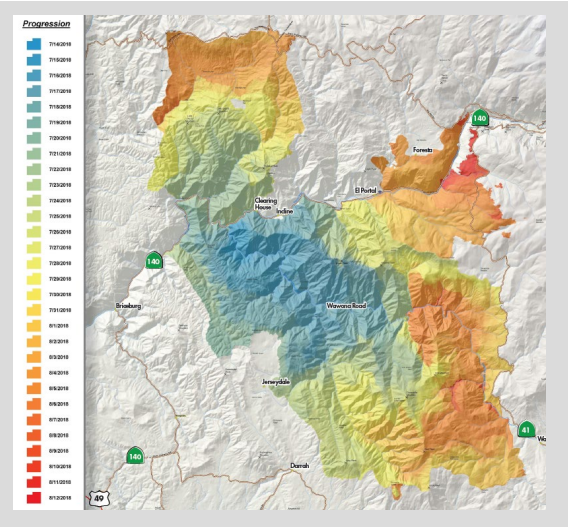
Tell real stories.

Telling stories of real individuals affected by climate change can help people better relate to the issue and understand its potential impacts. Personal experiences—such as those told by wildfire survivors—can elicit a stronger emotional connection than simply stating that as of May 2019, wildfires have destroyed almost 250,000 acres of land. But be sure to go beyond victims, too. Tell stories of leaders and innovators within the climate change movement or give examples of how local governments successfully implemented new mitigation or adaptation solutions. For example, Caltrans has supported many municipalities in their climate planning work with the SB1 Adaptation Planning Grants. These grants have supported the work of innovators in their communities, such as high school students creating YouTube videos to weigh in on Alameda City's Climate Action and Resiliency Plan. Caltrans has many stories to share of working with and supporting the work of seasoned and brand-new climate leaders through information sharing (e.g., district vulnerability assessments) or grant support, to provide a few examples. Sharing these stories can inspire audiences to act.

After a wildfire, slopes are vulnerable to mudslides during and after rain. To mitigate risks to transportation infrastructure, Caltrans uses hydroseeding by helicopter to reseed burned slopes. (credit: Caltrans)

Use effective visualizations.

Effective visuals can help make climate change concepts seem more real. Best practices include using photos that depict a hopeful future, which can reinforce the idea that there is time to act, as well as avoiding cliché images (e.g., polar bear on an ice floe, melting earth) that prompt fatigue and cynicism. Select thought-provoking images that help reframe climate change in the local public's mind and tell a story that people have not yet heard. Finally, although photos can offer a snapshot of a changing world, some information—particularly long-term trends or future projections—lends itself more to a graph or a map. To optimize these graphs and maps for public use, include colorful visuals, familiar (English) units instead of metric, colors that already mean something to the user (e.g., red is hot), easy-to-understand captions, and other user-friendly features.



Map of the progression of the Ferguson Fire as shown in the Caltrans District 10 Climate Change Vulnerability Assessment Report. (credit: Caltrans District 10)

Best Practice: Be Sensitive to Your Subpopulations

The adverse effects of climate change vary by population and geography, and the optimal mitigation and adaptation strategies vary, too. In a state as vast and geographically diverse as California, it is important to consider the many types of populations served, including those most vulnerable to climate change.

Planning and Investing for a Resilient California: A Guidebook for State Agencies identifies just some of California's vulnerable subpopulations. These include low-income people, some communities of color, people with disabilities or existing health conditions, immigrants and refugees, linguistically isolated populations, the young and elderly, pregnant women, the homeless, indigenous people and tribal nations, LGBTQQ communities, outdoor workers, and people who are or have been incarcerated.

To make sure the interests of all these unique and sensitive subpopulations are represented, remember these useful tips:

1. **Tailor messages to specific subpopulations.** Craft inclusive and culturally appropriate outreach messages to reach diverse and vulnerable populations. Translate information into native languages, and use audience-appropriate examples, media, and dissemination strategies.
2. **Focus on solutions rather than the cause.** Communities that are dealing with real-life impacts of climate change will be more receptive to messages about adaptation measures that will solve the problem rather than scientific explanations of causation. For example, communications targeting rural communities where many depend on agriculture for their livelihood could focus on ways to prepare for extreme weather and the increasing risk of severe floods and droughts.
3. **Tell stories about how you helped a local community.** Whether targeting urban or rural, coastal or mountain populations, focus on what is happening in their backyards. For example, in outreach to coastal communities, tell a real-life story about how Caltrans has preserved accessibility to beaches while improving coastal corridors and reducing travel times.
4. **Use visuals to overcome language barriers.** Visuals can paint a picture of climate change impacts for non-English-speakers or people with low literacy. For example, an animated GIF image of a bluff collapsing could illustrate what is meant by "erosion," and other animated graphics could be used to depict impacts that take shape over longer timeframes.

Caltrans Case Study

Demonstrating its commitment to social equity, Caltrans recently awarded a Sustainable Communities Grant for a study by the Future Mobility Initiative at the University of California, Davis. The study examined ways to increase the mobility of rural and disadvantaged communities in the agricultural San Joaquin Valley. Researchers examined how these communities could benefit from shared mobility options such as ride-sourcing, ride-splitting, car-sharing, and split car-sharing. These options represent opportunities to not only address air quality concerns, but to increase the affordability and accessibility of reliable transportation for vulnerable San Joaquin Valley residents.

Recommended Communication Channels

Table 4 provides recommended communication channels and formats that will help Caltrans address its climate communication needs. Communication channels refer to the general platforms you use to disseminate your messages, while format refers to the specific tools, products, and activities you develop within these broader categories. The channels and formats below were specifically selected to help Caltrans meet its internal and external audiences where they are and where they currently get information. They are founded on the idea that it is critical to reach audiences multiple times through multiple channels.

Table 4. Recommended Climate Change Communication Channels and Formats

Channel	Format	Audience
Assessments and reports	• Vulnerability and other risk assessments for all 12 districts. • Adaptation plans tailored to each district's unique vulnerabilities. • CTP and other long-range planning documents.	Caltrans staff Partners Public
Outreach	• Short, plain-language fact sheets distilling key messages about climate change. • District case studies and grant profiles describing work being done. • Press releases, web content, and social media posts that highlight the benefits of Caltrans activities and programs, describe achievements, and share upcoming engagement opportunities. • Engaging videos, visuals, and infographics that distill climate change information and show policies in action.	Caltrans staff Partners Public
Meetings and events	• Climate Change Working Group meetings that facilitate lateral, two-way communication between Headquarters and districts. • Regular multi-agency working groups or task force meetings that bring together all partners with a common mission. • Meetings and informal open houses with the public to share information and learn about people's priorities and concerns.	Caltrans staff Partners Public
Information-sharing forum	• Quarterly e-newsletter disseminated through a digital platform such as Constant Contact that includes policy updates, links to new climate change research, plain-language summaries of climate science, and highlights from districts and Headquarters. • Closed Facebook group or blog space.	Caltrans staff
Central data hub	• Reputable, Caltrans-endorsed climate change resources. • Impacts to facilities now, as well as long-term projections. • GIS map layers with high-resolution data.	Caltrans staff

Training	• On-boarding training for engineers that incorporates climate change information. • In-person, plain-language workshops and webinars that explain the implications and applicability of climate change to Caltrans projects. • General training and/or webinars that share the findings, lessons learned, and next steps from vulnerability and other risk assessments, as well as opportunities to apply the findings to project planning. • District-specific trainings that provide more tailored information.	Caltrans staff

Best Practices in Action: Closing the Communication Loop

This section uses flow charts to demonstrate how you can apply many of the best practices described in this guide to "close the communication loop." Closing the communication loop means that you have developed and delivered your climate change message to the intended audience(s) and evaluated whether the message was communicated effectively and accurately. At the end of this process, which is illustrated in Figure 1, you can adjust your products and messages to reflect lessons learned. This process can be adapted to any project with a climate change communications aspect.

For illustrative purposes, Figure 2 shows how Caltrans can use the closed-loop process to communicate the district vulnerability assessment results to Caltrans staff and partner organizations. Figure 3 on the next page shows the process for communicating the results to members of the public.

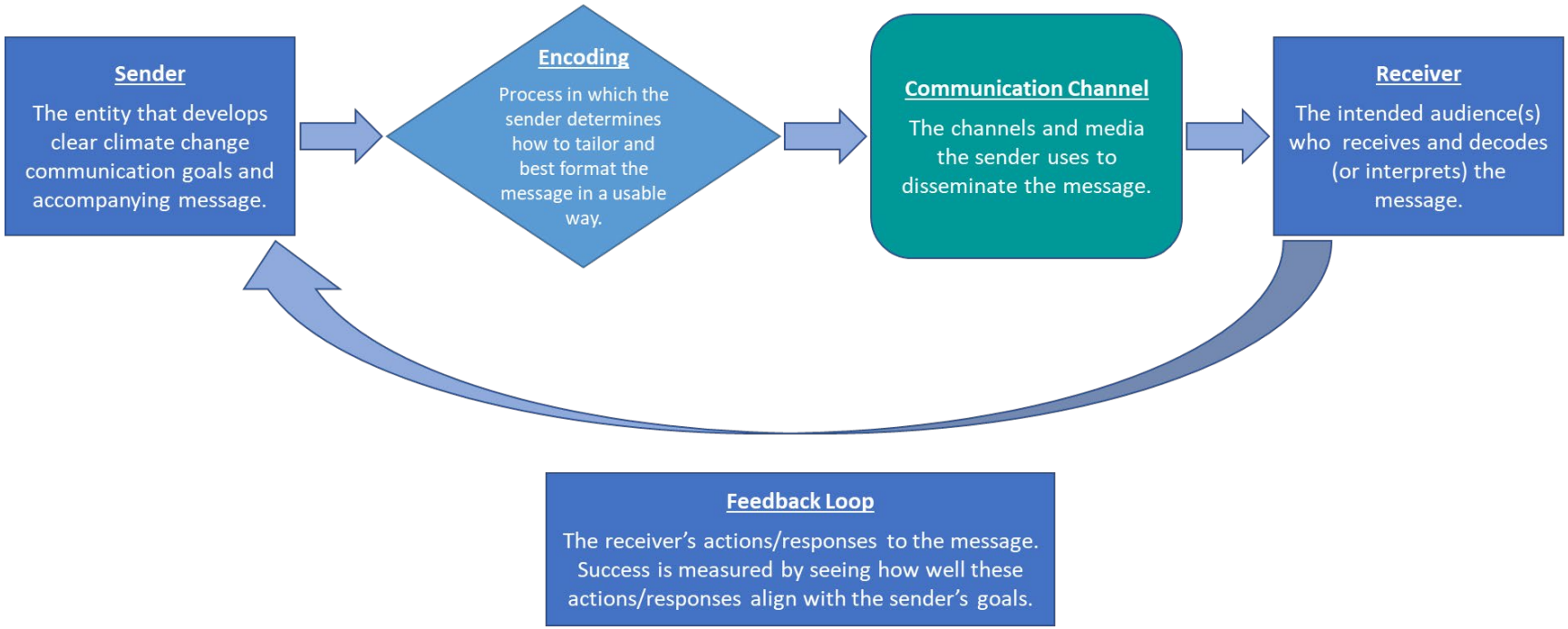


Figure 1. Process for closed-loop communication of climate change information.

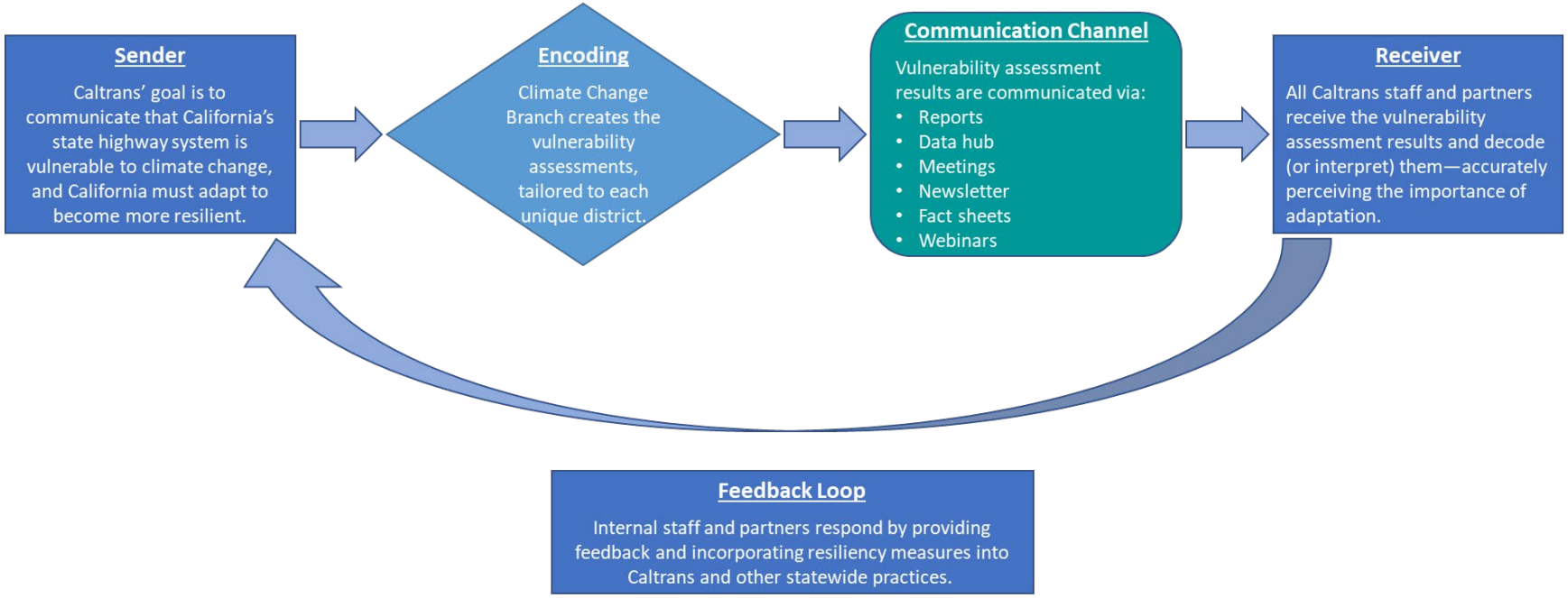


Figure 2. Communicating vulnerability assessment results to Caltrans staff and partner organizations.

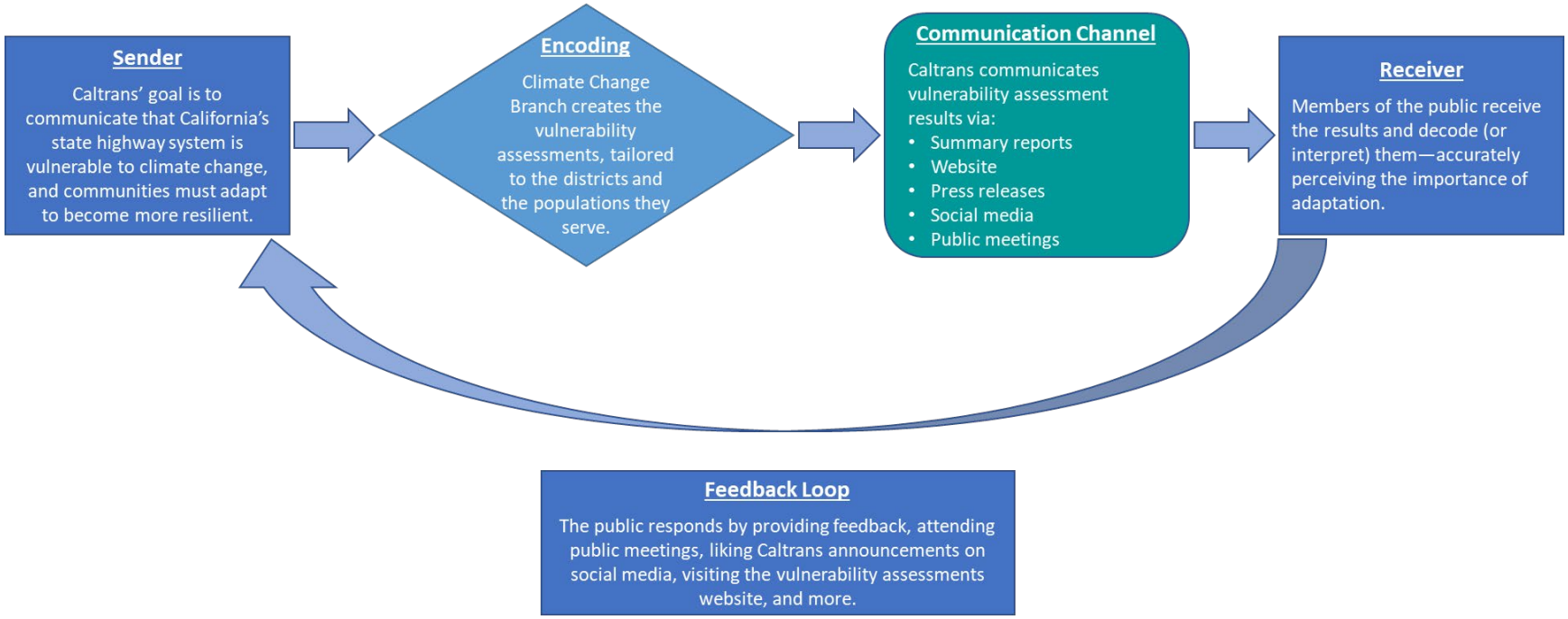


Figure 3. Communicating vulnerability assessment results to members of the public.

Appendix A: Assessment of the Current Situation

Background

California is vulnerable to nearly every climate change stressor and extreme weather threat: increasing temperatures, larger wildfires, heavier rainstorms, extended periods of drought, and rising sea levels and storm surges. These threats associated with climate change pose a significant risk to California's natural and human resources and to the state's transportation infrastructure. Caltrans must therefore plan proactively and incorporate mitigation and resilience into its planning, design, maintenance, programming, and operations.

Caltrans' climate change efforts revolve around 1) creating and maintaining sustainable practices to reduce greenhouse gas emissions from transportation operations and projects, and 2) implementing adaptation measures to increase the resilience of the state highway system to climate impacts and address vulnerabilities. The Climate Change Branch in Caltrans' Division of Transportation Planning oversees the development, coordination, and implementation of climate change policies in all aspects of the Department's decision-making. It serves as a resource for technical assistance, training, information exchange, and partnership-building.

Recently, the Climate Change Branch developed a series of vulnerability assessments for each of the Department's 12 districts. These assessments identified climate change vulnerabilities along the state highway system, including impacts from changes in temperature, precipitation, increased wildfires, sea level rise, storm surge, and cliff retreat. The assessments provide an important tool for communicating climate vulnerabilities both within Caltrans and to the Department's external partners. Caltrans is using the vulnerability assessment findings to inform adaptation plans customized for each district to increase highway resilience.

Internal and External Stakeholder Research

To supplement these efforts, Caltrans retained Eastern Research Group, Inc. (ERG) to develop a climate change communication guide. To help Caltrans develop the guide, ERG conducted the following formative research:

- **Scoping survey.** In June and July 2019, ERG worked with the Caltrans Climate Change Branch to develop and deploy an internal survey to elicit information about the Department's audiences, information dissemination mechanisms, challenges, and opportunities for enhancing climate communication. The 31 respondents represented seven districts and seven divisions or programs within Caltrans Headquarters.
- **Internal interviews.** ERG interviewed 37 representatives from all 12 districts, primarily from the transportation planning divisions, in September–October 2019. ERG also interviewed two senior staff representatives from the Division of Environmental Analysis and the Division of Design. The goals of the interviews were to:
    - Identify how internal staff currently use and communicate climate change information.
    - Identify how the districts incorporate climate change considerations into the project planning process.
    - Identify challenges when communicating about climate change internally and externally.

- Determine lessons learned from the vulnerability assessments process.
- Determine how Caltrans leadership can support the Department in improving climate change communication both internally and externally.

- **External partner interviews.** ERG interviewed three representatives from the California Air Resources Board (ARB), two representatives from the California Coastal Commission, one representative from the California Environmental Protection Agency, one partner from the California Natural Resources Agency, and seven representatives from five metropolitan planning organizations (MPOs): the San Bernardino Council of Governments, Shasta Regional Transportation Agency, San Diego Association of Governments, Kern Council of Governments, and Southern California Association of Governments. The goals of the interviews were to:
  - Learn about partner experiences in collaborating and communicating with Caltrans around climate change.
  - Identify key information that partners need from Caltrans on climate change and how to facilitate improved exchange of that information.

Figure A-1 depicts the number of participants in each research activity. The survey instrument and interview scripts are included in Appendix B.

Figure A-1. Number of participants in survey, internal interviews, and external interviews.

Common Themes

This research captured a number of consistent strengths and challenges related to climate change communication at Caltrans. These coalesced around two key themes: 1) positioning and roles, and 2) data and resources. These themes are described in more detail on the following pages.

The themes, strengths, and challenges discussed below represent key findings from the research ERG conducted under this project. Ongoing climate change communication work at Caltrans will inevitably reveal additional details and opinions that this effort did not capture.

Theme 1: Positioning and Roles

Positioning and roles refer to how internal staff and others perceive Caltrans' position and role as a department planning, building, maintaining, and safeguarding the state's transportation infrastructure.

Internal Strengths

As a state department of transportation, Caltrans has a position as a vital communicator of relevant climate information and data. Internal interviewees noted that the Climate Change Branch plays a strong role in climate change communication at Caltrans. At the

district level, some districts are also very engaged in climate change-related communication (e.g., Sea Level Rise Task Force in District 4).

Another strength is that Caltrans has some structured mechanisms that facilitate climate change communication, such as the Climate Change Working Group, which shares climate change-related directives and strategies with district representatives. The Working Group also hosts quarterly meetings with representatives from all districts, which interviewees found to be especially useful and informative.

Interviewees also noted that at the project level, different functional groups within Caltrans gather at a pre-project nomination meeting to discuss potential projects. This meeting gives planning staff a valuable opportunity to encourage other functional groups to consider adaptation and resilience measures throughout the life cycle of a project. At this stage, some climate change information is also shared through the Transportation Planning Scoping Information Sheet (TPSIS) and Project Initiation Document (PID).

The Department has also conducted vulnerability assessments and is actively engaged in adaptation planning, demonstrating Caltrans' commitment to considering climate impacts, addressing vulnerabilities, and increasing resilience. All districts have participated in vulnerability assessments and adaptation planning.

External Strengths

State agency interviewees expressed the importance of Caltrans' role as a key partner helping to solve interagency problems, such as reducing greenhouse gas emissions within the transportation sector and installing electric vehicle infrastructure. One interviewee highlighted the fact that Caltrans is the only agency they work with out of 44 agencies that has both a Sustainability Program and a Climate Change Branch.

External partners also emphasized the usefulness of meetings with Caltrans, such as an October 2019 statewide meeting in which partners met with a variety of representatives from Headquarters and outlined follow-up actions on how to collaborate to strengthen climate-related considerations in district planning documents. These types of information exchanges reaffirm Caltrans' commitment to addressing climate change with external partners.

Internal Challenges

While the research revealed vital strengths, it also showed where opportunities exist for improvement in defining Caltrans' position and role. Internally, interviewees expressed a need for a clear, consistent, top-down articulation of Caltrans' climate change policy and priorities. Interviewees also want more lateral communication between Headquarters and the districts, as well as among the districts, about what has been accomplished, what is currently being done, and what needs to be done in the future.

The research also suggested that climate change is internally perceived as largely Headquarters' domain and as a planning/environmental function. Interviewees noted that outside of planning, climate change is often viewed as a low priority—particularly due to timing or funding limitations. Some staff also view climate change as a political issue, which can influence the level of trust with which they view climate data. Some rural and inland

district representatives described encountering resistance or apathy about climate change among some of their colleagues.

Confusion also exists internally about roles and responsibilities when it comes to climate change (e.g., what is the role of the Climate Change Branch vis-a-vis the Environmental Division). Some interviewees said they do not know who the climate change contact is in their district or Headquarters, what other functional units do or require, or how internal units interface with external partners regarding climate change. Interviewees expressed a desire to integrate more offices, branches, and divisions (not just environmental and transportation planners) in climate change efforts, as well as more coordination between adaptation planning and project delivery. Internal interviewees reported that climate change considerations are largely handled at the project level on a case-by-case basis without a uniform approach.

External Challenges

External interviewees indicated a desire for closer collaboration and more proactive communication from Caltrans about the Department's position and role in climate change-related efforts. Permitting agencies especially felt that Caltrans needs to more strongly state its position in regard to viewing climate change as a priority. An interviewee also noted that inconsistent messaging among state agencies regarding adaptation scenarios and requirements poses a challenge for organizations applying for grant funding from multiple agencies. They suggested that greater alignment in messaging would allow Caltrans and its statewide partners to present a consistent, united front to stakeholders, the public, and grant applicants.

Partners at MPOs and permitting agencies also expressed a desire for more involvement, consultation, and timely exchanges with Caltrans when the Department conducts climate-related studies like the vulnerability assessments. They noted that it can be challenging to provide meaningful and useful feedback if they are not more integrated in the assessment development process.

Theme 2: Data and Resources

Internal Strengths

Caltrans currently provides valuable information about climate change vulnerabilities and impacts on California's transportation infrastructure. The Department's vulnerability assessments provide very useful high-level data about district vulnerabilities by identifying areas of high exposure to potential climate change stressors. The assessments used the most up-to-date climate models to help the districts and their partners understand how a changing climate could affect transportation system operations and users. These assessments provide foundational information on climate risk that Caltrans staff can integrate into long-range planning and project-level policies and documents.

Furthermore, Caltrans has internal design manuals and resources that provide climate change-related guidance, such as the Highway Design Manual (see "Topic 615: Climate" on pp. 610–619), which provides some direction on incorporating the effects of climate change into pavement engineering; the 2011 Guidance on Incorporating Sea Level Rise, for use in the planning and development of PIDs; and the climate change sections of the TPSIS and PID documents.

External Strengths

Several partners pointed out that Caltrans has done a lot in terms of identifying vulnerabilities and adaptation actions, particularly with the climate change vulnerability assessments. They suggested that the assessments provide good, higher-level treatment of the climate change issues California is grappling with now.

MPO interviewees mentioned that Caltrans has communicated useful recommendations that they have incorporated in their regional transportation plans. These partners emphasized that guidance materials released by Caltrans on climate impacts and mitigation strategies have also been valuable research tools that they cited within their planning documents.

Internal Challenges

While the vulnerability assessments are an important resource and provide useful high-level data, some internal interviewees indicated they need more specific or additional information than what is contained in the assessments.

Internal survey respondents and interviewees pointed to the availability and validity of climate change data as a key challenge, particularly for projections of climate stressors. Not only is there a preponderance of different data sets and models (e.g., Cal-Adapt has 10 models for precipitation that apply to California and the National Oceanic and Atmospheric Administration has additional models), but the data are inherently uncertain and often lack the needed level of geographic/district specificity and granularity. Information that staff receive from one source sometimes conflicts with information they receive from other sources. Staff said there is a lack of authoritative consensus on what resources, data sources, and projections to use.

Interviewees said they want clarity and consistency around data and data assumptions, as well as guidance on how to use those data to make informed planning design decisions and manage day-to-day assets. While Caltrans has manuals to guide functional areas in project development, much of the current guidance—like the Highway Design Manual and the Project Development Procedures Manual—provides minimal climate change information and needs to be updated. Moreover, interviewees in non-coastal areas expressed a need for more resources about non-sea-level-rise climate stressors.

Interviewees mentioned that within Caltrans, information about climate change is not centralized. Many functional groups and units are working on different projects, and there is no place to catalogue information, so everyone knows where to go. Many interviewees across the districts suggested Caltrans set up a centralized website or Intranet site that can be managed in real time, where individuals can find and share information. Having a central resource hub would enable Caltrans' staff to avoid redundancy in researching climate-related topics that other districts have already addressed.

External Challenges

Like internal staff at Caltrans, external interviewees also felt that the vulnerability assessments provide useful high-level data, but said they need more specific or additional data. For example, permitting agencies would like more information to help them identify priority infrastructure areas in need of adaptation, the costs of different adaptation

strategies, and potential funding sources. Interviewees suggested that more detailed information would better support statewide decision-making.

External partners also highlighted the fact that many different agencies collect or monitor data related to climate change, but they do not have the data all in one place. For example, a state agency interviewee said they did not know what tools Caltrans used to collect climate data, or even what types of data Caltrans collected until they attended an interagency meeting where state agencies described their data collection methods and findings.

MPOs and state agencies noted that they found it difficult to access climate change reports or information on the Caltrans website while that website was being remediated for accessibility purposes. Permitting and state agency interviewees also said they find it challenging at times to get information about what Caltrans is doing regarding climate investments, implemented projects, or climate change programming more broadly.

Addressing Challenges Through Effective Communication

In building on the strengths above and addressing the challenges that staff and partners shared, Caltrans can use this guide to help implement its new tools and resources—and share them with internal and external audiences—effectively. This guide could also help to inform future strategic planning efforts around topics such as developing consistent climate change messaging, compiling authoritative data sources, building internal expertise and capacity, and ultimately strengthening partnerships within and external to the Department.

Unique District Concerns

The themes, strengths, and challenges discussed above highlight recurring findings from across the districts. The following are some unique concerns the districts identified during the interviews:

- **District 1 (Eureka):** The district is rural and not heavily populated, and it faces funding constraints.
- **District 2 (Redding):** The district needs to think about social equity and sustainability from a rural rather than urban lens.
- **District 3 (Marysville/Sacramento):** Climate change communication is largely concentrated in one person's responsibility; the district needs more diffused knowledge.
- **District 4 (Bay Area/Oakland):** Sea level rise is a daily problem. The district has a sense of urgency regarding climate change and a well-informed public that wants to know what Caltrans is doing.
- **District 5 (Central Coast):** Some staff think projects only need to address sea level rise impacts; they do not see how precipitation, temperature changes, and wildfires relate to their work.
- **District 6 (Fresno/Bakersfield):** Many people in the Central Valley do not think they need to worry about climate change if they do not live near the ocean.
- **District 7 (Los Angeles):** Staff must communicate with system planners about climate change impacts along the I-405 corridor.

- **District 8 (San Bernardino/ Riverside):** The district would like a project planning menu or checklist of what can be done within budget regarding climate change, using Complete Streets as a model.
- **District 9 (Bishop):** Some staff and many community members view climate change as a political agenda and do not believe it is happening.
- **District 10 (Stockton):** Local communities do not want to see flood risk maps because they affect real estate values.
- **District 11 (San Diego):** Most concerns involve sea level rise because of the coastline, but there is also an interior county that experiences extreme heat and flooding. Climate change planning must address multiple extremes (sea, desert, forest).
- **District 12 (Orange County):** Some staff view Caltrans' role as reducing travel delays and maintaining roads for vehicles; climate change is not seen as a focus of daily work.

Credit: Caltrans District Map

Conclusion

In building on the strengths and addressing the challenges discovered during this formative research, ERG worked with Caltrans to develop the *California Department of Transportation Climate Change Communication Guide*. The guide articulates best practices that Caltrans can use to educate, inform, and strengthen collaboration within Caltrans, among external partners, and with the public on the topic of climate change. Climate change communication is a Department-wide responsibility. As such, all staff at Caltrans, from Headquarters to the districts, can benefit from using the best practices suggested in the guide.

Appendix B: Survey Instrument and Interview Scripts

Internal Scoping Survey (distributed to Caltrans staff)

Introduction

Caltrans is developing a communication plan to strengthen and inform Caltrans' communication around climate change. Please answer the following questions so we can learn more about how your work intersects with climate change, about your stakeholders and partners, and about your role in communicating around climate change vulnerabilities and adaptation. We appreciate your participation and feedback on these short questions.

Please send your completed survey to Michael.Sidhu@dot.ca.gov.

Who are your main audiences for communicating around climate change? Please list internal or external audiences as appropriate to your work.

What are their informational needs? (Please check all needs that are applicable.)

- ☐ Basic information about climate change
- ☐ Information related to the intersection of greenhouse gas emission reduction policies/strategies and climate adaptation action
- ☐ Potential transportation system vulnerabilities
- ☐ Projections (e.g., amount of sea level rise)
- ☐ Potential impacts of climate change on transportation system
- ☐ Adaptation strategies
- ☐ Information about what other districts/agencies/organizations are doing
- ☐ Guidance on integrating climate risk information into day-to-day asset management
- ☐ Other (please specify)

What challenges do you face in communicating about potential climate change threats and solutions with your audiences?

What kinds of activities and/or channels do you use to communicate with your audiences (e.g., teleconferences, webinars, emails)?

Are there any tools or resources that you are aware of that would be helpful to you in your communication around climate change?

Do you have any other comments or suggestions for enhancing Caltrans' climate change communication that you would like to share?

Interview Guide for District Staff

Introduction

Caltrans has received a grant from FHWA to develop a communication plan to strengthen internal and external engagement and outreach around climate change. ERG is providing support.

Our goal today is to learn more about your experience in communicating about climate change in your work. This will inform the development of the communication plan. The plan will support your work moving forward by articulating goals, audiences, messages, and strategies for communicating about climate change.

Introductions: Name, role

Climate Change Communication in Your Work Overall

1. Let's start by talking about climate change information in general. What kind of information do you use and communicate within your district related to climate change? Who needs this information?
2. Now to get a bit more specific, when a project moves through the Caltrans planning to implementation process in your district, how is climate change considered? Can you please walk me through step by step?
3. Who is responsible for gathering and integrating information on climate change impacts at each step?
4. Who *should* be involved? How could there be better communication about climate change impacts and adaptation in the planning process?
5. How would you describe the main challenges you face in communicating about climate change issues within your district and with headquarters?
6. What kinds of strategies have you found to be effective in addressing these challenges?
7. Now let's talk about external communication. Who do you communicate with externally around climate change issues?
    a. What information do external audiences need from you around climate change?
    b. Who provides that information?
    c. What challenges do you face in providing this information?
    d. [If relevant….] What could help you in your external communications?
8. Is there anything else that you would like to mention regarding climate change communication that we haven't already covered?

Vulnerability Assessment Process and Outputs

1. Now we just want to talk for a few minutes about the vulnerability assessment that was done/is underway for your district. Can you give me an overview of the process used to develop the vulnerability assessment for your district?
2. Who was involved within Caltrans and what role did they play?
    a. Were these/are these the appropriate people?

b. What were some of the lessons learned from this process?

3. How are you using the final products if already available (Technical Report, Summary Report, online maps)? [Probe for how useful these items are for communicating with staff and external partners]

Interview Guide for External Partners

Introduction

Introductions: Name, Role

Caltrans received a grant from FHWA to develop a communication plan to strengthen internal and external engagement and outreach regarding climate change. The Climate Change Communication Plan will support your work moving forward by articulating goals, audiences, messages, and strategies for communicating climate change issues and topics.

The intended outcome of this interview is to get your feedback on:

- How do you currently communicate climate change? What within your current means of communication is working well?
- How can climate change communication be improved both internally and externally?

Climate Change Communication in Your Work

1. Tell me about how your agency's/institution's work as it relates to extreme weather and climate impacts on the transportation system?
2. What kind of challenges or pain points do you face in communicating around climate change?
3. What strategies or systems do you find to be successful in communicating around climate change?
4. How you interface or engage with Caltrans around climate change issues?
    a. Di you meet with Caltrans staff (regularly, ad hoc)?
    b. Do you seek out information from Caltrans or does it come to you? Probe for detail: "If so, how, when, where, from whom, etc.?"
    c. How do you currently seek out or receive this information?
    d. Would you prefer to get or be able to access the information from Caltrans in a different way (e.g., more/less frequently, digitally, in-person in a public meeting, in-person privately, etc.)?
5. What Caltrans programs and/or functional units do you commonly interface with (e.g. Transportation Planning/Local Assistance, Environmental Analysis, Program/Project Management, Construction, Maintenance, Design?
6. What kinds of information do you seek or receive from Caltrans around climate change?
    a. How do you use this information, for example to support your project planning, to apply for funding, to implement and report on grants? Other?
    b. With whom do you share this information (e.g., upper management, constituents, partners, media, elected officials)?

7. Does this information meet the needs of your program/mission/organization?
8. Thinking back to the last time you received/sought climate change information from Caltrans, can you share your thoughts about the information's effectiveness and usefulness?
    a. Was it provided at the "right" time? Was it provided without undue delay?
    b. Was it at the right technical level (too technical? too basic?)?
    c. Did it answer your informational need(s)?
    d. Did you trust it? Trust the source it came from? Trust that it was accurate?
9. In your view, moving forward, how could Caltrans do better in communicating around climate change to you and your organization?

Interview Guide for Caltrans Divisions of Environmental Analysis and Design

Introduction

The Climate Change Communication Plan will support your work moving forward by articulating goals, audiences, messages, and strategies for communicating climate change issues and topics.

Introductions: Name, Role

Caltrans received a grant from FHWA to develop a communication plan to strengthen internal and external engagement and outreach regarding climate change.

The intended outcome of this interview is to get your feedback on:

- How do you currently communicate climate change? What within your current means of communication is working well?
- How can climate change communication be improved both internally and externally?

Climate Change Communication in Your Overall Work

1. How would you describe the main challenges you face in communicating climate change issues within your division, across divisions, and with the Districts?
    a. What kinds of strategies have you found to be effective in addressing these challenges?
    b. What form(s) of communication do you have with Caltrans Directors?
        - What communication mechanisms are used to share climate change related topics within your division and beyond to ensure it is implemented?
2. How do you see yourselves advancing communication regarding climate change within the organization?
    a. What barriers do you face and how do you overcome them?
    b. When does your Division consider climate change?
3. Who is responsible for gathering and integrating information on climate change impacts at each step?

a. Please describe how communication regarding climate change impacts and adaptation could be improved

b. Do you think the improved communication needs to come from the Districts, HQ, or both?

External Communication

1. Who do you and or your staff communicate with externally regarding climate change?
    a. What challenges do you and staff face in communicating externally?
    b. How could external communication be improved?
    c. What challenges and effective strategies have you encountered in communicating with regulatory agencies on climate change?
        - Consider communications you prepare for the agencies as well as those you receive from the agencies.

Is there anything else that you would like to mention regarding climate change communication that we haven't already covered?

Appendix C: Suggested Climate Change Data Sources

When developing a central data hub, consider sourcing data from existing data repositories, indicators published by government agencies (e.g., www.epa.gov/climate-indicators; https://oehha.ca.gov/climate-change/report/2018-report-indicators-climate-change-california), and synthesis reports like the National Climate Assessment (NCA) (www.globalchange.gov) and state-level analogues.

The Federal Highway Administration's Vulnerability Assessment and Adaptation Framework (2017) recommends several specific data sources of use for transportation planning, as well as types of organizations to consult for additional data. In particular, see Section 3 of the framework.

Within California, the state's official Climate Change Assessment (http://climateassessment.ca.gov) provides access to a wealth of authoritative observed and projected climate data, including interactive graphs and high-resolution mapping tools through the Cal-Adapt portal (https://cal-adapt.org). Projections in Cal-Adapt have been downscaled to provide more granular resolution than the underlying global climate models.

For additional variables or broader nationwide coverage, examples of widely respected sources of underlying data include the following:

- Within the National Oceanic and Atmospheric Administration (NOAA), the **National Centers for Environmental Information** (NCEI: www.ncei.noaa.gov) provides access to historical weather and climate data from long-running, quality-controlled networks of weather stations across the United States. NCEI also stores an extensive array of oceanographic and geophysical data.

- The **U.S. Geological Survey** (https://waterdata.usgs.gov/nwis) maintains a comprehensive database of historical information about rivers, streams, and lakes across the United States—including data collected by a variety of state and federal agencies. This database is a useful source of data to calculate long-term trends in water levels, streamflow, and other variables related to flooding.

- For projections of future climate change in the United States, see the projections associated with the NCA. As of 2020, the preferred projections come from a suite of global climate models called the **Coupled Model Intercomparison Project Phase 5** (CMIP5) (https://esgf-node.llnl.gov/projects/cmip5), along with some downscaled regional climate models. Consult with a climate modeling expert for help obtaining and interpreting detailed model outputs.

Appendix D: Climate Change Communication Resources

Agency/Author	Citation	Resource/Year	Key Takeaways
Matthew T. Ballew, Anthony Leiserowitz, Connie Roser-Renouf, Seth A. Rosenthal, John E. Kotcher, Jennifer R. Marlon, Erik Lyon, Matthew H. Goldberg, and Edward W. Maibach	Matthew T. Ballew, Anthony Leiserowitz, Connie Roser-Renouf, Seth A. Rosenthal, John E. Kotcher, Jennifer R. Marlon, Erik Lyon, Matthew H. Goldberg & Edward W. Maibach (2019) Climate Change in the American Mind: Data, Tools, and Trends, Environment: Science and Policy for Sustainable Development, 61:3, 4-18, DOI: 10.1080/00139157.2019.1589300	Climate Change in the American Mind: Data, Tools, and Trends 2019	• Recognize that **#political** views affect climate change opinions. Conservative Republicans remain outliers relative to other Americans in denialism. • Focus on "gains" such as benefits of action to economies and societies rather than losses (e.g., carbon taxes). • Consider messaging around **#moral** values (ingroup loyalty, authority, respect, and purity), which resonate with the moral concerns of conservatives. • Communicate the co-benefits to society provided by climate solutions—especially those that accrue in the near versus the distant future. • Use **#hopeful** emotions (see also Smith and Leiserowitz).
N. Smith and A. Leiserowitz	Smith, N., & Leiserowitz, A. (2014). The role of emotion in global warming policy support and opposition. Risk analysis: an official publication of the Society for Risk Analysis, 34(5), 937–948. doi:10.1111/risa.12140	The Role of Emotion in Global Warming Policy Support and Opposition 2014	• Recognize that discrete emotions (e.g., worry, hope, fear) are strong predictors of climate change policy support • **#Worry** is the single strongest predictor. The more people worry about climate change warming, the more likely they will support climate and energy policies. • **#Fear** appeals are often ineffective or even counterproductive. "Dire" messaging around extreme weather and other issues can distance the public. • Use messaging around **#positive** (rather than negative) emotions, which are more apt to promote positive attitudes toward climate change mitigation.

Agency/Author	Citation	Resource/Year	Key Takeaways
Columbia Center for Research on Environmental Decisions	Center for Research on Environmental Decisions. (2009). The Psychology of Climate Change Communication: A Guide for Scientists, Journalists, Educators, Political Aides, and the Interested Public. New York.	The Psychology of Climate Change Communication 2009	• Know your **#audience**. Consider political affiliation, demographics, subcultures). Reference local impacts to increase audience connection to the issue. Leverage local extreme weather events. • Tap into people's desire to avoid future losses rather than realize future gain (e.g., it is better to lose a little now than a lot more in the future). • Translate scientific data into concrete experience. People respond better to **#experiential** (e.g., real stories of cc) rather than statistical evidence. • Use vivid imagery and messages highlighting **#personal** experience and that are designed to elicit an emotional response. • Avoid scientific language, **#jargon**, acronyms, and technical terms. Jargon-filled explanations of uncertainty can translate into a belief that the science is unreliable. • Emphasize that scientific **#uncertainty** alone is not an adequate justification for inaction or business-as-usual policies and behaviors. Rather, it suggests that, at a minimum, it would be prudent to develop contingency plans and adopt adaptive management strategies. • Recognize appeals to emotion work in short term, but people can't retain that level of emotional intensity. • Effects of worry can lead to emotional numbing. • Address scientific and climate change uncertainties. • Tap into social identities and affiliations. • Balance information that triggers an emotional response with more analytic information. • Communicators should suggest neither more, nor less scientific certainty about climate change than actually exists. When significant uncertainty remains about a specific effect, they should explain why that uncertainty exists (e.g., the systems involved are so complex that science has yet to understand them sufficiently). • Acknowledge that an audience has other pressing issues.

Adam Corner, Robin Webster, and Christian Teriete	Corner, A., Webster, R. & Teriete, C. (2015). Climate Visuals: Seven principles for visual climate change communication (based on international social research). Oxford: Climate Outreach.	Climate Visuals : Seven principles for visual climate change communication (based on international research) 2015	Developed by the nonprofit Climate Outreach, this library of visuals is available for communicators to use and is based on seven core principles for effective communication. The principles were developed based on research conducted internationally with the public. **1. Show 'real people', not staged photo-ops** • staged photos are perceived as 'gimicky'/manipulative - especially when politicians are featured **2. Tell new stories** • classic images (polar bears on melting ice caps, deforestation, smoke stacks, etc.) are quickly and easily understood, but can prompt fatigue and cynicism • less familiar and more thought-provoking images help to remake the image of climate change in the public mind and tell a new story they have not yet heard **3. Show climate causes at scale** • when communicating links between problematic behavior and climate change (meat-eating), it is better to show the large-scale impact of the behavior rather than the individual one to prevent defensive reactions **4. Climate impacts are emotionally powerful** • images of climate impacts (e.g. floods) are more moving than images of causes or solutions • pairing images of impacts with actions individuals can take helps to prevent the individual from becoming overwhelmed **5. Show local (but serious) climate impacts** • strike a balance between localizing climate change (so that individuals understand it is relevant to them) and trivializing the issue by not making the bigger picture clear enough **6. Be very careful with protest imagery** • images of protesters attract cynicism - many people don't feel an affinity with "typical environmentalist" protesters • more effective to show images of people directly affected by climate change **7. Understand your audience** • images of "distant" climate impacts were not as impactful among the political right

Agency/Author	Citation	Resource/Year	Key Takeaways
			• images of climate change 'solutions' were received positively by those on the left and right
IPCC	Mastrandrea, M.D., C.B. Field, T.F. Stocker, O. Edenhofer, K.L. Ebi, D.J. Frame, H. Held, E. Kriegler, K.J. Mach, P.R. Matschoss, G.-K. Plattner, G.W. Yohe, and F.W. Zwiers, 2010: Guidance Note for Lead Authors of the *IPCC Fifth Assessment Report on Consistent Treatment of Uncertainties*. Intergovernmental Panel on Climate Change (IPCC)	Guidance Note for Lead Authors of the IPCC Fifth Assessment Report on Consistent Treatment of Uncertainties 2010	Designed to assist lead authors of the AR5 in the consistent treatment of uncertainties. The guidance provides definitions of "likelihood" (based on probability of an outcome) and "confidence" (based on agreement and evidence, but not interpreted probabilistically). The guidance assigns numerical values to phrases; for example, the guidance defines "virtually certain" as 99-100% probability, "about as likely as not" to a 33 to 66% probability and "very unlikely" to a 0-10% probability.
IPCC	Corner, A., Shaw, C. and Clarke, J. (2018). Principles for effective communication and public engagement on climate change: A Handbook for IPCC authors. Oxford: Climate Outreach.	Principles for effective communication and public engagement on climate change: A Handbook for IPCC Authors 2018	Distills essential principles for effective communication and engagement with practical tips, including 1) be a confident communicator, 2) talk about the real world, not abstract ideas, 3) connect with what matters to your audience, 4) tell a human story, 5) lead with what you know, and 6) use effective visualizations.

Agency/Author	Citation	Resource/Year	Key Takeaways
Tyndall Centre for Climate Change Research	Harold, J., Lorenzoni, I., & Minns, K. R. C. A. (2017). Enhancing the accessibility of climate change data visuals.	Enhancing the Accessibility of Climate Change Data Visuals 2017	Focuses on 12 evidence-based guidelines for enhancing the accessibility of data visuals while maintaining scientific accuracy. While the guidance is directed at IPCC, the guidance has broad applicability beyond just IPCC data visuals. Based on the 'MADE' principle: Message, Audience, Design, Evaluation • Identify your main message • Assess audience's prior knowledge • Consider how your audience thinks • Choose visual formats familiar to your audience • Reduce complexity where possible • Build-up information to provide visual structure • Integrate and structure text • Avoid **#jargon** and explain acronyms • Use cognitive perceptual design principles • Consider cognitive aspects when using digital animation and interaction • Consider cognitive aspects when visually communicating uncertainty • Test visuals to check comprehension

Yale Program on Climate Change Communication	Roser-Renouf, C., Stenhouse, N., Rolfe-Redding, J., Maibach, E., & Leiserowitz, A. (2015) Engaging diverse audiences with climate change: Message strategies for Global Warming's Six Americas. In Cox, R. & Anders, H. (eds.) Handbook of Environment and Communication.	Engaging Diverse Audiences with Climate Change: Message Strategies for Global Warning's Six Americas 2014	Designed to help communicators understand the sources of diverse perspectives on climate change in the United States and develop messaging content to effectively communicate with these different audiences. • Messages that ignore #cultural and #political foundations of the public's view of climate change are less likely to be effective Global Warming's Six Americas – unique audiences that view and respond to climate change in distinct ways • **Alarmed** – certain global warming is happening, perceive it as a current and future risk, is human-caused, is potentially solvable, and they understand that scientists think it is happening • **Concerned** – largest difference between concerned and alarmed is the proportion reporting high levels of involvement with climate change (13% compared to 63%) **Engagement Strategies for Alarmed and Concerned:** o Use centrally processed arguments to promote lasting behavior change o Build perception of efficacy to compliment perception of high risk and to motivate action o Tap potential to act as opinion leaders • **Cautious** – more likely than not to believe climate change is happening, believe the future is at risk but less likely to believe their family is at risk/that it is a current issue, have given little thought to climate change • **Disengaged** – have given least amount of thought to climate change **Engagement Strategies for the Cautious and Disengaged:** o Use visual imagery, humor, and attractive or highly credible sources o Promote positive social norms – climate-friendly behaviors are popular, respected, the norm o Show rather than tell o Personalize the threat by showing #local impacts or impacts on emotionally significant places (national parks) o Generate involvement by telling a story • **Doubtful** – many believe global warming is happening but view it as low risk and less convinced that humans have caused it or

Agency/Author	Citation	Resource/Year	Key Takeaways
			can solve it, few think scientists agree that climate change is happening, not strident in their views • **Dismissive** – most certain that climate change is not happening and are highly confident in their views, don't believe it is having negative impacts now, think about climate change a lot **Engagement Strategies for the Doubtful and Dismissive** o Adopt less #confrontational and more indirect approaches o Persuade that their beliefs about climate change are incorrect, rather than simply informing of existing beliefs that climate change is real o Climate change can be perceived as a threat to values of individualism and respect for established order – communicate about climate change in more value-congruent ways o Point out #concrete ways in which people have been impacted by climate change o **#Frame** impacts in view of public health o Use simple and easy to understand language
Yale Program on Climate Change Communication	Leiserowitz, A., Cutler, M., & Rosenthal, S. (2017). Climate change in the Latino mind: May 2017. Yale University. New Haven, CT: Yale Program on Climate Change Communication.	Climate Change in the Latino Mind 2017	Based on two surveys of Latinos' engagement and viewpoints on climate change in the United States. The report summarizes Latinos' beliefs and attitudes, policy and politics, and actions and behaviors around climate change. • Latinos are more engaged with global warming than non-latinos • Latinos are more convinced it is happening, human-caused, more supportive of climate change policies, more concerned about risks, more willing to get involved politically • Spanish-language latinos are more engaged that English-speaking latinos

Agency/Author	Citation	Resource/Year	Key Takeaways
Richard Somerville and Susan Hassol	Somerville, RCJ, Hassol SJ. 2011. Communicating the science of climate change. Physics Today. 64:48-53.	Communicating the Science of Climate Change 2011	• Craft **#simple** #clear messages and repeat them often • Speak in plain #language, #substitute simpler words • Put findings into **#context** • Lead with what we know, not what we don't know • **#reframe** questions to give better context • Use #metaphors and #analogies • Anticipate common misunderstandings to avoid reinforcing them • Provide examples of behavioral changes and solutions that can be implemented so as not to give the impression that nothing can be done to lessen the future impacts of climate change • Know your #audience! Talk about #local impacts and connect to the bigger picture
Susan Hassol	Hassol, S. J. (2008), Improving How Scientists Communicate About Climate Change, Eos Trans. AGU, 89(11),106– 107, doi:10.1029/2008EO110002.	Improving How Scientists Communicate About Climate Change 2008	Focuses on helping scientists communicate more simply and clearly with nonscientists about climate change issues. • Words that seem common to a scientist are jargon to nonscientists – substitute for simpler terms (human-caused rather than anthropogenic, time and space instead of temporal and spatial, etc.) • Some words used in the science community have different meanings to the public, always spell out acronyms • Know your audience! Always use Fahrenheit for Americans • Clearly state settled scientific conclusions to avoid reinforcing the incorrect notion that there is debate amongst scientists about climate change • Use metaphors to help the public more clearly relate to and understand climate change • When asked a poorly framed question (is global warming to blame for this hurricane?), **#reframe** it to answer the essence of the question (is global warming having an effect on these events?)

Agency/Author	Citation	Resource/Year	Key Takeaways
George Mason University Center for Climate Change Communication	Nurmis, J. (2015) Using photographs to engage the public with climate change: a brief on communication strategies. George Mason University, Fairfax, VA: Center for Climate Change Communication.	Photojournalism as a Vehicle for Public Engagement with Climate Change 2015	Meta-analysis of studies re: how to use photographs to maximize impact and engagement. Author provides four recommendations for photo editors to maximize effect of climate change images on the public: • Use **#local** images to demonstrate local relevance of impacts • Include people • Go beyond victims of climate change and show innovators/environmental leaders • Use images depicting a hopeful future (green cities, affordable electric cars, etc.) rather than a despondent one
Climate & Development Knowledge Network	Dupar, M., with McNamara, L. and Pacha, M. (2019). Communicating climate change: A practitioner's guide. Cape Town: Climate and Development Knowledge Network.	Communicating climate change: a practitioner's guide 2019	Climate & Development Knowledge Network's (CDKN) climate change communications guide focuses on lessons learned in low- and middle-income countries in South Asia and Southeast Asia, sub-Saharan Africa, Latin America, and the Caribbean since 2010. Principles for effective communication: **1. Know your audience** • Identify stakeholder groups that can affect positive change • Segment your audience and tailor communications to specific concerns and needs • Understand audience's knowledge and values • Identify messengers that are most likely to capture the attention of your intended audience • Request audience feedback often and revise and update message when necessary **2. Tailor informational products to your audience and use multiple formats** • Use appropriate language (different languages and/or more or less technical language) • Layer the message from simple to more complex • Diversify formats – text, images, films, animations, multimedia • Make content easy to access, easy to use, and easy to share. **3. Combine digital and face-to-face communications** • Use well-tested tactics such as high-quality imagery, infographics, clear copywriting, and memes to make information easily shareable • Combine face-to-face engagements with smaller groups with larger digital outreach

Agency/Author	Citation	Resource/Year	Key Takeaways
Thomas A. Morton, Anna Rabinovich, Dan Marshall, Pamela Bretschneider	Morton, Thomas A., Anna Rabinovich, Dan Marshall, and Pamela Bretschneider. "The future that may (or may not) come: How framing changes responses to uncertainty in climate change communications" Global environmental change 21, no. 1 (2011): 103-109.	The future that may (or may not) come: How framing changes responses to uncertainty in climate change communications 2011	Research considers how #**framing** climate change predictions differently might moderate the tendency for #**uncertainty** to undermine action • Higher uncertainty combined with negative frame (highlighting potential losses) decreased individuals' intentions to behave more environmentally • Higher uncertainty combined with positive frame (highlighting potential losses not materializing) produced stronger intentions to behave environmentally • Feelings of **#efficacy** helps to mediate effects of uncertainty
Rose Hendricks	Hendricks, Rose. "Communicating Climate Change: Focus on the Framing, Not Just the Facts." The Conversation. March 5, 2017. Accessed July 22, 2019.	Communicating climate change: Focus on the framing, not just the facts 2017	Past-focused messages invokes more pro-environmental feelings amongst conservatives.
ICLEI – Local Governments for Sustainability		Climate Communication for Local Governments 2011	Five guidelines for communicating climate change: • Know your audience • Be aware of how values shape beliefs on climate change • Talk about climate change in local, immediate terms • Emphasize power and practicality of local comate solutions • Address climate science in simple compelling way

Agency/Author	Citation	Resource/Year	Key Takeaways

University of California Press	Barnosky, A D et al. 2016 Chapter 9. Establishing Common Ground: Finding Better Ways to Communicate About Climate Disruption. Collabra, 2(1): 23, pp. 1–20.	Chapter 9. Establishing Common Ground: Finding Better Ways to Communicate About Climate Disruption
		
		2016
			• Misconception that there is not scientific consensus about climate change.
			• California is the most diverse state in the U.S.
			• Effective communication strategies to motivate social and behavioral changes:
			  o Develop coordinate local, state, national, and international informational campaigns (framed for and targeted to specific audiences)
			  o Integrate **#climate change education,** including impacts and solutions, into all levels of education
			  o Create venues for decision makers in the business, religious, academic, and economic sectors to collaborate on the intertwined political, economic, health, ethical, scientific (etc) dimensions of climate disruption
			  o Communicate that actionable and feasible solutions to climate change problems exist

Oregon Department of Transportation	Oregon Department of Transportation. "More than Climate Change: Best Communications Practices". (2012)	More than Climate Change: Best Communications Practices
		
		2012
			• Make climate change solutions **#local**, relevant, and urgent
			• Correct basic #misconceptions
			  o Difference between weather and climate
			• Use clear, non-technical language
			  o Careful with scientific **#jargon**, for example: Avoid the word "theory" which can cause the public to underestimate scientific validity of conclusions.
			  o Use simple **#metaphors** and #analogies
			  o Express concepts in ways that are easily visualized:
			  o Say "climate change" rather than "global warming"
			• Connect climate change with the **#economy**
			  o Increasing energy efficiency of vehicles and buildings, creating jobs in fast-growing industries
			• Align messaging with supportive infrastructure changes
			• Tap into people's identities
			• Communicate through trusted, local sources and reach people through their existing networks
			• Consider your **#audience**
			• Lead with outcomes and benefits
			• Listen and Document
			• Celebrate Local success
			• Make actions accessible

Agency/Author	Citation	Resource/Year	Key Takeaways
David Demeritt and Diana Langdon	Demeritt, David & Langdon, Diana. (2004). The UK Climate Change Programme and Communication with Local Authorities. Global Environmental Change-human and Policy Dimensions - GLOBAL ENVIRON CHANGE. 14. 325-336. 10.1016/j.gloenvcha.2004.06.003.	The UK Climate Change Programme and communication with local authorities 2004	Local government officers felt they did not have access to the best available reports on climate change (even though many up-to-date reports were available). This is because officers are more commonly reading local newspapers and the internet. Recommendations: • All reports should have simple, concise executive summaries that indicate intended use and audience. • Press officers should work to ensure new publications are covered by the press. • More locally-specific studies needed on climate impacts • Email effective at circulating new reports
Renee Cho	How climate change impacts the economy (2019, June 20) retrieved 15 October 2019 from https://phys.org/news/2019-06-climate-impacts-economy.html	How Climate Change Impacts the Economy 2019	Sectors affected by climate change: • Agriculture is the sector most vulnerable to climate risk • Infrastructure (buildings, highways, military bases, railways, communication systems) • Human health and productivity (temperature-related deaths, loss of labor hours) • Tourism (less snow and ice for skiing, algae blooms could affect freshwater fishing, loss of biodiversity could result in decrease in visitors to national parks) • Business and the financial market (weather can damage factories, increase cost of raw materials)
Claire Q. Evans and Elizabeth J. Zechmeister	Education and Risk Assessments Predict Climate Change Concerns in Latin America and the Caribbean	Education and Risk Assessments Predict Climate Change Concerns in Latin America and the Caribbean 2018	Assesses individuals' views on how serious a problem climate change is in their countries through nationally representative surveys • Individuals who are more aware of the risks posed by climate change, through education or their perception of their own personal risk, are much more likely to view climate change as a serious problem • Concern regarding climate change is already high in the Latin America and Caribbean regions, partly due to their first-hand experience with destructive natural disasters they have experienced in recent years. Therefore, the political arena would be most effectively utilized by finding and implementing solutions to mitigate climate change rather than by shaping attitudes about climate change.

Agency/Author	Citation	Resource/Year	Key Takeaways
Axel Franzen and Dominikus Vogl	Franzen, Axel & Vogl, Dominikus. (2013). Two Decades of Measuring Environmental Attitudes: A Comparative Analysis of 33 Countries. Global Environmental Change. 23. 1001–1008. 10.1016/j.gloenvcha.2013.03.009.	Two Decades of Measuring Environmental Attitudes: A Comparative Analysis of 33 Countries 2013	This paper uses the International Social Survey Programme's environmental modules to analyze the development of environmental concern by first discussing how to measure environmental concern and then analyzing the determinants of environmental concern. • Social and demographic characteristics that are linked to an individual's environmental concern: age, **#education**, sex, income • Environmental concern is closely correlated to a nation's wealth • Environmental concern decreased slightly in almost all nations during the last 20 years o This decline is lower in countries with improving economic conditions (suggests economic growth helps maintain higher levels of environmental concern

Appendix E: Memo: Best Practices for Communicating Climate Change

Background research and recommendations to support the Caltrans Climate Change Communication Guide

Climate change is one of the most pressing issues facing the world today, yet a sizable proportion of U.S. citizens doubt that humans are the cause, or even that climate change is occurring at all. Climate change poses many communication challenges, including the complexity of the science (a complexity that is easily manipulated by parties with a vested interest in sowing doubt and confusion) and the fact that many of the impacts are hard to see (ex: ocean acidification, sea level rise, effects on the economy) or are perceived to be distant in time and space. As a result, many scientists and others struggle to convey the causes, risks, and uncertainties of climate change in terms that people can understand. However, social scientists have identified several techniques that can help communicators overcome these challenges. Many of these techniques are grounded in studies of how people communicate with the broader public, yet they may be equally valuable for helping government agencies communicate with their own staff, who may represent a similarly broad spectrum of attitudes and understanding.

This communication plan outlines several best practices for communicating climate change science to both the public and government employees, such as the staff of the California Department of Transportation (Caltrans). Some of the practices listed below may be directly applicable for connecting with Caltrans staff, especially those who have not been directly involved in climate change work to date. Other best practices will become most relevant as Caltrans moves into phase two of its communications work (following creation of the initial Climate Change Communication Plan), focused more on public outreach.

1. Convey your message clearly and concisely

Climate change involves scientific concepts and principles that are sometimes difficult for those without a scientific background to understand. Presenting climate change research in a simple, clear, relatable way is imperative to preventing the spread of misperceptions and the creation of opposing narratives.

Avoid scientific "jargon"

Many commonly used and well understood words in the scientific community may have different meanings to the general public or professionals who are new to climate change work. Using these terms when trying to communicate about climate change can sometimes cause misunderstandings and lead to the spread of misinformation. For example, while the word "theory" within the scientific community is widely understood to mean something that has been thoroughly tested and substantiated through repeated experiments, to the general public the word "theory" may be understood as "hypothesis" or "speculation" (Somerville and Hassol, 2011). This misunderstanding can undermine the scientific validity of climate change research (Oregon Department of Transportation, 2012). Table 1 provides more examples of words that may have different meanings to scientists and non-scientists.

Use metaphors and analogies

Another way to simplify the complex science behind climate change is to use metaphors and analogies. Metaphors use basic language and concepts to provide a point of reference for the audience. By putting scientific information in terms of everyday knowledge and experience, your audience can better relate to it (Somerville and Hassol, 2011). A common mistake made by climate skeptics is confusing climate with weather. People tend to ask how scientists can expect to predict what the climate will be like in 50 years when we can't even predict the weather in two weeks. A good metaphor to use in this situation would be boiling a pot of water. When you place a pot of water on the stove to boil, you may not be able to predict the time or place each individual bubble will appear, but you can say with certainty that the water will be boiling in about 10 minutes (Hassol, 2008).

Table E-1. Examples of Non-Scientific Words to Use When Communicating with the General Public (credit: Center for Research on Environmental Decisions, 2009)

Scientific Words	Non-Scientific Meaning	Better Words
Enhance	Improve	Intensify, increase
Uncertainty	Not knowing	Range
Risk	Low-probability event	Probability
Error	Wrong, incorrect	Uncertainty associated with a measuring device or model
Bias	Unfair and deliberate distortion	Offset from the observed value
Positive trend	A good trend	Upward trend
Positive feedback	Constructive criticism	Self-reinforcing cycle, vicious circle
Theory	A hunch, opinion, conjecture, speculation	Physical understanding of how this works
Hypothesis	Conjecture	Framework for physical understanding
Sign	Indication	Positive/negative value, plus/minus sign
Values	Ethics, money	Numbers, quantity
Manipulation	Exploitation	Changes in experimental or model conditions to study the impact of that condition
Scheme	Conspiracy	Blueprint
Productivity	Working hard	Photosynthesis
Anomaly	Abnormal occurrence	The deviation from a long-term average

2. Focus on framing

The scientific facts behind climate change are very important, but the framing of the message supported by these facts is equally important. The framing of the discussion and the language used affect the way people think about climate change (Hendricks, 2017).

Depoliticize the message

In the United States, political party lines often mark a stark divide between groups of people across the country. Finding common ground and mutual values is important for uniting people in the discussion on climate change. Framing the message behind climate change not as an environmental issue, a topic with strong political connotations, but as an issue of public health, with our most basic needs of food, water, and safety being threatened is one way to reach people across the political spectrum (Somerville and Hassol, 2011).

Framing climate change as an economic issue is also an effective way to reach audiences on both the right and the left. Severe weather events, such as hurricanes and wildfires, that have been linked to rising global temperatures have cost the United States an estimated $306.2 billion in 2017 and $91 billion in 2018 (NOAA, 2019). Historic drought and flooding have severely impacted agriculture across the country, particularly in the Midwest, which is projected to lose 25% of its current corn and soybean yield by 2050 due to climate change impacts (Cho, 2019). On the coasts, sea level rise could result in the loss of trillions of dollars in the value of infrastructure such as buildings and coastal railways and highways (Cho, 2019). However, when discussing the impacts of climate change on the economy, it is also important to stress the economic opportunities that have arisen in areas such as clean energy and resilient and green infrastructure. Benefits of investing in these areas come in the forms of job creation, increasing energy efficiency of vehicles and buildings, and a reduction in the amount that citizens and businesses pay for fuel as they become regional leaders in emerging markets for clean technology (OSTI, 2012). Outlining the high costs of complacency as well as the potential benefits of investing in resilience and green technology is a strategy that will motivate audiences regardless of political background.

Focus on positive messaging

The topic of climate change can invoke some strong and often overwhelming emotions in your audience. Studies have found that focusing on devastating climate impacts and worst-case scenarios can invoke fear in an individual which can lead to despondence, disengagement, and even hostile backlash as the fight or flight reflex engages (Smith and Leiserowitz, 2014). In contrast, combining discussion of worrisome climate impacts with positive solutions and concrete behavioral actions individuals can implement to overcome them has been found to produce more sustainable and constructive engagement (Corner et al, 2015). It is important to inspire action by providing hope for the future rather than fear of it.

Figure E-1. This image of kids helping with bioswale maintenance provides an example of active engagement in a solution. (credit: Parkstone Community Assoc.)

Correct misconceptions

There is a common misconception that climate experts strongly disagree about whether climate change is happening and whether it is human-caused, when in reality the vast majority of climate experts agree that it is in fact happening and caused by human activities (Barnosky et al, 2016; Hassol 2008). It is important to reframe the discussion on climate change not as a debate, but as a settled scientific fact (Hassol, 2008). Reinforce this message by repeating it clearly and often. While it is important to acknowledge that there are a range of projections when modeling climate impacts, it is also important to point out the overwhelming level of agreement across all the models. For example, while some models may project greater increase in sea level rise than others, every model nevertheless shows significant sea level rise increase over time.

3. Tailor your message to your audience

Understanding the background of your audience is imperative to engaging them effectively, as their personal experiences and influences directly shape their beliefs and values. Targeting your presentation to your audience will also allow them to more easily receive and retain the information.

Political affiliations

There is a strong link between an individual's political affiliation and his or her opinions on climate change (Ballew et al, 2019). Research shows that there are stark differences between the perceptions of climate change on the political left and right. People on the left are more likely to support climate change policies and those on the right are more likely to oppose them (Smith and Leiserowitz, 2014). Individuals on opposing sides of the political spectrum tend to have different values, so it is important to tailor your message about climate change to those specific values. Framing climate change as a moral issue and a matter of defending the purity of nature concerns the left and demonstrating patriotism to our country and our land capitalizes on the values of ingroup loyalty and respect for authority is commonly held by conservatives. Along these lines, using past-focused messages and imagery invokes more pro-environmental feelings amongst conservatives than future-focused ones (Hendricks, 2017).

Cultural background

California is the most populous and diverse state in the nation, with 44% of its population speaking a language other than English (Barnosky et al, 2016). According to the 2010 census, about 28% of the population speaks Spanish at home, 10% speak Asian and Pacific Island languages such as Chinese, Tagalog, and Vietnamese, and 4% speak an Indo-European language such as Farsi, Armenian, and Russian. It is important to have information available in a variety of common languages of the state (in engaging formats) in order to involve its diverse population in climate preparation and action (Leiserowitz and Rosenthal, 2017). For example, findings indicate that Latinos are more engaged with global warming than non-Latinos and specifically Spanish-speaking Latinos are more engaged than English-speaking Latinos. Making information available in Spanish and easily accessible will help engage these communities who may be looking for information on this topic and to implement a course of action.

Education

Several studies have concluded that education level is strongly correlated to an individual's awareness, understanding, and acceptance of climate change (Franzen and Vogl, 2013; Evans and Zechmeister 2018). Many individuals who are skeptical of climate change have received little to no formal education on the topic. The most effective way to address this issue is to implement education programs in pre-university curricula that focus on teaching the science behind climate change, and the impacts, solutions, and cross-cutting implications of climate change (Barnosky et al.). It can be more difficult communicating climate change to adults who have not received formal schooling in climate change science, as they may not be able to understand high level implications of climate change impacts without a basic understanding of the science underlying them. Knowing your audience's education level is key to knowing where to begin the conversation. In some cases, you may have to correct ingrained misconceptions by starting from the beginning and presenting climate change basics in a clear, easily digestible format.

Figure E-2. This Fotonovela (in Spanish and English language) produced by EPA Region 9 in partnership with the Center for Community Action and Environmental Justice in California is an example of a culturally appropriate tool for raising awareness of an environmental issue (in this case, toxic hazards). A fotonovela was selected as this graphic format because it is common in Latin America, where many residents of the community were born and/or have cultural ties. (credit: EPA Region 9, Center for Community Action & Environmental Justice; https://www.epa.gov/toxics-release-inventory-tri-program/tri-fotonovela-latinohispanic-novella-style-introduction-tri)

4. Focus on local impacts

People tend to feel less threatened by abstract and distant impacts of climate change but are more engaged and feel more responsible when presented with concrete and visible impacts to their communities. To inspire motivation and action in a group of people, it is important to show how climate change poses a current and real threat to their own families.

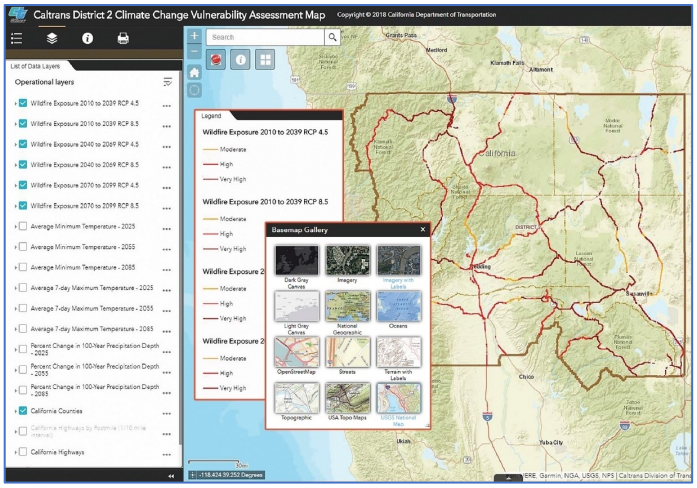


Figure E-3. Caltrans District Vulnerability Assessment Maps (ArcGIS online) allows users to review the climate data and exposed segments of the state highway system, a key output of the vulnerability assessments. (credit: https://www.arcgis.com/apps/webappviewer/index.html?id=517eecf1b5a542e5b0e25f337f87f5bb)

Focus on impacts specific to California

In recent years California has been experiencing record water shortages, devastating wildfires, floods, and landslides. Discussing how climate change is directly related to the frequency and increased severity of these events in the past few years helps to put the threat of climate change into concrete and emotionally relevant terms for the target audience. It is important, however, to make it clear that we cannot claim that climate change is directly responsible for a specific wildfire or storm, to avoid furthering the misconception that weather and climate are the same. We can, however, impress upon our audience the fact that wildfire risk increases due to drought conditions, and drought frequency is projected to increase with climate change.

5. Tell real stories

Research shows that people tend to think of climate change as a distant threat, affecting future generations and foreign lands (ICLEI, 2011). By telling real stories of real individuals affected by climate change, we can put a face and a name to the victims of climate change.

Focus on experiential as well as statistical evidence

Abstract stories and staged photos, especially featuring politicians, are perceived as manipulative and "gimmicky". Studies have found that personal experiences have the strongest impact on climate change beliefs among the least engaged populations (Ballew et al, 2019). A raw image of one of the many victims of California's wildfires from recent years can produce a much stronger emotional reaction and connection

Figure E-4. Victims of California's 2018 Camp Fire. (credit: Noah Berger)

than stating that as of May 2019, almost 250,000 acres of land have been destroyed by wildfires this year alone.

Go beyond victims

Depicting images of the victims of climate change impacts is an effective way to invoke sympathy in the climate change discussion. However, in order to inspire action, it is important to provide concrete examples of how individuals can take action. Telling stories of leaders and innovators within the climate change movement or examples of how local governments have successfully implemented new mitigation or adaptation solutions can give the audience an inspiring example to follow (George Mason University, 2015).

Figure E-5. Resilient by Design, a 2018 design challenge, focused on designing solutions to protect Bay Area communities from sea level rise. The challenge Instagram feed featured student leadership in climate work. (credit: RbD)

6. Use effective visualizations

It is one thing to hear about the impacts of climate change and the innovative technologies designed to help combat them but seeing images of these ideas helps to make them more concrete.

Use images depicting a hopeful future

Images of climate impacts (e.g. floods, wildfires, hurricanes) are more moving than images of causes or solutions, but they can be overwhelming. Pairing these images with images of a hopeful future and the solutions that can help us get there (e.g., green cities, affordable electric cars) can help to mitigate the feeling of being overwhelmed and reinforce the idea that there is still time to act (Corner et al, 2015).

Figure E-6. Images showing children interacting with a climate solution tend to generate a particularly positive emotional response (Corner et al, 2015). This image shows students in Berkeley, CA helping at the King Middle School's garden, The Edible Schoolyard. (*credit*: *https://edibleschoolyard.org/berkeley*)

Avoid cliché images

While classic images of polar bears on melting ice floes, deforestation, and smokestacks are quickly and easily understood, they have been used so often that they can prompt fatigue and cynicism (Corner et al, 2015). Using less familiar and more thought-provoking images help to reframe the image of climate change in the local public's mind and tell a new story that people have not yet heard. Using recent photos also may cause self-realization of how often and recently these impacts have occurred to drive the point home. Similarly, using images of impacts that can be seen in the audience's own community can help them relate more strongly to the message behind the images.

Figure E-7. Smoke and aerosol plumes over California's Central Valley and coast as seen from space soon after the Camp Fire started. (credit: NASA Earth Observatory/Aqua/ MODIS)

While images of polar bears on melting ice caps are powerful, they are also hard for people who have never seen a polar bear in the wild to relate to. For example, residents of Northern California and the Central Valley who experienced poor air quality during the 2018 Camp Fire will have a personal connection to related images (Figure E-7).

Use graphs and maps effectively

While photos can offer a snapshot of a changing world, some information—particularly long-term trends or future projections—lends itself more to a graph or a map. Graphs and maps also convey credibility, as they reveal actual numbers and how they are changing over time, as opposed to a photo that could have been "cherry-picked" to show the most extreme outcomes. However, graphs and maps can be intimidating to some audiences, particularly if they are cluttered or use unfamiliar jargon or statistical techniques. Through more than a decade of work on climate change indicators for state, federal, and international agencies, ERG has developed a compendium of best practices to create understandable graphs and maps that capture readers' attention and avoid scaring them away. Examples of these best practices include making visuals colorful, using colors that correlate to the user's experience (e.g., red is hot), using familiar (English) units instead of metric, avoiding the use of secondary axes and multiple panels, using error bars or confidence intervals sparingly (only when this clutter is justified by a need to convey uncertainty), and adding captions that explain key points.

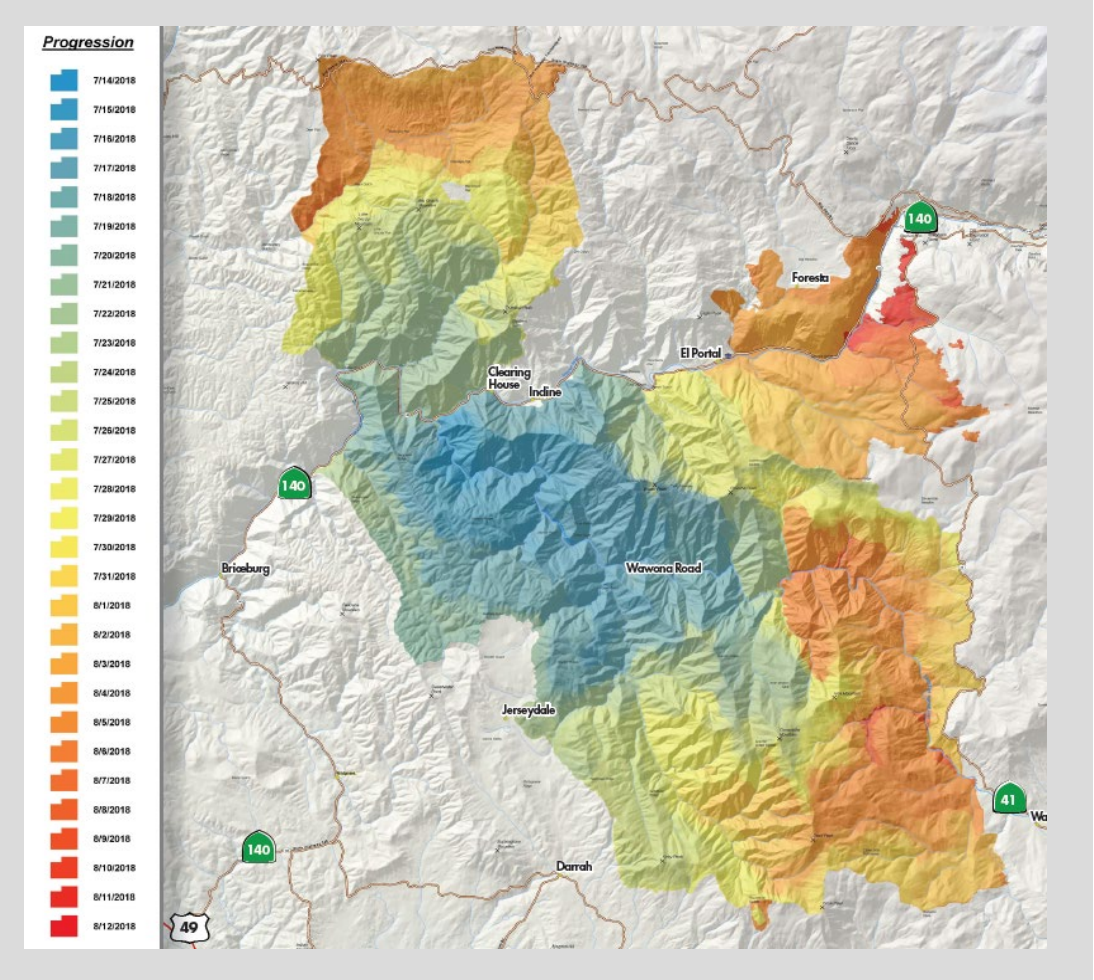


Figure E-8. This map from Caltrans District 10 Climate Change Vulnerability Assessment Report (data source: Sierra National Forest, US Forest Service) shows the progression of the Ferguson Fire from 7/14/18 (in the darkest blue) to 8/12/18 (in the darkest red).

7. Make information accessible

While many publicly available sources provide data on climate change, many people in the public as well as in local government feel that they do not have access to the best information about the most pressing climate change impacts relevant to their work and communities (Demeritt and Langdon, 2004). Making this information easily accessible both internally and externally is essential for successful communication.

Create a centralized clearinghouse

With so much information available online, it can be difficult and draining for individuals to sift through internet search results and decipher which sources are the most reliable and accepted. By providing a centralized database online with links to up-to-date climate data, reports, graphics, and messaging that can easily be shared, we can take the burden off government employees and members of the public to seek out the information themselves. It is important that these sources and reports should include simple and concise executive summaries explaining how the information relates to specific audiences and the work they do.

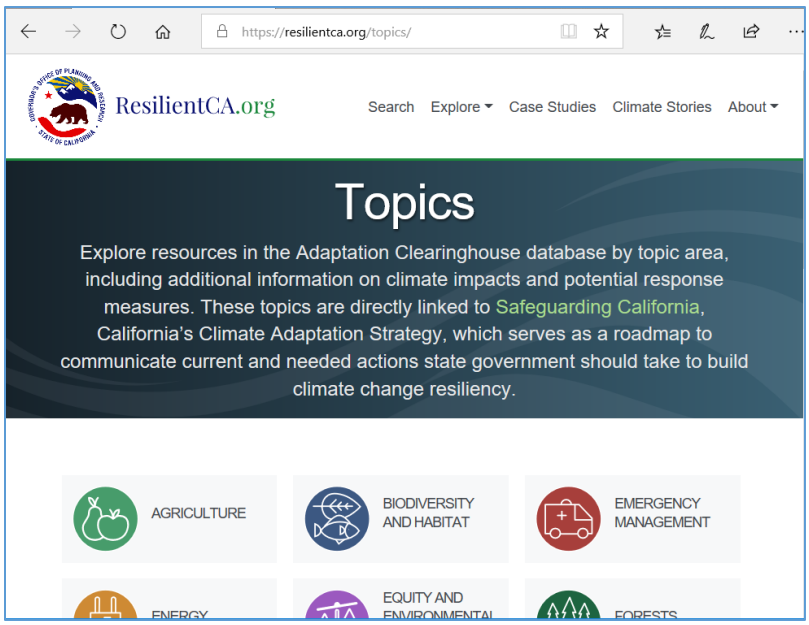


Figure E-9. The California Adaptation Clearinghouse, maintained by the Governor's Office of Planning and Research is used by many natural resource agencies, non-profits, and others in California as a key central database of climate adaptation tools and resources. For access to climate data, it provides a direct link to Cal-Adapt. While a great resource, some agencies require something developed specifically for internal agency and connected to agency policies and practices.

Establish direct lines of communication

While creating a centralized repository of important climate change resources is a good way to make information easily accessible, it does not ensure that the information is reaching the appropriate people. Many people feel that the onus is on them to be alert for the publishing of new reports and that if they do not actively seek information, they will not be informed (Demeritt and Langdon, 2004). Often, especially in local government, climate issues make up a small fraction of a person's job and they do not have a lot of time to spend searching for information. It is therefore important to establish direct communication with each department through establishing key points of contact, clear modes of communication (e.g., a regular meeting, list-serves), and seek opportunities to integrate climate change into existing (and widely consumed) communications.

Key findings from each of the publications cited above are summarized in Appendix D.