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**CLIMATE CHANGE/VARIABILITY SCIENCE AND ADAPTIVE STRATEGIES FOR STATE AND
REGIONAL TRANSPORTATION DECISION MAKING**

by
Eric Lindquist

Report 167165-1
Project Title: Climate Change/Variability Science and Adaptive
Strategies for State and Regional Transportation Decision Making

Performed in cooperation with the
Southwest Region University Transportation Center

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April 2010

ABSTRACT

The objective of this study was to generate a baseline understanding of current policy responses to climate change/variability at the state and regional transportation-planning and -decision levels. Specifically, researchers were interested in the question of whether state and regional governments were currently including climate change impacts or vulnerability issues in their decision and planning processes. The focus of this report is on the basic question: are state DOTs and MPOs in the United States addressing the issue of climate change in general and, more specifically, the issue of adaptation to potential climate change and -variability impacts? The research approach included content analysis, an in-depth survey of stakeholders, and interviews with stakeholders. The aggregate findings reveal that acceptance and movement in state DOTs and MPOs on these complex climate-related issues and solutions, where they exist at all, are slow. Mitigating the impacts from transportation appears to still be the primary policy linkage between climate change and transportation for these agencies. Public interest, political acceptance, and lack of downscaled state- and regional-level data are all factors that require further attention in the climate change/transportation nexus.

EXECUTIVE SUMMARY

Despite the potential for billions of dollars of damage, the possibility of climate change's impact on transportation planning and infrastructure has received little attention. Most of the focus on the climate change/transportation nexus has been on impacts to the environment from transportation sources, such as automobile emissions. While mitigation as a solution needs to be a significant part of the policy response to climate change, considerations of adaptation to the potential impacts from sea-level rise, changes in precipitation and temperature, and an increase in the magnitude and frequency of severe storms are equally important, and there has been little attention to how transportation infrastructure, and its associated governance systems, will respond. This is particularly important in areas vulnerable to sea-level rise, storm surge, and flooding.

The objective of this study was to generate a baseline understanding of current policy responses to climate change/variability at the state and regional transportation-planning and -decision levels. At the time, there was a significant lack of information of this kind available for decision makers. Specifically, researchers were interested in the question of whether state and regional governments are currently including climate change impacts or vulnerability issues in their decision and planning processes. The focus of this report is on the basic question: are state DOTs and MPOs in the United States addressing the issue of climate change in general and, more specifically, the issue of adaptation to potential climate change and -variability impacts?

Adaptation to climate change, as a general concept, has been defined by the Intergovernmental Panel on Climate Change (IPCC) as "actions taken to reduce the vulnerability of natural and human systems against actual or expected climate change effects" (Adger et al. 2007). The 2007 IPCC report emphasizes adaptation practices, which are defined as "actual adjustments, or changes in decision environment, which might ultimately enhance resilience or reduce vulnerability to observed or expected changes in climate" (Adger et al. 2007).

This study focused on several basic questions. First, are state DOTs and MPOs in the United States addressing the issue of climate change, in general? Researchers were interested in developing a basic understanding of the state of climate change as a factor in decision making in these agencies. Anecdotal evidence suggested that some of these agencies were engaged in this issue; however, many more were probably not. Since a baseline assessment on this issue had not been conducted, this was the first question to be addressed. Second, and more specifically, if these agencies were engaged in the climate change issue institutionally through planning and programming efforts, was adaptation, as a solution to the probability of climate change stressors, being considered? Again, no such systematic assessment of this question had been conducted.

In order to answer these questions, researchers designed a multi-method approach. The research included content analysis, an in-depth survey of stakeholders, and interviews with stakeholders. Each of these methods, derived and formulated from social-science methodologies and best practices, contributed to and supported the other methods and resulted in an aggregate picture of the current situation and prospects for the future.

Content Analysis

Researchers conducted content analysis of all 50 state DOT planning documents. They conducted this at two times during the duration of this project, first in 2007 and then again in 2009, in order to identify and assess any changes in the documents that might reflect movement toward an increase in interest or integration of climate change and adaptation in state-level transportation planning.

Overall, the initial review of these documents and policy statements revealed that most did not include climate change, much less adaptation, as explicit decision factors or issues of concern. Only four states (California, Connecticut, Oregon, and Washington) explicitly mentioned climate change. Researchers revisited the available documents again in 2009 in order to assess changes or revisions. Only three states added climate change as a factor.

Researchers also identified the approximately 70 largest MPOs and conducted content analysis for their plans and policy statements in the same manner as researchers had for the state DOTs. Conducted in the spring of 2007, this assessment revealed similar results to the state DOT review. Very few of the MPOs included climate change as an issue in their transportation-planning documents.

Decision-Maker Survey

The second method of data collection was a mail survey targeted at relevant decision makers in the 50 state DOTs and 70 MPOs. These individuals were identified through an assessment of the agency organizational charts, identifying those key individuals that would be in positions of authority for planning as well as those placed in environment-related units or divisions within the agency. The objective of the survey was to gather information on climate change as it relates to these agencies in general and the role of scientific information in decision making. The survey responses illustrate a situation of very mixed engagement with climate change as a significant issue in state and regional transportation planning. For this report, the finding that there was almost no attention being paid to adaptation is also of significance.

Decision-Maker Interviews

Researchers conducted 12 in-depth telephone interviews with agency representatives (six respondents from state DOTs and six respondents from five MPOs). These individuals were again identified as persons most likely to be able to provide insight and information on the research questions. The interviews revealed that while many of the respondents, and their respective agencies, did recognize the potential problems posed by climate change to their areas, this recognition was not finding its way into the actual plans and policies at the time. Further, there was no indication from the interviews that adaptation, as a climate change solution, was being discussed in a significant manner. Responses do suggest that this could change in the future and lead to more substantive integration of climate change issues and ideas into future revisions of plans and policies. Two significant findings came from the interview responses regarding information and the use of science. First, respondents utilized a very wide range of sources, both public and private, for their scientific and climate change information and data. Second, there was an overall sense that the issue of climate change suffered from a lack of detailed and downscaled state- and regional-level information, which was seen as critical to both decision making and public participation on the issue.

Conclusions and Recommendations

In conclusion, the aggregate findings reveal that acceptance and movement in state DOTs and MPOs on these complex climate-related issues and solutions, where they exist at all, are slow. The findings can point to several additional important points:

- Politics and public opinion play and will continue to play important roles in these agencies moving toward the integration of climate change as a decision factor.

- Lack of direction, suggested primarily as a lack of any top-down federal-state guidance, has impeded progress on the understanding of and response to the climate change/transportation nexus.
- Respondents stressed the need for downscaled state- and regional-level data on climate change impacts and probabilities. This needs to be communicated to the climate science community, as do specific transportation-related data needs.

Recommendations include the following main points:

- Public interest in climate change as an issue is low at this time, compared with other issues such as health care and the economy. This situation will have to be addressed as state DOTs and MPOs seek public support for climate change policies and solutions.
- The study has shown that there is also incomplete acceptance from transportation professionals in regard to climate change as an issue. There are few data on the overall research capacity or on what state and regional agencies may need in regard to training and support for dealing with the complex issues of climate change as they gain prominence on the public and political agenda.
- The political reality of climate change as a contentious issue may be impeding the integration of adaptation as a solution at the state and regional levels of transportation planning. More research is currently needed in order to better understand the role of politics in decision making at the state and MPO levels. Each of these levels of planning and policy has its own political dynamics, constituents, and processes, which interact differently for different issues.
- The politics of local transportation planning is understudied and is traditionally the domain of the case-study method. While case studies are effective and informative, there is also a need for larger N and comparative studies on this issue.

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PROBLEM

Despite the potential for billions of dollars of damage, the possibility of climate change's impact on transportation planning and infrastructure has received little attention. Most of the focus on the climate change/transportation nexus has been on impacts to the environment from transportation sources, such as automobile emissions. While mitigation as a solution needs to be a significant part of the policy response to climate change, considerations of adaptation to the potential impacts from sea-level rise, changes in precipitation and temperature, and an increase in magnitude and frequency of severe storms are equally important, and there has been little attention to how transportation infrastructure, and its associated governance systems, will respond. This is particularly important in areas vulnerable to sea-level rise, storm surge, and flooding.

The objective of this study was to generate a baseline understanding of current policy responses to climate change/variability at the state and regional transportation planning and decision levels. At the time, there was a significant lack of information of this kind available for decision makers. Specifically, researchers were interested in the question of whether state and regional governments are currently including climate change impacts or vulnerability issues in their decision and planning processes. The focus of this report is on the basic question: are state departments of transportation (DOTs) and metropolitan planning organizations (MPOs) in the United States addressing the issue of climate change in general and, more specifically, the issue of adaptation to potential climate change and variability impacts?

Adaptation to climate change, as a general concept, has been defined by the Intergovernmental Panel on Climate Change (IPCC) as "actions taken to reduce the vulnerability of natural and human systems against actual or expected climate change effects" (Adger et al. 2007). The 2007 IPCC report emphasizes adaptation practices, which are defined as "actual adjustments or changes in decision environment, which might ultimately enhance resilience or reduce vulnerability to observed or expected changes in climate" (Adger et al. 2007). The U.S. Climate Change Science Program (CCSP) Gulf Coast Assessment Study further considered adaptation in its assessment of the climate change/transportation nexus (CCSP 2008). Derived from the IPCC definitions, the CCSP report includes this definition of adaptation (CCSP 2008):

Adaptation

Actions taken to reduce the vulnerability of natural and human systems against actual or expected climate change effects. Various types of adaptation can be distinguished, including anticipatory, autonomous, and planned adaptation.

Anticipatory Adaptation—Adaptation that takes place before impacts of climate change are observed. Also referred to as proactive adaptation.

Autonomous Adaptation—Adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or welfare changes in human systems. Also referred to as spontaneous adaptation.

Planned Adaptation—Adaptation that is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state.

Adaptive strategies can be further delineated into three possible alternatives: protect, accommodate, and retreat. These adaptive responses are derived from the IPCC framework for assessing coastal adaptation options. From the transportation perspective, adapting to climate change will impact operations, design, investment, land use, and planning activities. In addition to adaptation, other key associated concepts include resilience, or “the capacity of a system to absorb disturbances and retain essential processes,” and vulnerability, or “the structural strength and integrity of key facilities or systems and the resulting potential for damage and disruption in transportation services from climate change stressors” (CCSP 2008). These were the concepts, terms, and issues this project was looking for in developing its baseline understanding of where the transportation sector stood at the time in regard to climate change and adaptation.

To date, most adaptive strategies have been developed at the state level of government (Litz 2008). Since transportation decision making cuts across multiple levels of government, adaptive strategies for large-scale climate changes in the United States will also primarily be addressed at the sub-national level. Institutionally, for transportation infrastructure decision making, this adaptation will occur in the DOTs in each of the 50 states, and the MPOs and regional transportation planning and support agencies. Much of the impact of climate variability will be felt at these levels, and there may be significant negative implications for not developing adaptation strategies. This section of the report will provide some background into the problem of climate change and transportation and how, up to this point, the climate change and associated stressors, as potentially serious problems for transportation, have been considered and included in planning and programming efforts.

According to a U.S. Department of Transportation (USDOT) Center for Climate Change and Environmental Forecasting workshop, projected climate-related changes in sea level, weather patterns, temperatures, and precipitation and an increase in extreme weather events (including tropical storms and hurricanes) will adversely affect transportation infrastructure and decision making (Center for Climate Change and Environmental Forecasting 2002). Transportation infrastructure across all modes is considered to be vulnerable to these impacts, even in the near future. Much of the debate over climate change and transportation has previously been focused on mitigating the impact of automobile greenhouse-gas emissions. However, the need to link climate change/variability science (including modeling, risk analysis and assessments, regional impacts assessment, projections, and probabilities) with adaptive strategies, regardless of the cause, has risen on the decision agenda within the USDOT and the Transportation Research Board. Key findings from the USDOT workshop identified research needs in the area of climate change assessment integration with existing transportation-decision processes and for an assessment of response strategies. Much of the impact of climate change and variability will be felt at the state and regional levels, and there will be significant negative implications for not developing adaptation strategies at these decision and policy levels.

The impact of climate change/variability on transportation is an area that has seen little attention, considering the significant potential damage to billions of dollars worth of critical infrastructure in this country. Much of the focus on the climate change/transportation nexus has been on the impact to the climate from transportation, such as automobile emissions, and policies designed to mitigate this impact. The other side of the equation, and equally as important, is

adaptation and recovery, and there has been little attention paid to how transportation infrastructure can adapt to potential changes or variation in climate and how this infrastructure will recover from specific negative events. Adaptation to change and recovery from specific events present important policy process issues for transportation planners and decision makers, yet there is a surprising lack of research being conducted on these issues.

In an early report on the linkages between climate change and transportation, the U.S. Department of Transportation released a report analyzing the potential impacts of global climate change on transportation (U.S. Department of Transportation 1998). While most of the report focused on the contribution of transportation to the greenhouse-gas (GHG) problem, adaptation was raised as a potential response to such potential impacts as sea-level rise. For example, technical solutions, such as seawalls, were suggested for protecting roads and causeways in coastal areas. Airports would also require sea walls, and port facilities would need improvements to handle higher tides. It also noted that freight transportation systems would need to adapt to increases in severity and frequency of severe weather patterns. Land-use planning was also suggested as an adaptability mechanism. This would be particularly significant in coastal areas that could potentially see massive disturbances of the population.

Several years later, the 2002 workshop conducted by the U.S. Department of Transportation Center for Climate Change and Environmental Forecasting brought together experts from diverse backgrounds working on climate change impacts. Participants agreed that more research was needed to better understand shifts in weather patterns and potential impacts on infrastructure since nearly all infrastructure could be considered vulnerable: a sea-level change would require the relocation of roads and airport runways, and the flooding of underground tunnels and damaged pipelines could occur from increased freeze-thaw cycles. Ultimately, the workshop summary report stresses the need for more comprehensive research on climate change and its impacts and for disseminating the information to key transportation decision makers (U.S. Department of Transportation. Center for Climate Change and Environmental Forecasting 2002). More recently, the Transportation Research Board (TRB) established its Committee on Climate Change and U.S. Transportation to examine possible consequences of climate change on U.S. transportation as well as the issue of adaptation.

These developments suggest an incremental movement in the United States toward recognition of the significance of climate change impacts on transportation, yet many other relevant stakeholders have not addressed the need for climate change adaptation for transportation. A review of planning and strategic documents from relevant interest groups including the American Association of State Highway and Transportation Officials (AASHTO), National Association of Regional Councils (NARC), and American Planning Association supports this assertion since even these institutions are not addressing the climate change issue. Overall, the picture in the United States in regard to adaptation of transportation infrastructure and systems to potential impacts from climate change suggests that currently this issue is not on the agenda for most of the relevant stakeholders in the transportation planning and decision processes. As McBeath (2003, 4) states, “American governments at the federal levels and at the state and local levels have been slow to respond to the evidence of climate change impacts.”

The Canadian perspective more thoroughly addresses the impacts of climate change on transportation and possible adaptation mechanisms. According to Transport Canada (2004), global warming may be a net savings to the country. Yet significant problems will arise from a shift in temperatures. In northern Canada, roads will experience increased damage from more frequent freeze-thaw cycles. These northern roads may require expensive changes in design and

maintenance. The report indicates that more populous areas in southern Canada are susceptible to change. For example, an increase in sea level may cause flooding of coastal areas. Additionally, as the Great Lakes evaporate more quickly, ships will be required to carry less payload, increasing shipping costs. Yet there are benefits to warming a cold climate. The document indicates that warmer temperatures may extend the road-construction season and increase Arctic shipping.

The report suggests several mechanisms for adaptation. One possible solution is to relocate facilities in coastal areas threatened by sea-level rise. Another option requires spending more money for road maintenance and supplies. Transportation officials will want to select better asphalt, one that can withstand the increased freeze-thaw cycles of the northern regions. This recommendation is echoed by Haas et al. (2006) in their 2006 Transportation Research Board paper, which suggests selecting less frost-susceptible foundation materials as an adaptation strategy, and also suggests that roads will need more frequent maintenance. A 2003 conference, "Impacts of Climate Change on Transportation in Canada," underscores the anticipated impacts of climate change noted above. Conclusions from the workshop include suggestions for government planning and preventative measures (Transport Canada 2003).

The U.K. Department of Transport's (2005) report, *The Changing Climate: Impact on the Department for Transport*, details the impact of climate change on the transportation system. In general the report suggests that climate change will bring an increase in flash floods and harsher weather conditions in the country. Officials believe that poor travel conditions will result in a transport system that runs with less safety and performance than before. The report largely ignores adaptation measures but does say that transportation infrastructure will no longer be built in flood-prone areas. The report credits the delay in action to uncertainty about climate change, citing that stakeholders want more certainty before investing in transportation upgrades. Other sectors in the United Kingdom are also including climate change adaptation in planning and development processes, including development, and land-use decision making, both relevant to transportation decision making (Institute for Development Studies 2007). Finally, according to the European Environment Agency, many European Union countries are developing climate change adaptation plans. For example, in Denmark, transportation planners considered an anticipated rise in sea level when developing Metro stations (European Environment Agency 2005).

While this brief introduction to the problem and previous responses is not exhaustive, it does provide a basic framework for the research conducted for this project and the objective of filling knowledge gaps in regard to these complex issues. An updated and extended perspective and literature review of the climate change adaptation and transportation link will be covered in a subsequent report (Lindquist forthcoming).

APPROACH

This study focused on several basic questions. First, are state DOTs and MPOs in the United States addressing the issue of climate change in general? Researchers were interested in developing a basic understanding of the state of climate change as a factor in decision making in these agencies. Anecdotal evidence suggested that some of these agencies were engaged in this issue; however, many more were probably not. Since a baseline assessment on this issue had not been conducted, this was the first question to be addressed. Second, and more specifically, if these agencies were engaged in the climate change issue institutionally through planning and programming efforts, was adaptation, as a solution to the probability of climate change stressors, being considered? Again, no such systematic assessment of this question had been conducted.

In order to answer these questions, researchers designed a multi-method approach. The research included content analysis, an in-depth survey of stakeholders, and elite interviews with stakeholders. Each of these methods, derived and formulated from social-science methodologies and best practices, contributed to and supported the other methods and resulted in an aggregate picture of the current situation and prospect for the future. The next section of this report outlines these methods in more detail.

METHODOLOGY AND FINDINGS

This section outlines the three methodological and data-collection methods used in this study and subsequent findings for each.

Content Analysis

Introduction

In order to address the general questions raised in this research, researchers conducted World Wide Web searches for relevant policy documents from the target agencies (state DOTs and MPOs). For the search of the 50 state DOTs, researchers downloaded and reviewed general state transportation plan documents, mission statements, or strategic plans. When possible they used key-word searches of the electronic documents and searched for “climate change,” “climate,” “global warming,” “adaptation,” and other appropriate key words. Multiple documents for each state were generally assessed for this task since most states provide a general policy or strategic statement or summary, plus more-extensive mobility or statewide transportation-planning documents. The Texas Department of Transportation, for example, published the following relevant documents:

- *TxDOT Has a Plan: Strategic Plan for 2007-2011* (Texas Department of Transportation 2007a) and
- *2007 Unified Transportation Program Statewide Mobility Program* (Texas Department of Transportation 2007b).

The strategic plan outlined the general vision, mission, goals, and strategies, while the Statewide Mobility Program was an extensive project-by-project matrix of budget and spending priorities for the state.

Researchers conducted a similar approach to identifying and reviewing the MPO transportation-related documents for the approximately 70 largest MPOs in the United States (see Appendix A for a list of the MPOs). The objective in this task was to identify those agencies that explicitly included “climate change” in the text of these documents and then to further identify if “adaptation” was included in the discussion. While this approach may seem simplistic, the objective was to develop a baseline understanding of the extent to which these agencies were including climate change and adaptation in their plans and programs. To date, even such a rudimentary understanding and inventory had not yet been systematically developed and implemented.

50 State DOT Content Analysis Methods and Findings

Researchers conducted content analysis of all 50 state DOT planning documents. They conducted this at two times during the duration of this project, first in 2007 and then again in 2009, in order to identify and assess any changes in the documents that might reflect movement toward an increase in interest or integration of climate change and adaptation in state-level transportation planning.

Overall, the initial review of these documents and policy statements revealed that most did not include climate change, much less adaptation, as explicit decision factors or issues of concern. Only four states (California, Connecticut, Oregon, and Washington) explicitly mentioned climate change.

The *California Transportation Plan 2025* includes several mentions of climate change, including a relatively strong statement in the initial “Trends and Challenges” section of the plan under the “Environmental Impacts” section (California Department of Transportation 2006):

The earth’s atmosphere is warmed resulting in climate change and potential adverse impacts to public health, agriculture, forests, storm frequency and intensity, mountain snow pack, smog, and rising sea levels (2006, 21).

Additional mention of climate change shows up in later sections of the plan, under goals to enhance the environment, by focusing on GHG emissions. No specific goals or strategies are articulated to adapt to potential impacts from climate change, however.

The *Long-Range Transportation Plan for the State of Connecticut* includes climate change as an issue in the section on environment, energy conservation, and quality of life (Connecticut Department of Transportation 2004). While the section mainly focuses on greenhouse-gas emission strategies, one action item was included on what can be interpreted as adaptation:

Encourage efforts that focus on risk and response assessment, including prediction tools, products and strategies for potential maintenance, system planning, safety management and emergency preparedness issues arising from global climate change.

Similarly, the *Oregon Transportation Plan* includes the reduction of GHG emissions as one of its “sustainability” goals (Oregon Department of Transportation 2006, II-14). While not linked directly to climate change, one of the key stressors of climate change, flooding, was also identified in the *Oregon Transportation Plan* as a natural disaster that would impact “on the efficiency and sustainability of the location and design of new or improved transportation facilities as appropriate.”(Oregon Department of Transportation 2006, II-15). In Washington State, the most recent transportation plan (2006) also links transportation and environmental quality with climate change, focusing on emissions and related issues. No specific mention was made of adaptation, however, as a solution or policy response.

The available documents were revisited in the summer of 2009 in order to assess changes or revisions. Three states were shown to have added climate change as a factor. The 2009 *Maryland Transportation Plan* added a discussion of climate change adaptation in regard to the stressors of sea-level rise, temperature increases, and storms (Maryland Department of Transportation 2009). In the “Message from the Secretary” in one of the five critical issues, the agency states that Maryland will respond to reduction of greenhouse-gas emissions and provide a coordinated response to climate change (Maryland Department of Transportation 2009, 1). While most of the attention to climate change in the document is in regard to the contribution of transportation to the problems, it does seek to address the consequences, including sea-level rise. It also addresses adaptation in its strategies for the future, stating: “MDOT will develop a plan to assess the risks to transportation infrastructure, mobility, and emergency management of sea level rise and other climate change impacts and to identify adaptation options” (2009, 21). Finally, the plan recognizes the “growing public concern about air quality, climate change, energy costs and congestion” with a stated commitment to smart growth as a solution (2009, 25). This suggests the influence of citizen input and concern for public policy in this area.

The *Kansas Long Range Transportation Plan* also added similar factors and attention to adaptation, and included wind as an additional storm factor for consideration (Kansas Department of Transportation 2008). For example, in the final chapter, “A Look Beyond,” the plan states: “at present the long term impact of climate change on Kansas is uncertain” (87). In spite of this uncertainty, the DOT stresses 100-year life spans for infrastructure, and links risk

management to such potential climate change impacts of wider temperature variations and increased precipitation. In response, the plan goes as far as suggesting that “revised engineering standards and practices may be needed to ensure infrastructure is built to withstand these forces” (87).

In Nevada, the *Statewide Transportation Plan—Moving Nevada through 2028* discusses temperature and increased rains and flooding as important considerations (Nevada Department of Transportation 2008). In the “Asset, Operations and Maintenance” chapter, the plan states: “NDOT will be closely watching the affects that global warming is predicted to have on our assets and the type of work we perform in our Districts” (2008, II-6). Possible impacts from global warming that are identified in the plan include increased frequency of wildfires due to an increase in higher temperatures and hotter days, increased flooding, and heavier rainfall. Finally, the plan addresses the important intergovernmental linkages required to address these issues:

Addressing the impacts of climate change will also require regional and multistate involvement. Planners will have to address climate change from a long-term perspective, recognizing that the investment decisions we make today, particularly about the location of our transportation infrastructure, are going to shape long term development patterns” (2008, II-9).

The multi-year findings from the state DOT document review are summarized in Appendix B.

MPO Content Analysis Methods and Findings

Researchers identified the 68 largest MPOs and conducted content analysis for their plans and policy statements in the same manner as researchers had for the state DOTs. They were able to access 40 of these plans online. Conducted in the spring of 2007, this assessment revealed similar results to the state DOT review. Very few of the MPOs included climate change as an issue in their transportation-planning documents. For example, the Grand Valley (Michigan) Metropolitan Council included one mention of climate change in its section on biodiesel as an alternative fuel to help reduce emissions (2007). The Pioneer Valley (Massachusetts) Planning Commission (2007) did not include climate change as an issue, only a brief note that several of its communities participated in a local climate-change and transportation project for emission-reduction planning.

One exception was the Metropolitan Transportation Commission (MTC), the San Francisco Bay Area agency responsible for regional transportation planning. Although its transportation plan did not mention climate change or its impacts, the agency did develop public workshops of a more general level on climate change and the Bay Area (Metropolitan Transportation Commission 2005, 2007). Adaptation was included as a strategy for one of the partner agencies, the Bay Conservation and Development Commission, but not for the MTC. Overall, however, the workshop raised the question of how regional agencies and resources should be devoted to adaptation. This suggests that the MTC may include adaptation issues in future transportation plans for the area.

In 2009, researchers revisited the available online MPO documents in order to assess changes or revisions. In general, while researchers found climate change mentioned in more of the planning documents (“climate change” was found in 11 new or revised MPO documents), for the most part this was in regard to GHG emissions and mitigation efforts by or through the agency, and not adaptation. The multi-year findings from the MPO document review are summarized in Appendix C. Four examples of these additions were in the following:

- *Bridging Our Communities 2035: The 2035 Houston-Galveston Regional Transportation Plan* (Houston-Galveston Area Council 2007). The Houston-Galveston Area Council's (H-GAC's) regional transportation plan (RTP), which came out in late 2007, includes a section on transportation and climate change. Two specific statements in this section are of interest. First, it recognizes the linkage between the potential impacts from climate change to the area, primarily sea-level rise and the area's vulnerability to storms and flooding. Second, it recognizes the necessity for integrating climate change into transportation planning.
- *2010-2035 NYMTC Regional Transportation Plan: A Shared Vision for a Shared Future* (New York Metropolitan Transportation Council 2009). The New York Metropolitan Transportation Council's (NYMTC's) RTP includes a policy for "incorporating climate change and carbon reduction considerations into regional 'green' transportation policies" (2009, 1-23). Most of the specifics for this policy are related to GHG-reduction measures (e.g. incentives for low- or zero-emission vehicles). In regard to potential impacts from climate change in the region, the report points to floods, sea-level surges, and land subsidence. No specific adaptation responses are included in the report.
- *The 2030 Long-Range Transportation Plan for the Erie and Niagara Counties Region* (Greater Buffalo-Niagara Regional Transportation Council 2007). The 2030 plan includes the statement: "Substantial shifts in public and political sentiment could produce a commitment by the nation, or a collection of serious commitments by state and localities to the issue of global climate change" (2007, 43). As in most of the MPO plans, attention here is focused on mitigation; however, growth-management and development practices are also included in the statement, which suggests possible adaptation responses at some point in the future.
- *Pathways to the Future: The 2030 San Diego Regional Transportation Plan* (San Diego Association of Governments 2007). The San Diego Association of Governments' (SANDAG's) RTP includes one mention of climate change in the proposed actions section of the "Land Use and Transportation" chapter. Proposed Action 15 states: "Update the region's long term energy plan, Regional Energy Strategy 2030, to incorporate energy and climate change impacts of land use and transportation measures (2007, 5-33).

Content Analysis Summary

In general, the findings from the multi-year content analysis suggest two significant points. First, few of the agencies were considering climate change as a factor, and the ones that did focused on mitigation rather than adaptation. Second, as shown through the follow up 2009 assessment, there has been some incremental, albeit slow, movement by these agencies toward increased interest and attention to climate change as a factor in transportation decision making and planning. While this interest is still focusing on mitigation, at least in the published plans and policy statements there was some variation from the initial review in early 2007.

Decision Maker Survey Methods and Findings

The second method of data collection was a mail survey targeted at relevant decision makers in the 50 state DOTs and target MPOs. These individuals were identified through an assessment of the agency organizational charts, identifying those key individuals that would be in positions of authority for planning as well as those placed in environment-related units or divisions within the agency. The objective of the survey was articulated in the contact protocol as follows:

As part of this research project, we are surveying decision makers in state Departments of Transportation and Metropolitan Planning Organizations across the U.S. to gather information on climate change as it relates to your agency, in general, and the role of scientific information in decision making. This survey will be focused around several areas of interest to our project:

- 1) Understanding the significance of climate change/variability to your agency,
- 2) Adaptation as a specific policy response to climate change/variability, and
- 3) How climate science is used in decision making in your agency.

In accordance with the human-subjects research protocol for Texas A&M University, researchers submitted the participant contact and solicitation materials and survey instrument for Institutional Review Board approval. The survey instrument is included in Appendix D.

Surveys were mailed to 118 individuals, with 53 responses, or a 45 percent response rate. Target individuals were encouraged to forward the survey to a more appropriate respondent if necessary. Responses were anonymous; however, researchers did differentiate between DOT and MPO responses for statistical purposes. Responses were coded numerically or as open-ended questions (depending on the type of question). This section of the report summarizes the responses and findings from the survey. For purposes of this report, survey responses and findings are focused on several illustrative parameters, general responses, differentiation between DOT and MPO responses, and coastal versus inland responses.

The first set of responses is from the “general state of knowledge” questions designed to understand the general state of awareness and acceptance of climate change as an issue in the target agencies. These responses are shown in Figures 1 through 9.

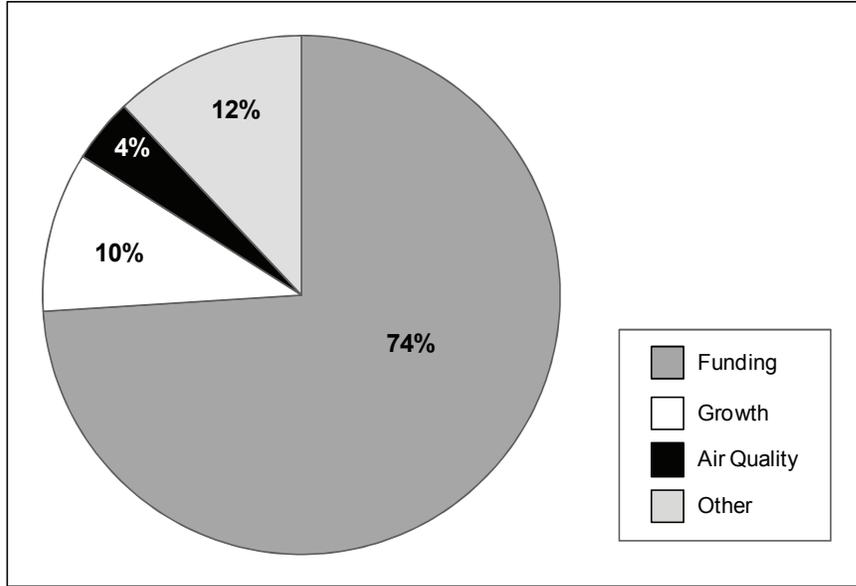


Figure 1. What is the most important issue or problem your agency is currently facing?

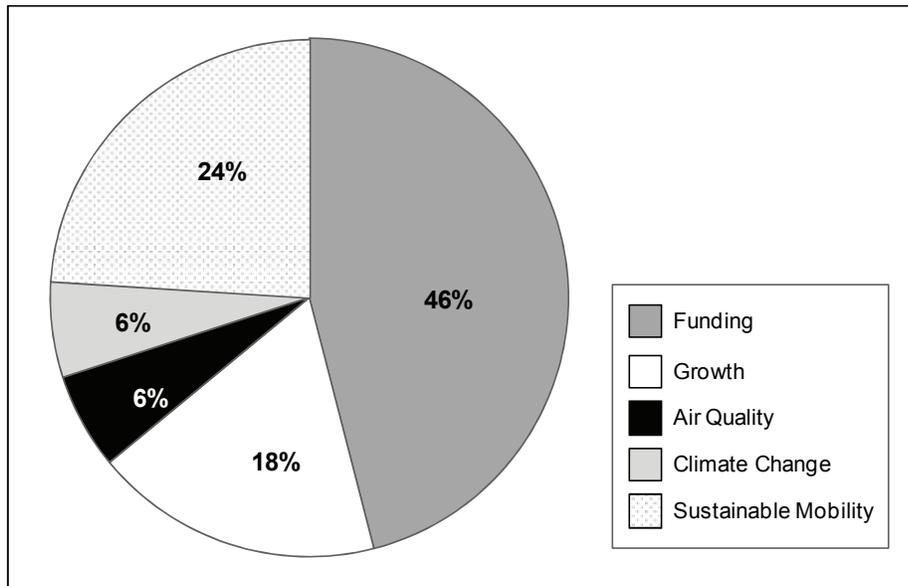
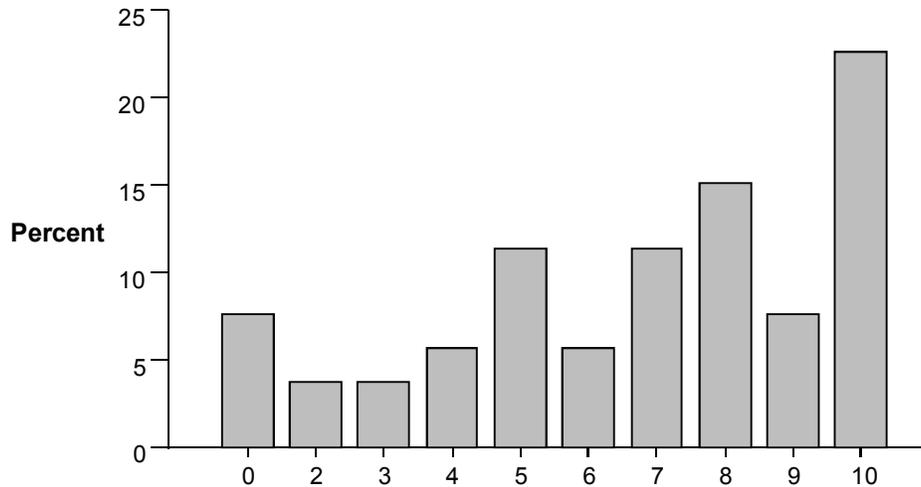


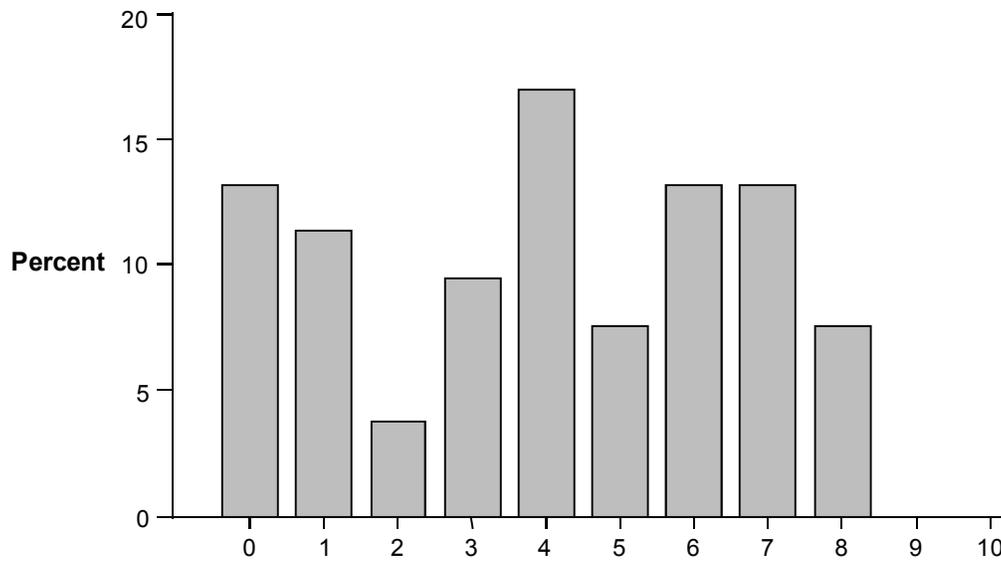
Figure 2. What is the most important issue that will face your agency over the next 50-100 years?



11-point scale where 0 means *Not a Problem at All* and 10 means *Very Significant Problem*

Effect of global warming on environmental well being

Figure 3a. How would you rate global warming as it currently affects the environmental well-being of U.S. society?



11-point scale where 0 means *Not a Problem at All* and 10 means *Very Significant Problem*

Effect of global warming on transportation reliability

Figure 3b. How would you rate global warming as it currently affects the transportation reliability of U.S. society?

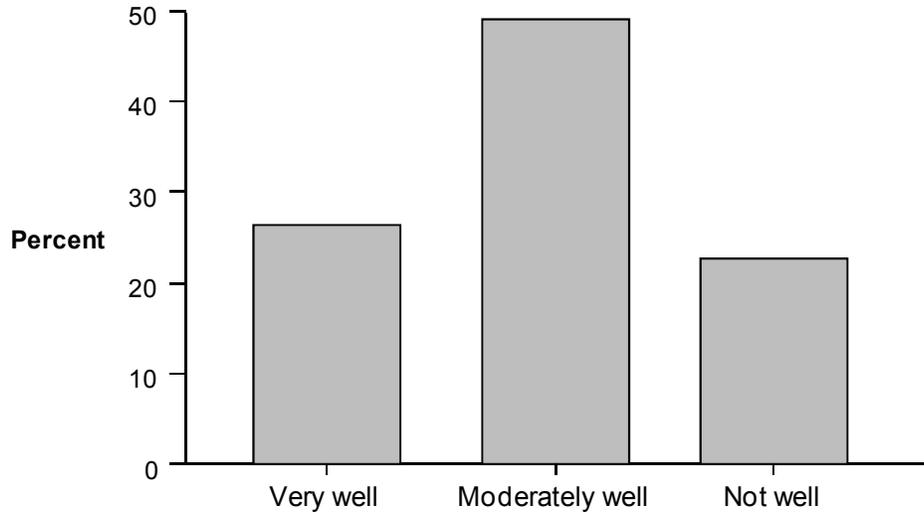


Figure 4. How well do you think climate scientists understand global warming and climate change?

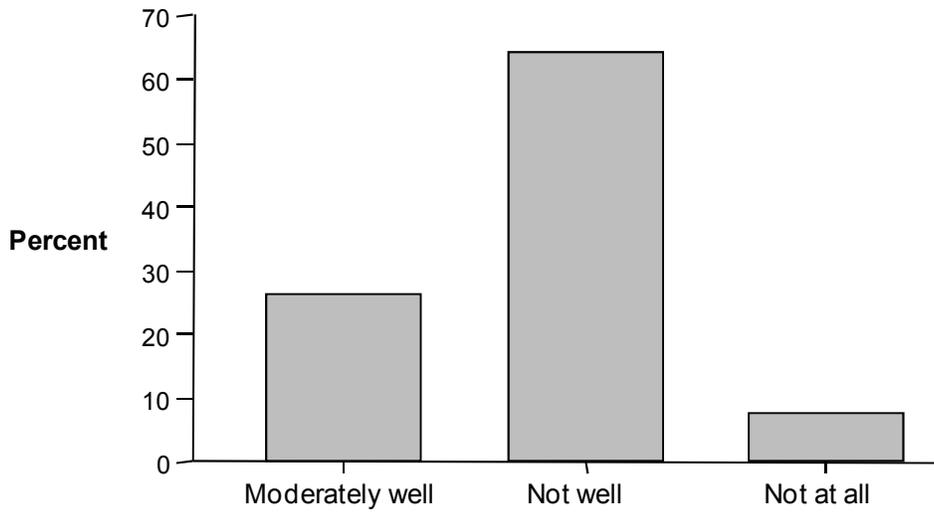


Figure 5. How well do you think members of the media understand global warming and climate change?

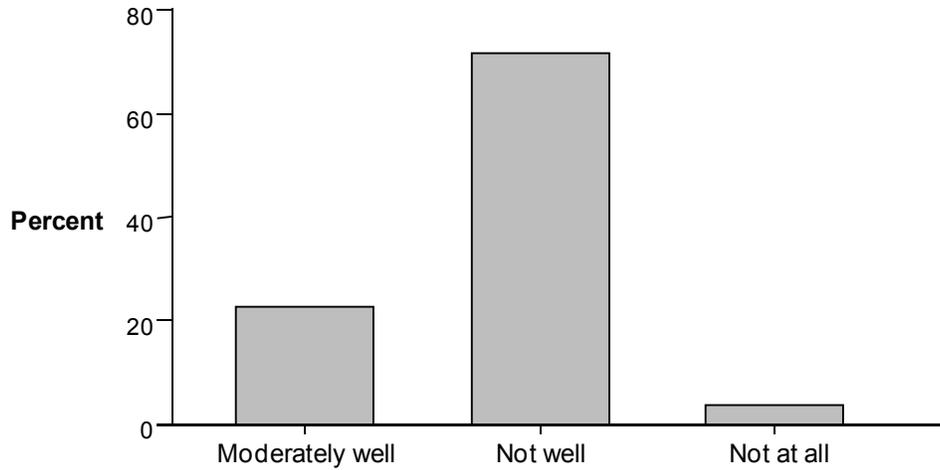


Figure 6. How well do you think policy makers—such as elected officials—understand global warming and climate change?

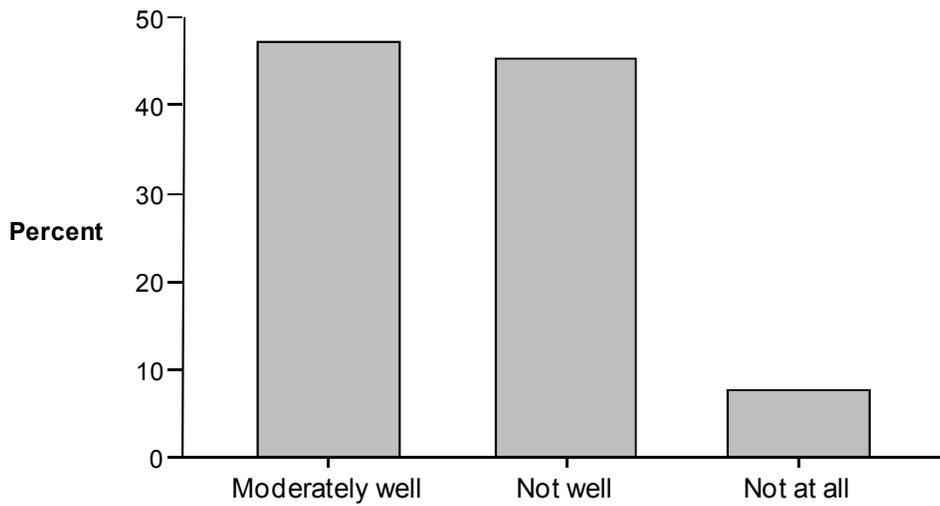


Figure 7. How well do you think transportation professionals understand global warming and climate change?

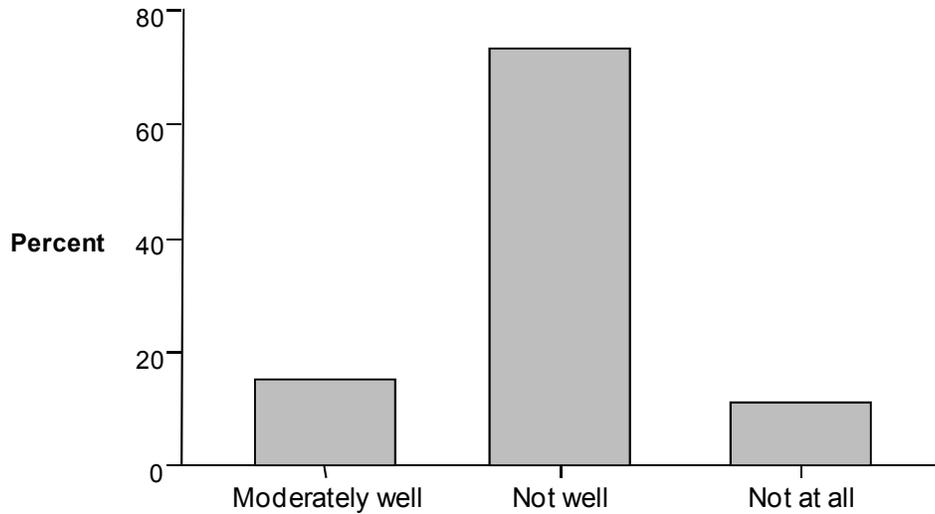


Figure 8. How well do you think the general public understands global warming and climate change?

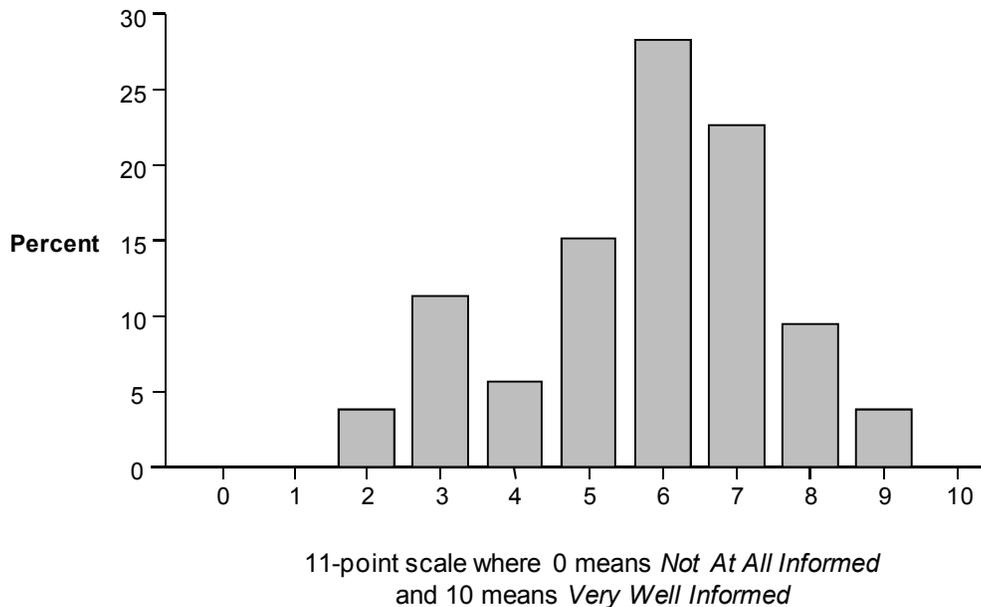


Figure 9. How informed do you consider yourself to be about global warming and climate change?

The dominant issue from the responses is funding, both at the present time and in the future. Climate change is low on the agenda as far as important issues with a slight increase possible in

the future, according to the responses. These results also illustrate that the level of understanding in regard to climate change, from the perception of the transportation professionals surveyed, is fairly low. Self-assessment on the same question, however, is higher.

The next set of questions, shown in Figures 10 through 12, focused on climate change and the respondents' agency.

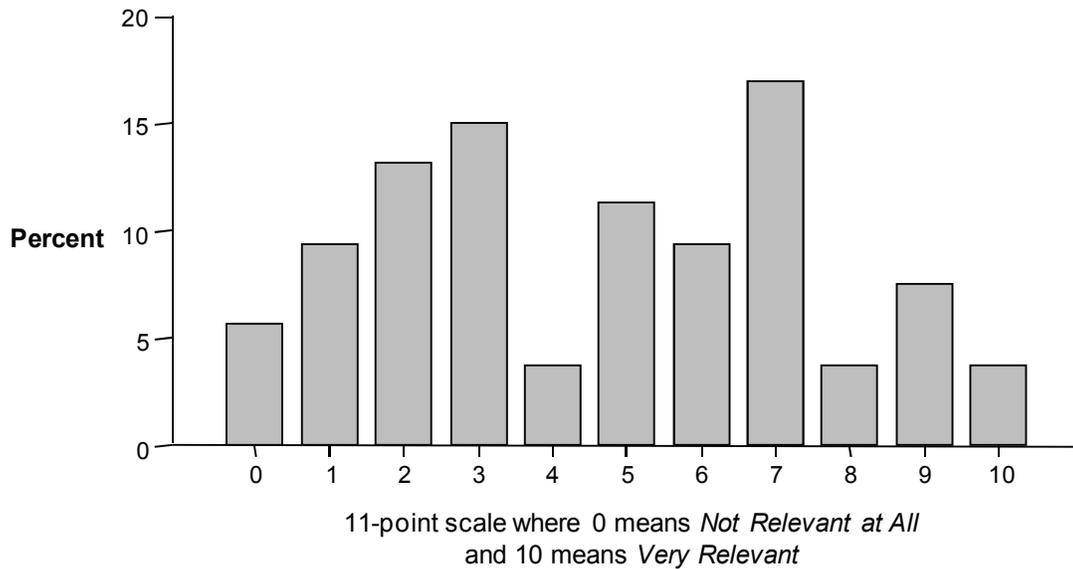


Figure 10. How relevant do you consider global warming and climate change to be to the work you do?

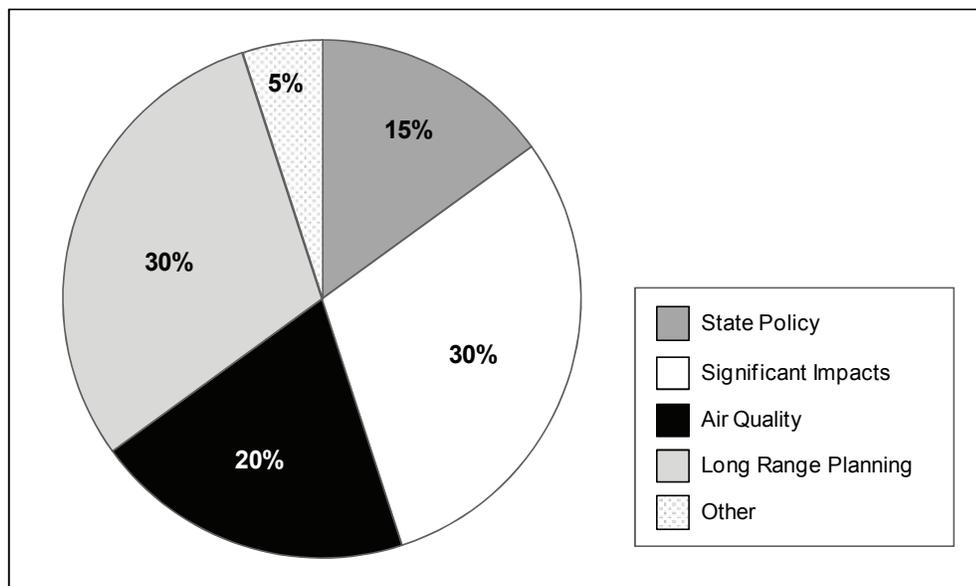


Figure 11a. Is your agency currently considering climate change as a factor in decision making? If yes, why?

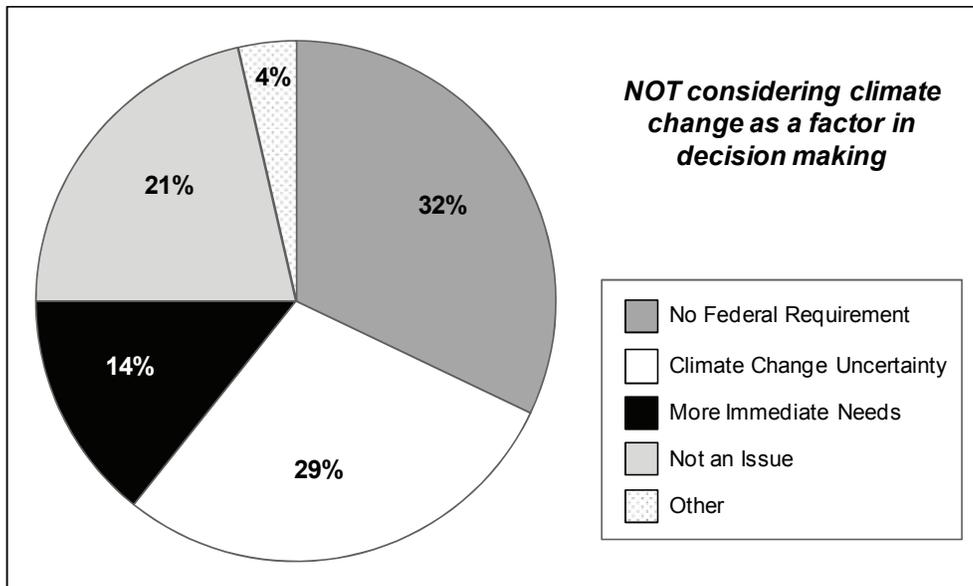


Figure 11b. Is your agency currently considering climate change as a factor in decision making? If no, why?

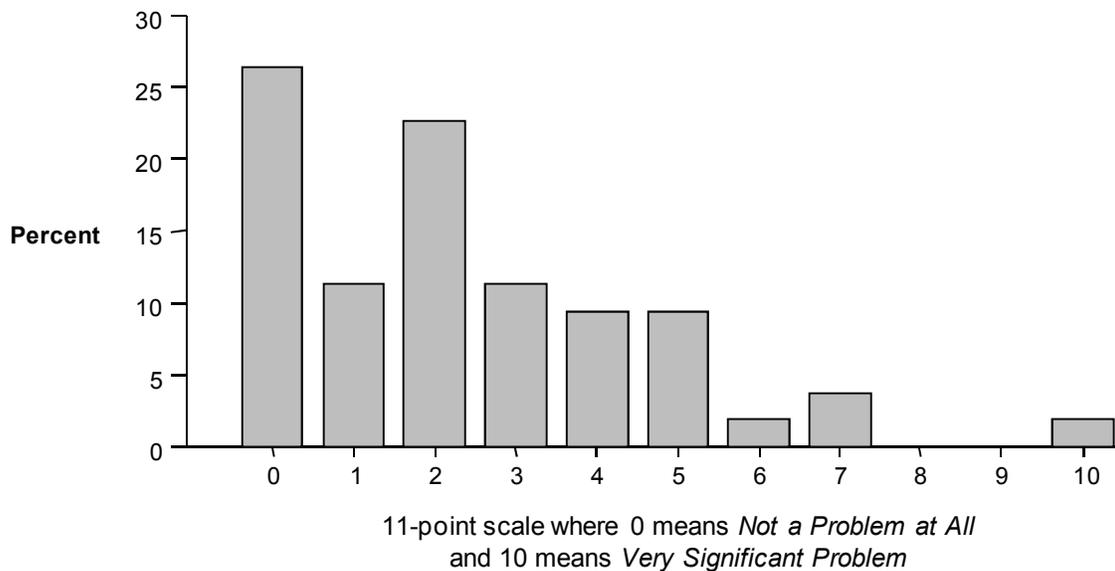


Figure 12. If adaptation is defined as adjustments in natural or human systems in response to climate change conditions or effects, is adaptation something your organization considers in its decision making?

The picture from this section of questions shows a very mixed response. First, there is a wide range of responses regarding the general question of relevance. Second, of those agencies involved with climate change, the dominant reasons are related to impacts, air quality, and long-range planning. Third, and most telling, are the responses when the agency is not considering climate change in decision making, which include lack of a federal mandate to do anything, the uncertainty of the science, and a lack of public interest.

The next set of questions, shown in Figures 13 through 17, focused on climate science and the respondent/agency and interactions in regard to information or data on climate change.

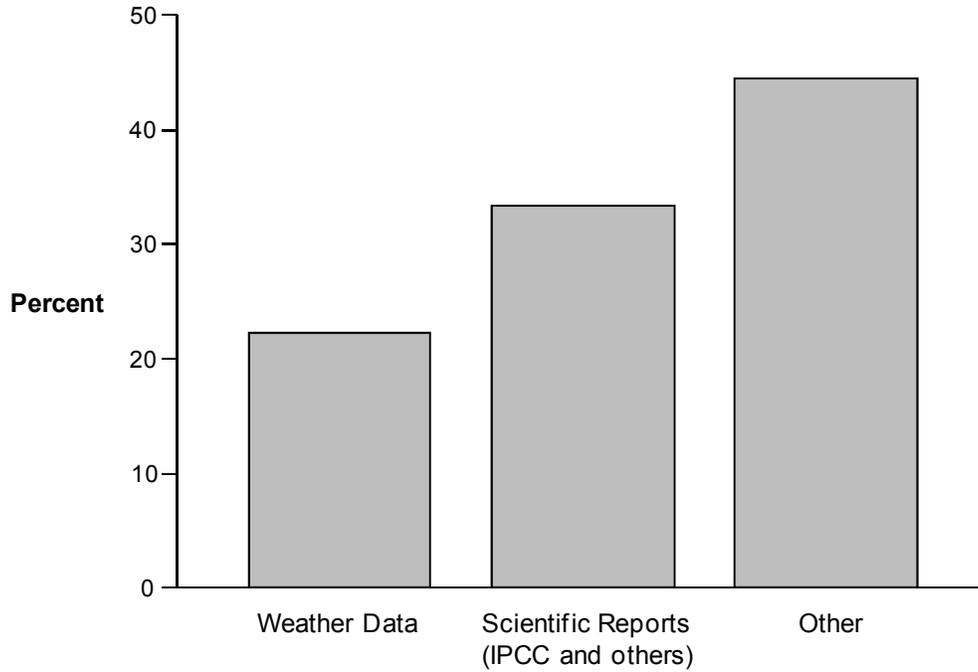


Figure 13. What scientific information on climate change are you using?

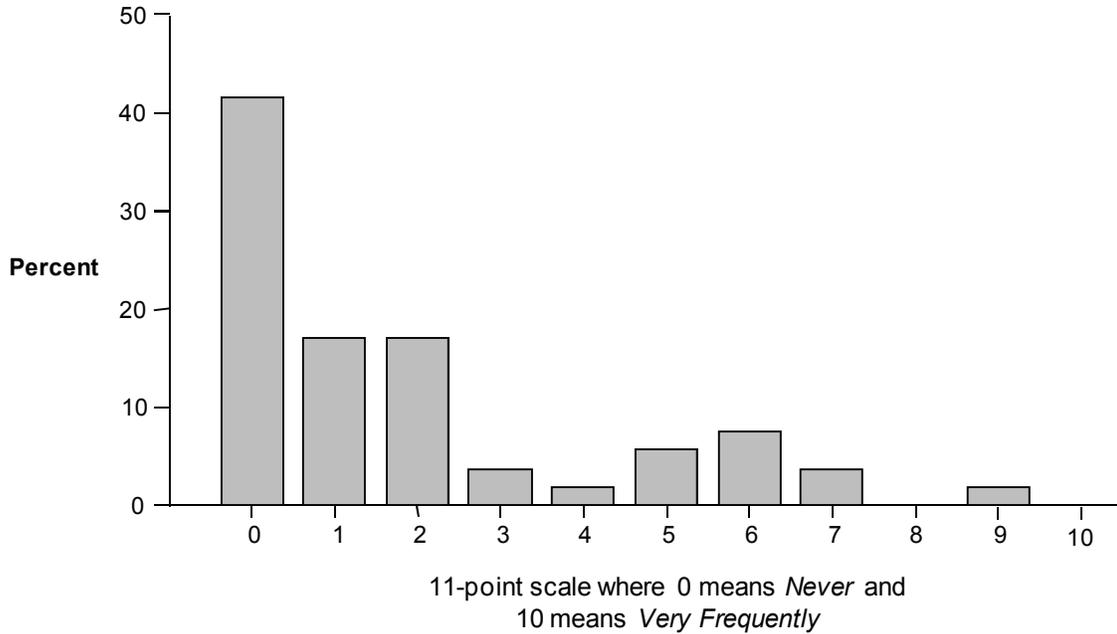


Figure 14. How often do you use science-based information on global warming and climate change to evaluate policy alternatives?

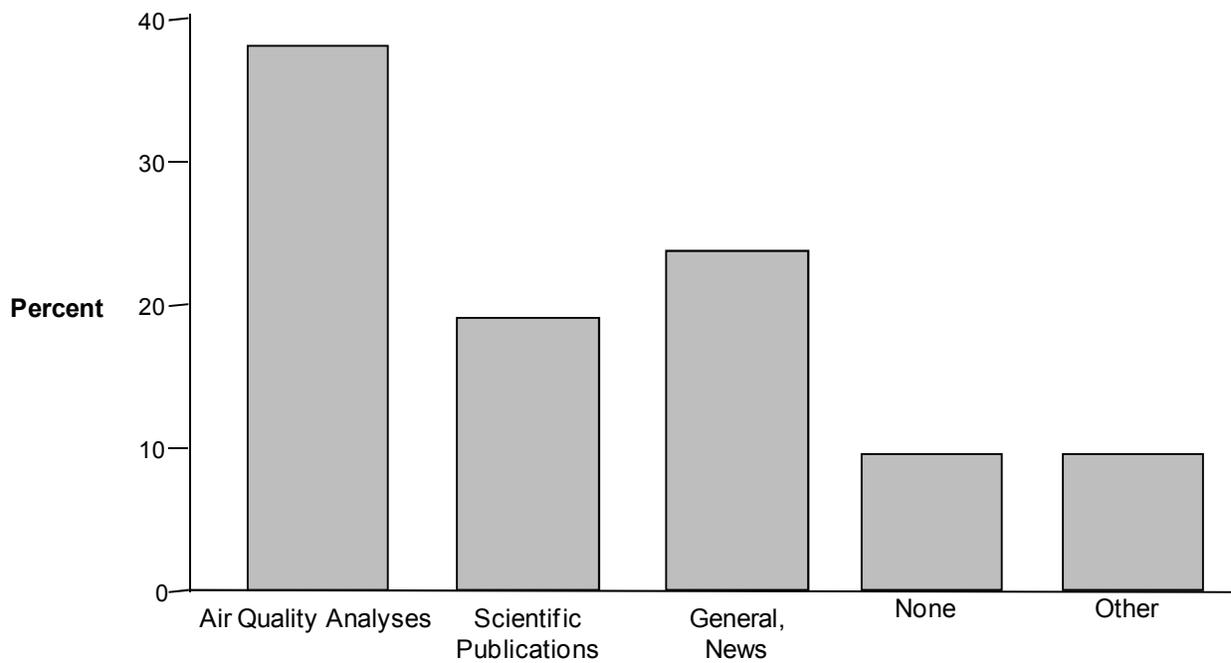


Figure 15. What types of information on climate change do you use most often?

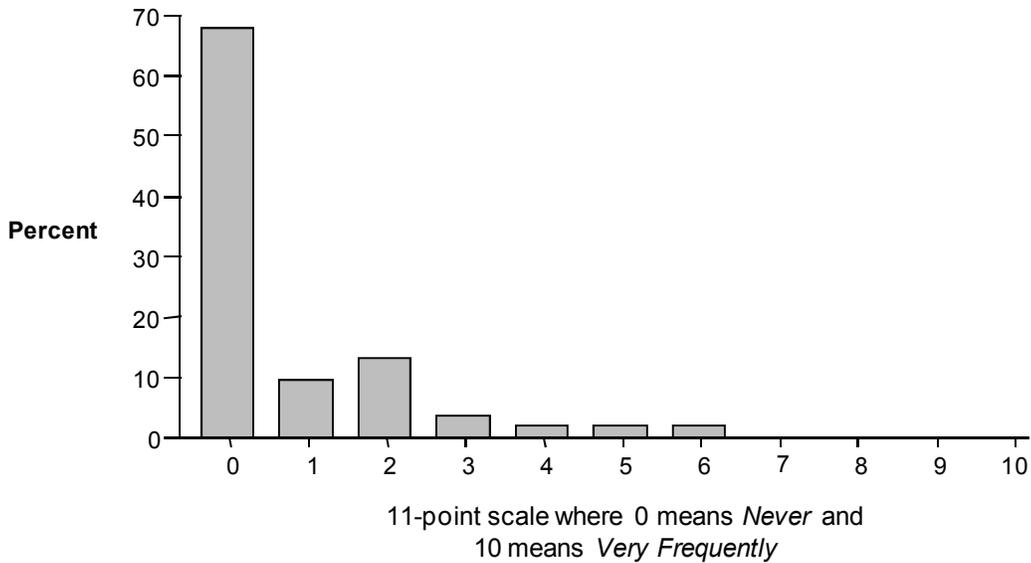


Figure 16. How often do you contact scientists for information related to global warming and climate change?

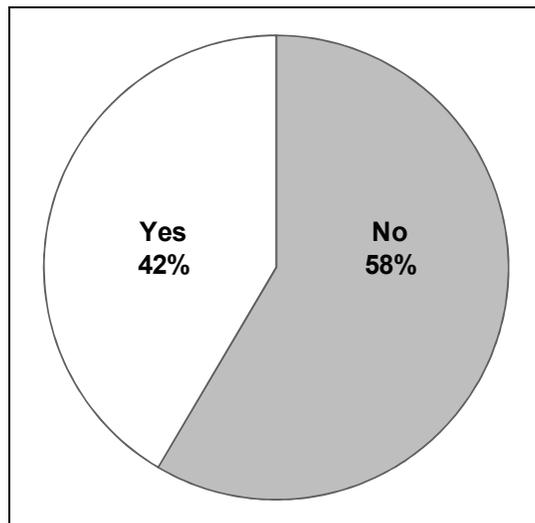


Figure 17. Prior to this survey, has anyone ever asked you for your opinion on global warming?

In regard to the use of science, the results show that respondents utilized a wide variety of sources; however, they rarely went directly to the source and contacted climate scientists.

The next set of questions, shown in Figures 18 through 23, was related to the individual respondent’s views on climate change. Researchers asked these questions in order to develop an

understanding of where transportation professionals in these agencies stood on the issue of climate change, in general. Note: due to rounding, some totals do not equal 100 percent.

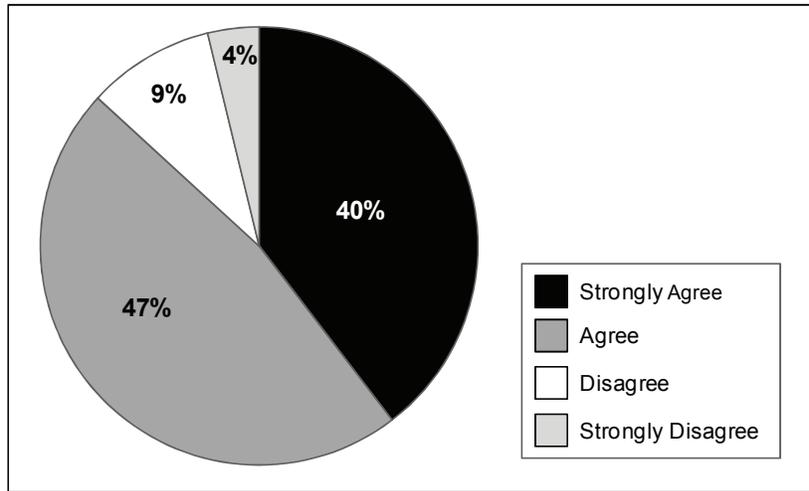


Figure 18. Scientists can say for certain that global warming is a process that is already underway.

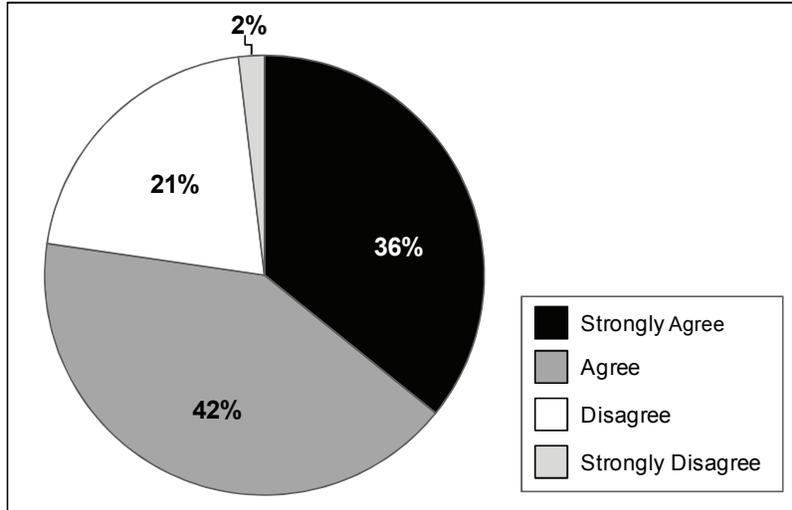


Figure 19. We can say for certain that human activities are accelerating global warming.

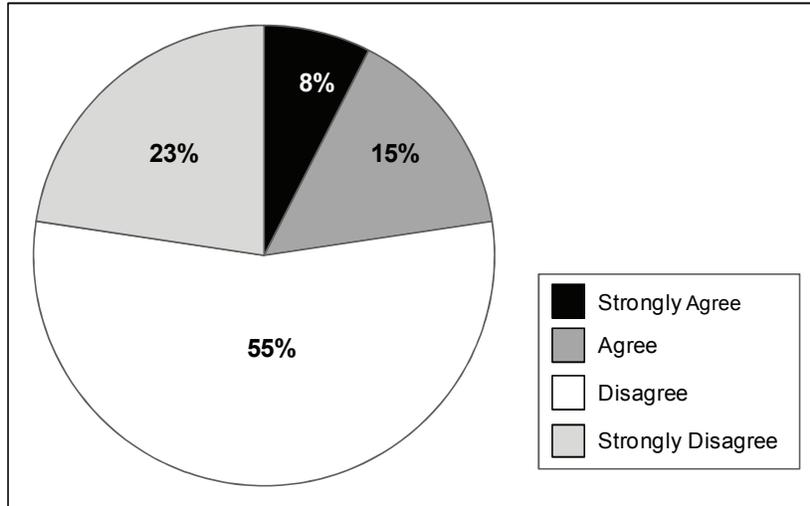


Figure 20. There is enough scientific uncertainty about the rate and extent of global warming/climate change that there is no need for immediate policy decisions.

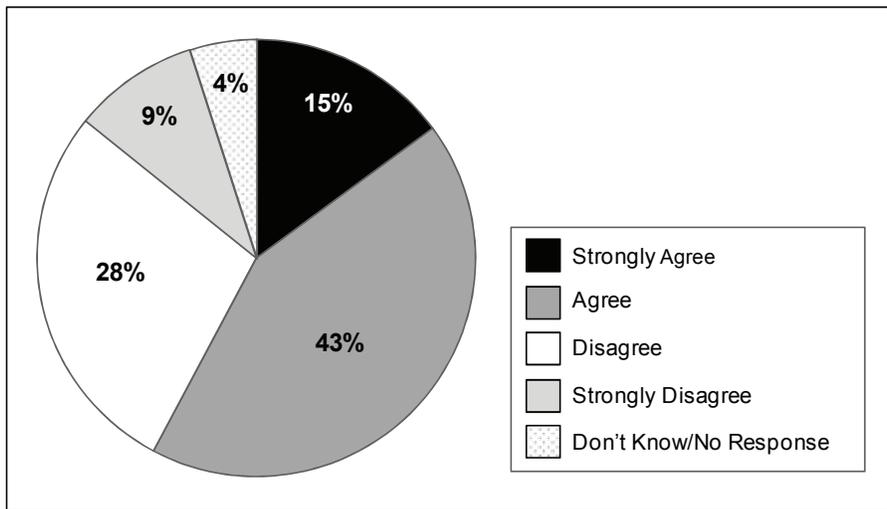


Figure 21. Climate change scientists can be trusted to communicate unbiased information about global warming and climate change.

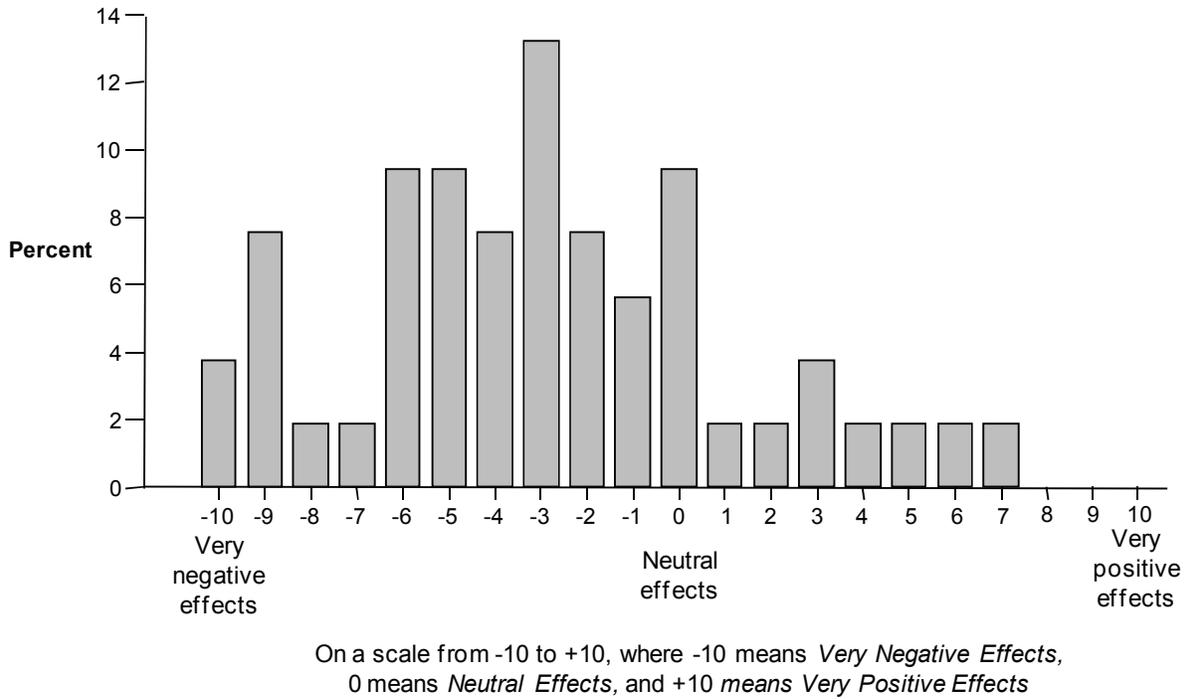


Figure 22. Overall, what kinds of effects do you think global warming and climate change will have on your general geographic area?

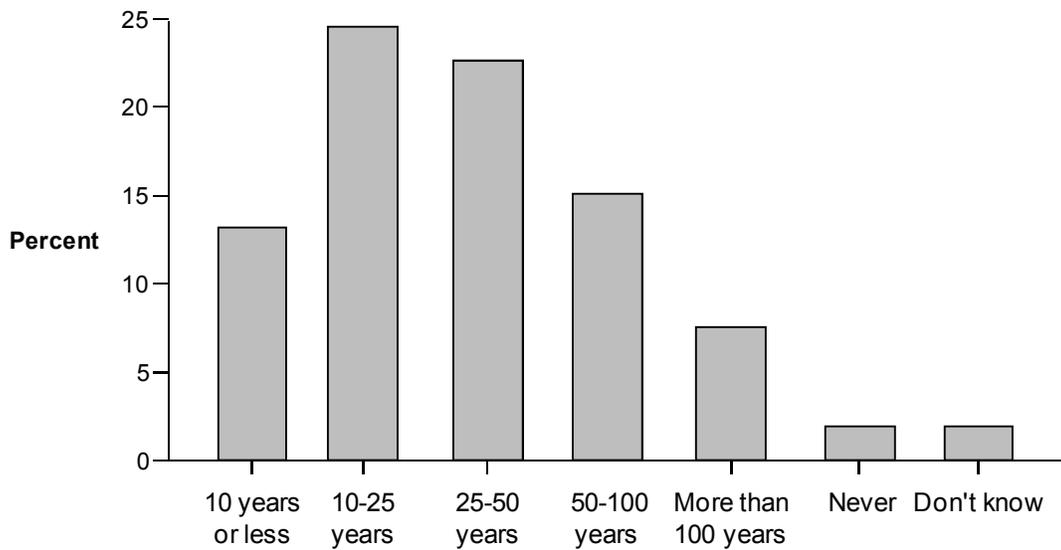


Figure 23. In your opinion, global warming and climate change will be most likely to exert significant impact in your area in how many years?

Figures 24 through 27 delineate the responses between those from coastal states and MPOs and those from inland states and MPOs. This delineation shows that those respondents from coastal states and MPOs appear to be more engaged with the climate change issue and better informed on the issue than their counterparts inland.

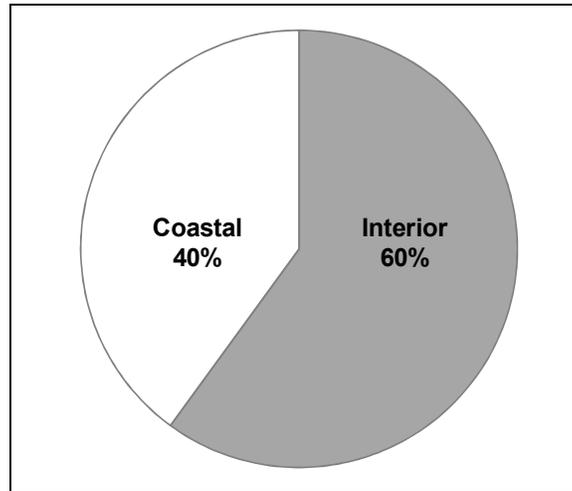


Figure 24. Percent of responses from agency in coastal state/MPO versus inland state/MPO.

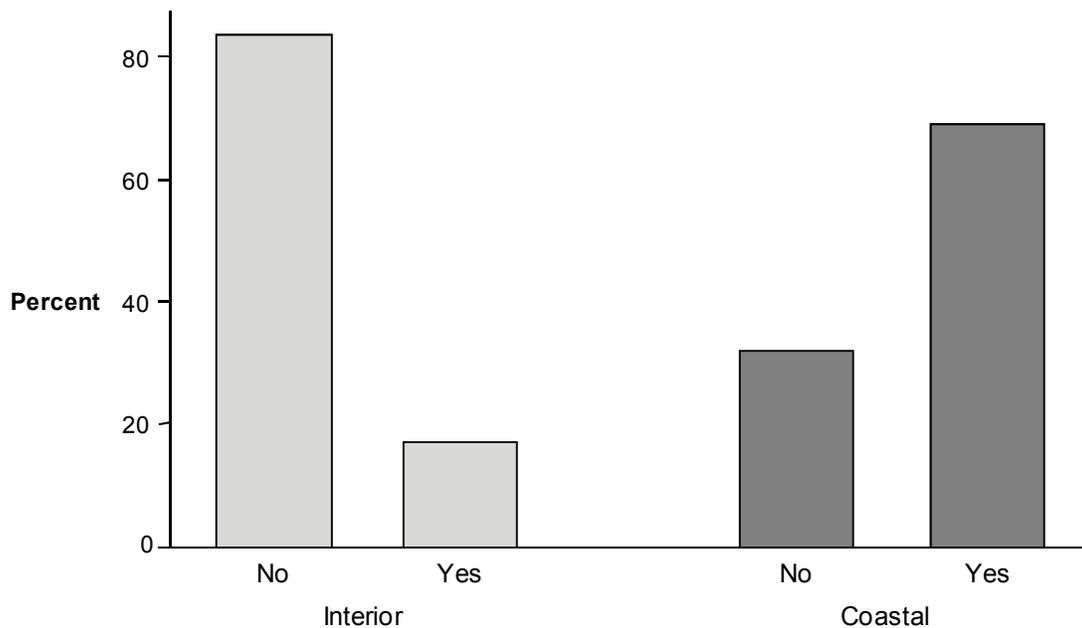


Figure 25. Agencies located in coastal areas are more likely to include consideration of climate change in their planning and decision making.

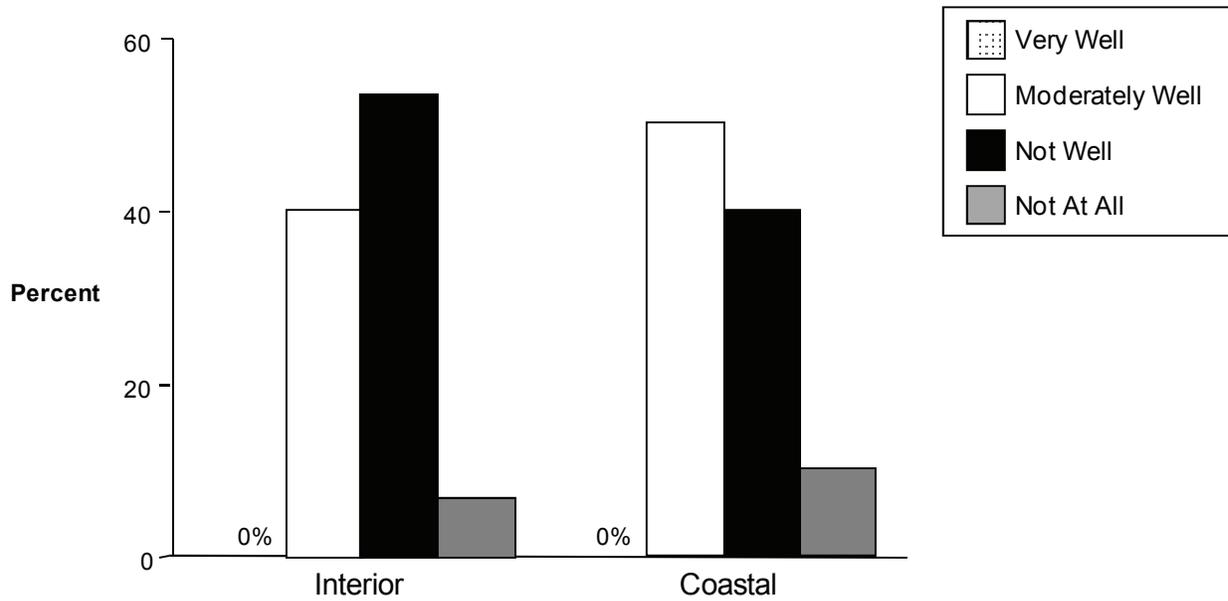


Figure 26. Respondents affiliated with agencies located on the coast are more likely to believe that transportation professionals understand global warming/climate change.

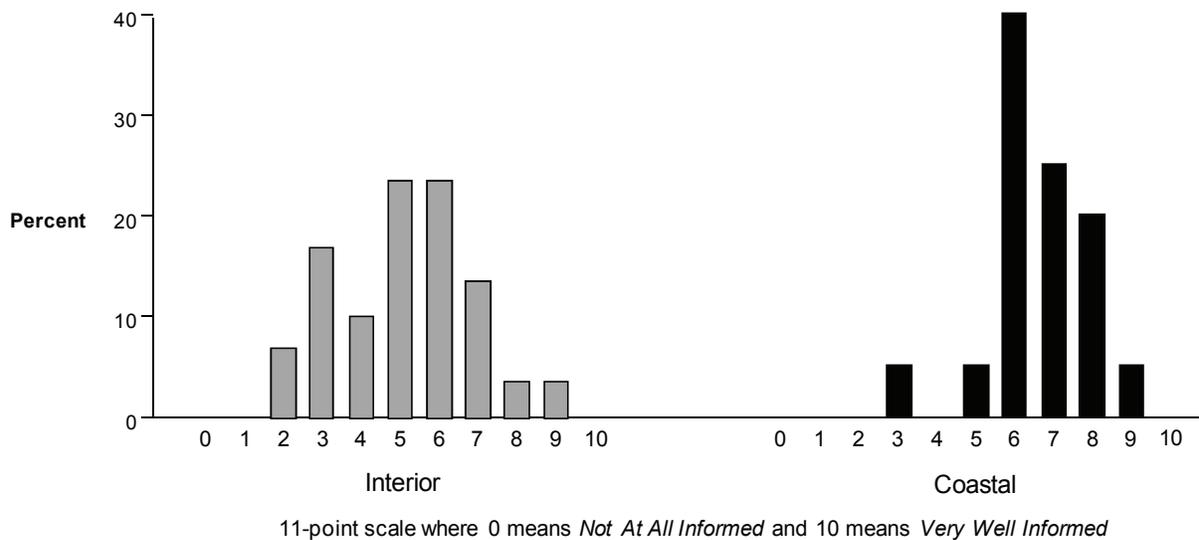


Figure 27. Respondents affiliated with agencies located on the coast are more likely to consider themselves to be well informed about global warming/climate change.

Figures 28 through 32 show the delineation between state DOT respondents and MPO respondents on several of the survey questions.

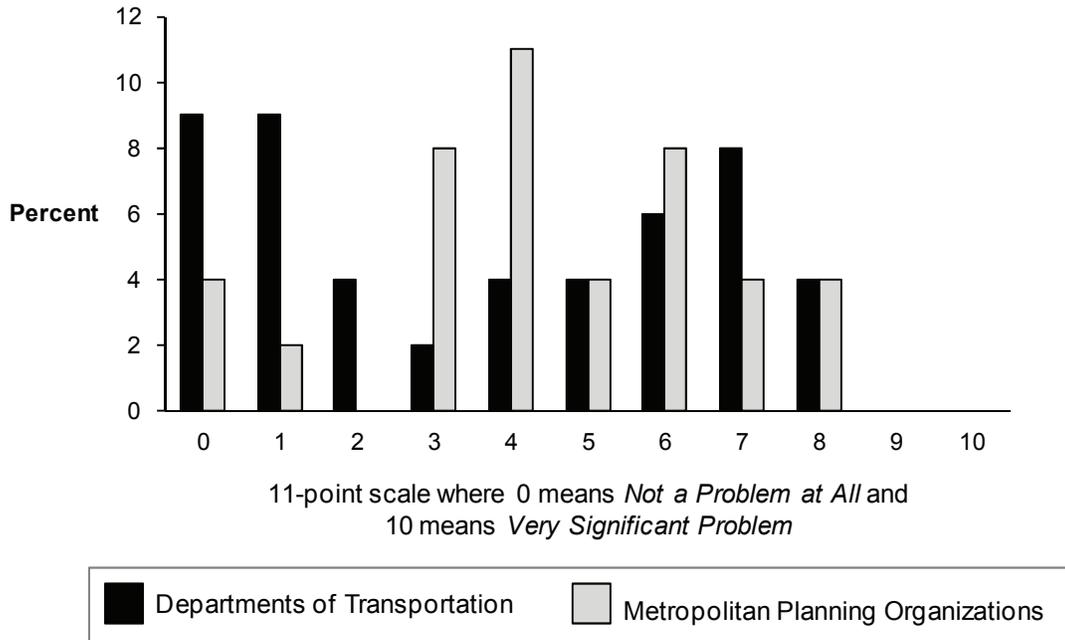


Figure 28. How would you rate global warming as it currently affects the transportation reliability of U.S. society?

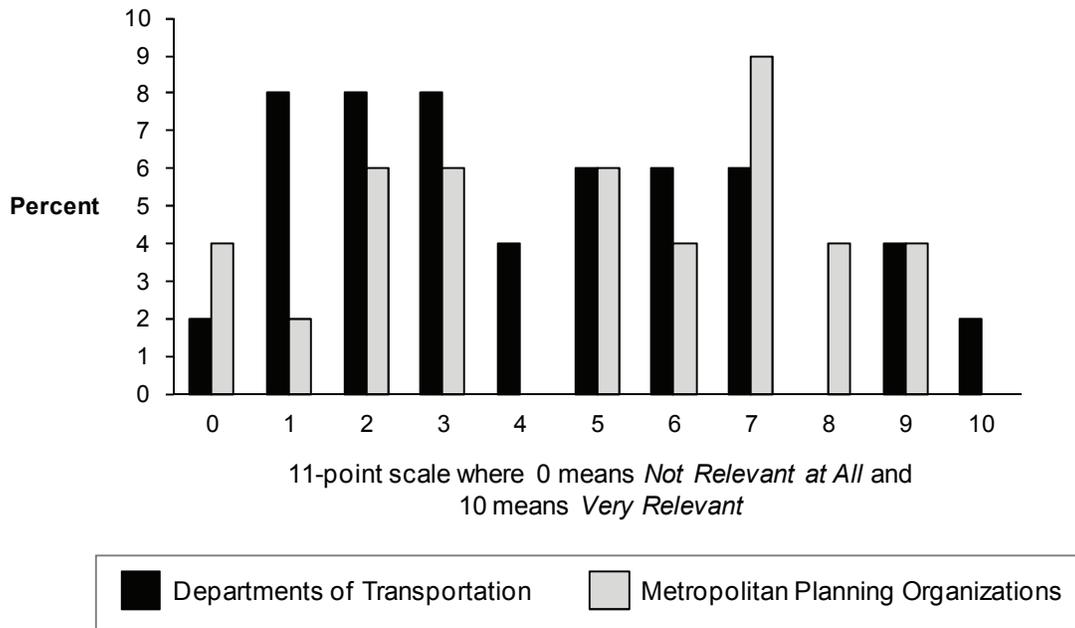


Figure 29. How relevant do you consider global warming and climate change to be to the work you do?

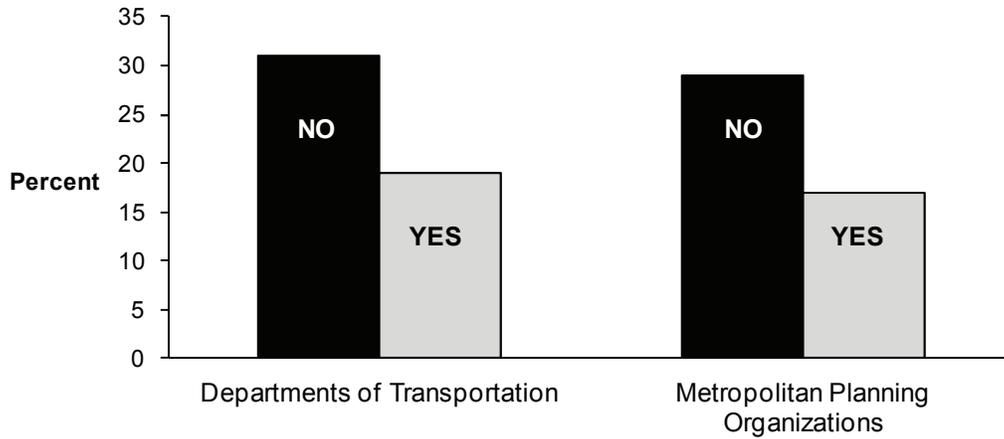


Figure 30. Is your agency currently considering climate change as a factor in its decision making or planning processes?

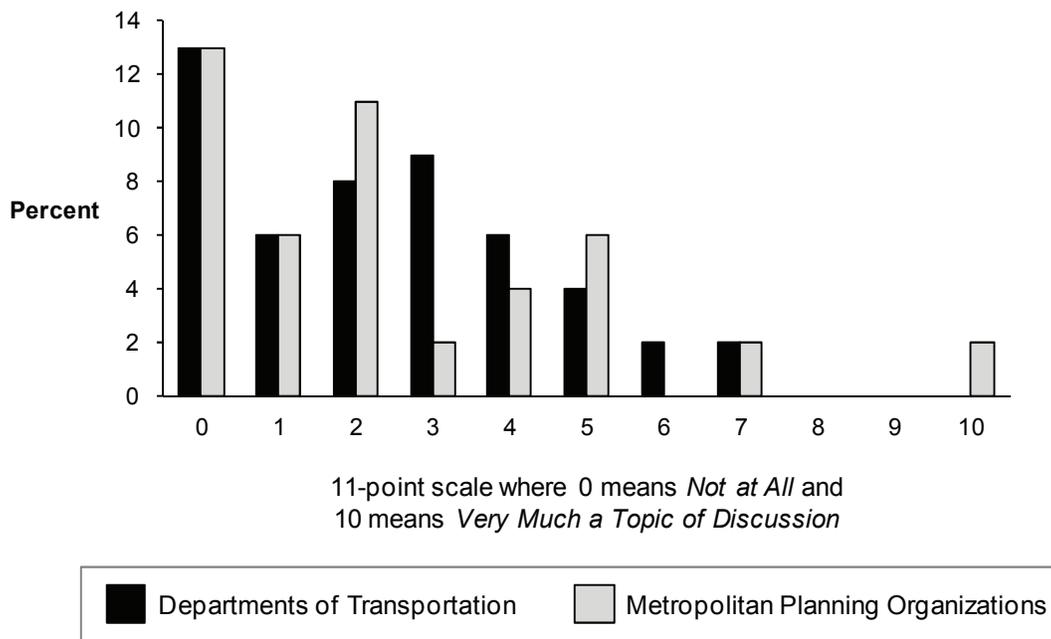


Figure 31. If adaptation is defined as adjustments in natural or human systems in response to climate change conditions or effects, is adaptation something your organization considers in its decision making?

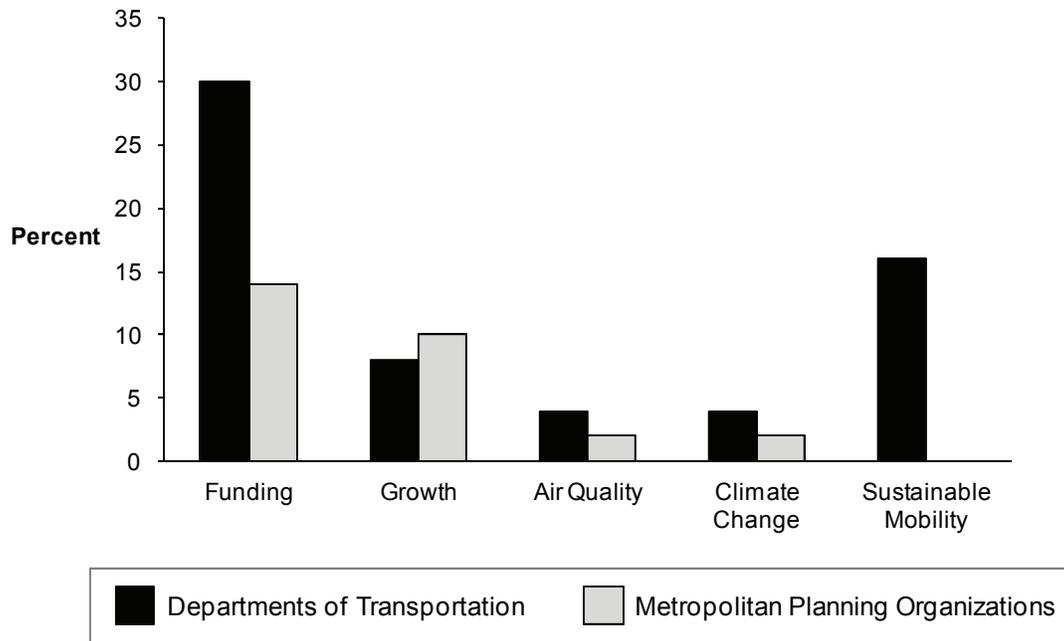


Figure 32. In your opinion, what is the most important issue that will face your agency over the next 50-100 years?

The delineated figures suggest that to a small extent, MPOs are more engaged in the climate change discussion and recognize to a slightly greater extent the problem of climate change impacts and transportation. On most issues, there is not much distinction between the two agency types. In summary, the overall survey responses illustrate a situation of very mixed engagement with climate change as a significant issue in state and regional transportation planning. For this report the finding that there was almost no attention being paid to adaptation is of significance.

Decision Maker Interview Methods and Findings

Following completion of the survey, researchers conducted 12 in-depth telephone interviews with agency representatives (six respondents from state DOTs and six respondents from five MPOs). These individuals were again identified as persons most likely to be able to provide insight and information on the research questions. These individuals were contacted via e-mail with a follow-up phone call to schedule the interview. Interviews lasted approximately 45 minutes and were conducted to collect and assess more detailed responses to questions asked in the survey. The interview discussion guide is included in Appendix E.

The findings from these interviews are summarized here and are intended to supplement the more quantitative responses from the survey. As with the survey, all interview material was reviewed and approved by the Institutional Review Board at Texas A&M University. Consent to be quoted and cited as a representative member of the respondents' respective agencies was requested and secured prior to each interview. Responses, as aggregated and summarized here, are anonymous; however, where permitted and appropriate, the study does identify the respondent as a representative of a state DOT or an MPO for statistical or assessment purposes. Researchers also aggregated the responses geographically between coastal and landlocked states.

Respondents represented a variety of academic disciplines, including civil engineering, environmental sciences, public administration, urban planning, and business. They also represented a wide range of experience, from only a few years to many decades in the transportation field.

The initial set of questions focused on general comments about climate change, whether it was accepted as a problem, and general causes. In response to the question, “Is climate change currently being discussed as a potential problem in your area of responsibility?” respondents from all five MPOs answered yes. Four of the DOT responses were yes, and two were negative. The more specific responses as to why or why not focused on a variety of reasons: significance of air quality to the region or state and a perception that air quality was linked to climate change issues, political interest in the issue of climate change, land-use implications from climate change, and perceived linkages between climate change and disaster responses to storms and flooding. The negative responses focused on the fact that climate change was not yet an issue for the agency and that other issues had a higher priority. In regard to the perceived link between transportation and climate change, the respondents focused much more on the impact of transportation as a contributor to climate change than on the potential impacts of climate change on transportation infrastructure. Compared to the findings from the content analysis and the survey, it would appear that much more discussion is going on in regard to climate change, in general, than actual integration of policies or planning ideas into plans and documentation at this time.

Researchers were also interested in determining what the perception was of the stressor with the most likely impact (sea-level rise, temperature, precipitation, and an increased frequency/magnitude of storms) to the jurisdiction of the respondent’s agency. Responses were almost equal across all four stressors. Sea-level rise held a slight edge with five respondents stating that this stressor would have the most impact, while the other three stressors each had three responses. Of the coastal respondents, sea-level rise also held a slight edge, as was to be expected.

In regard to decision factors for transportation planning, researchers were interested in the temporal framework used by the respondent agency and whether or not the agency was considering a longer time frame, in conjunction with those associated with climate change impacts (50-100 years). Researchers were interested, first, in what the time frame or generally accepted planning window was for the respondent agencies and, second, whether or not the longer time frame for probable climate change impacts was of concern or was being considered. Overall, the respondents and their respective agencies focused on a range of planning time frames from 10 to 30 years out. In general, respondents were not considering the longer time frames associated with climate change impacts in temporal perspectives for decision making. The one exception raised by two respondents was 100-year flood-plain data used for land-use decisions.

The second major focus for this project, in regard to adaptation as an alternative solution to the impacts from climate change, revealed very little in terms of concrete interest and implementation. Researchers were interested, first, in determining if the agency was in fact considering or implementing such solutions and, second, if the respondent was familiar with other agencies applying adaptation responses. None of the respondents replied that they or their agencies were doing any adaptation planning or related activities at the present time. However, most of the respondents (9 or 11) did state that they were considering adaptation or were just now starting the discussion among staff. One respondent also stated that he/she had been

contacted by local citizens and citizen groups about adaptation. In addition, knowledge of other adaptation efforts (outside their own jurisdiction) was nonexistent.

Since one of the other project objectives was to better understand the use of science and other information in the decision process, researchers asked respondents what scientific information on climate change they were using and from what sources. Responses varied considerably, with the state DOTs more inclined to gather information and data from higher levels of government, specifically federal agencies such as USDOT and the Federal Highway Administration (FHWA), the Environmental Protection Agency (EPA), the National Aeronautics and Space Administration (NASA), and the U.S. Army Corps of Engineers. MPOs, on the other hand, looked to federal agencies (and their respective state DOTs) as well as to their more regional local constituents for information and input. Interest groups were also mentioned, such as AASHTO and the Union of Concerned Scientists, as well as academics and universities. Only one interview respondent mentioned the IPCC reports as an information source. Overall, there was a wide net of sources being utilized for gathering information. In regard to the kind of data, primarily this focused on emissions and environmental information on air-quality issues pertinent to the state or regional situation. Very little, if any, climate change information directly linked to adaptation responses was mentioned. There was also considerable concern from several respondents that they did not have reliable downscaled climate change information, at the state or regional levels, and that this was going to be a significant problem in the future for both decision making and public engagement and acceptance of the issue. Finally, the lack of guidance from other institutions was of concern to several respondents. Without reports and best practices from the traditional and reliable sources (e.g., USDOT or a state DOT), these agencies were uncomfortable moving forward on climate change as a factor. In general, responses suggest that the necessary information had not yet caught up with the demand in these agencies.

Finally, researchers include responses regarding the future, or whether or not the agency had plans or was moving toward integrating climate change and adaptation in future planning efforts. While many of the respondents to the general query regarding adaptation did respond that they were starting to discuss this issue as part of a broader discussion of climate change in general, researchers probed further for more details in order to understand the trajectory for adaptation in the future for these agencies. One respondent even mentioned that his/her agency had developed a grant to study adaptation and the transportation-planning process.

Specific linkages between climate change impact and adaptation responses in the foreseeable future included land-use decisions (location of infrastructure), maintenance decisions (whether increased temperatures mean roads would have to be repaired every two years instead of five), bridge repair and design (increased flooding and sea-level rise impacting current design and maintenance practices), and using climate change as a factor in support of encouraging increased mass-transit funding and ridership.

In summary, the interviews revealed that while most of the respondents, and their respective agencies, did recognize the potential problems posed by climate change to their areas, this recognition was not finding its way into the actual plans and policies at the time. Further, there was no indication from the interviews that adaptation, as a climate change solution, was being discussed. Responses do suggest that this could change in the future since discussions could lead to more substantive integration of climate change issues and ideas into future revisions of plans and policies. Two significant findings from the interview responses regarding information and the use of science are that, first, respondents utilized a very wide range of sources, both public and private, for their scientific and climate change information and data; second, there was an

overall sense that the issue of climate change suffered from a lack of detailed state- and regional-level information, which was seen as critical to both decision making and public participation on the issue.

CONCLUSIONS

This study developed and implemented a multi-method approach and data-collection effort. The three data-collection methods provide an unprecedented perspective on the state of transportation planning at the sub-national level of government in the United States in regard to climate change as a decision factor and, more specifically, whether or not adaptation is being considered as an alternative solution to this problem.

The aggregate findings from the content analysis, survey, and interviews reveal that acceptance and movement in state DOTs and MPOs on these complex climate-related issues and solutions, where they exist at all, are slow. Mitigating the impacts from transportation appears to still be the primary linkage between climate change and transportation for these agencies. The findings point to several additional important points:

- Politics and public opinion play and will continue to play important roles in these agencies moving toward the integration of climate change as a decision factor.
- Lack of direction and guidance, suggested primarily as a lack of any top-down federal-state information or relationship, has impeded progress in understating and responding to the climate change/transportation nexus.
- Respondents stressed the need for downscaled state- and regional-level data on climate change impacts and probabilities. This needs to be communicated to the climate science community, as does specific transportation-related data needs.
- Coastal-area respondents appear to be better informed (self-assessment) and engaged in the climate change issue. This may be a factor of the proximity to vulnerable coastlines and sea-level rise stressors, however, this suggests that the other climate change stressors of temperature and precipitation variation may be more difficult to visualize or communicate effectively.
- Adaptation as an alternative solution—and one that can be considered and developed at the state and regional levels—is gaining slight attention from planners and decision makers. This was identified in the interview process, and not in the formal survey or content analysis components of the study. This suggests that in spite of recent movement toward including climate change as a factor, the consideration of adaptation responses will be even slower.

Creating a snapshot in time of the complex issues of climate change and transportation planning, such as is provided by this report, has been similar to trying to shoot at a moving target. Planning and decision making in the transportation policy domain do not stand still for long, and the discussions, revisions, and assorted research activities and input from the public are typically all in full swing even before the most recent plan or policy is printed and adopted. Considering this reality, the situation since the conclusion of the surveys and interviews has pushed the issue even further into the transportation-planning psyche. More research is now available on these issues and connections. More interest, guidance, and federal and state information have been produced, and there does not appear to be any loss of momentum at this time (e.g., see Climate Change Science Program 2008, Transportation Research Board 2008). It is not easy to integrate any new concept into established planning practices (e.g., see Lindquist 2001 for a discussion of integrating the concept of sustainability into local transportation decision making). This is especially true when a concept, such as climate change, is politically

and emotionally charged. This should not, however, dissuade transportation professionals from discussing and considering this complex issue, alternative solutions and related factors of climate change.

RECOMMENDATIONS

Based on the findings and conclusions, the researchers provide several recommendations in the area of climate change, transportation planning and decision making, and adaptation. The first recommendation relates to the overarching issue of the public's perception of climate change as a problem and its significance to the transportation policy domain. The general public seems to be losing interest in climate change as an important issue, recent public surveys suggest (e.g., see Pew Research Center for the People and the Press 2009). As health care and the economy continue to dominate the political debate, other issues tend to fall further down the agenda or list of concerns. This does not mean, however, that interested stakeholders, such as researchers, interest groups, and even state DOTs and MPOs, have dropped climate change as an issue. It does suggest that gaining the public's interest and support will be difficult in the short term as long as climate change is either a suspect issue or not an issue at all in the public eye. Since physical factors such as geographic location and proximity to the coast may influence the public's acceptance and support for climate change solutions, studies on how the public reacts to possible climate change solutions will need to be carried out in diverse locations. One top-down solution from the federal level, for example, will not be applicable in all geographic regions of the country because residents in certain areas may be more aware of and supportive of climate change solutions such as adaptation.

This study has shown that there is also incomplete acceptance from transportation professionals in regard to climate change as an issue. While researchers see incremental movement in this regard, there may never be total acceptance of climate change in this domain. However, there are few data on the research capacity or on what state and regional agencies may need in regard to training and support for the complex issues of climate change as they gain prominence on the public and political agenda. Adaptation, unlike mitigation, is not necessarily an environmental issue, which may create a demand for different types of transportation professionals. Research into staffing and educational needs for climate change research and decision making, as well as institutional analyses on overall capacity needs for effectively responding to such issues as climate change, its associated stressors, and sudden as well as long term change are areas that have yet to be studied.

A related recommendation is in regard to the role of sub-national institutions of the state DOT and regional MPO themselves. In other countries, there is currently considerable interest in the question of the appropriate level, scale, or scope of governance for sustainability and climate change adaptation (e.g., see Biermann 2007; Biermann et al. 2009; Lindquist 2007, 2009). The major question posed here is whether or not the existing governmental structure is adequate to respond to and manage such complex issues as climate change. This concern is just now reaching the United States, and the role of the state DOT and the MPO will need to be prominent in any discussion of transportation and governance for climate change.

The political reality of climate change as a contentious issue may also be impeding the integration of adaptation as a solution at the state and regional levels of transportation planning. More research is currently needed in order to better understand the role of politics in decision making at the state and MPO levels. Each of these levels of planning and policy has its own political dynamics, constituents, and processes that interact differently for different issues, as well as the intergovernmental nature of the federal system of national governance. The politics of local transportation planning is understudied and is traditionally the domain of the case-study

method (e.g., see Suarez et al. 2005). While case studies are effective and informative and should be applied, there is also a need for larger N studies as well as comparative studies on this issue.

From a technical perspective, one of the first activities a state DOT or MPO should accomplish when considering climate change and adaptation is a vulnerability study or assessment of existing infrastructure in order to create a baseline inventory of assets vulnerable to climate change stressors. Creating tools and methods for vulnerability assessments can be the first step toward adaptation to climate change impacts. Vulnerability assessments, risk assessments, and related tools and approaches are available and commonly applied in other disciplines and issue areas; they can easily be translated into the transportation area. A related approach of developing multiple scenarios for a state or region would also be appropriate. Tools for transportation planning for adaptation to climate change would appear to be an appropriate topic for a workshop or TRB session.

Finally, as more of these sub-national agencies do get involved with climate change and adaptation policy and planning, a larger body of work, experiments, and ideas will evolve and become available for discussion, comparison, and scrutiny. These shared experiences should lead to the development, testing, and implementation of best practices. This is a common approach to new ideas in the transportation-planning realm and should be encouraged in regard to climate change and its relevant solutions.

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**APPENDIX A—METROPOLITAN PLANNING ORGANIZATIONS
CONTACTED FOR THE SURVEY**

Organization Name	City	State
Regional Planning Commission of Greater Birmingham	Birmingham	AL
Maricopa Association of Governments	Phoenix	AZ
Pima Association of Governments	Tucson	AZ
Metropolitan Transportation Commission	Oakland	CA
San Diego Association of Governments	San Diego	CA
Southern California Association of Governments	Los Angeles	CA
Sacramento Area Council of Governments	Sacramento	CA
Association of Monterey Bay Area Governments	Marina	CA
Council of Fresno County Governments	Fresno	CA
Kern Council of Governments	Bakersfield	CA
Denver Regional Council of Governments	Denver	CO
Capitol Region Council of Governments	Hartford	CT
National Capital Region Transportation Planning Board	Washington	DC
Broward Metro Planning Organization	Ft. Lauderdale	FL
First Coast Metropolitan Planning Organization	Jacksonville	FL
Miami-Dade Metropolitan Planning Organization	Miami	FL
Palm Beach County Metropolitan Planning Organization	West Palm Beach	FL
Hillsborough County Metropolitan Planning Organization	Tampa	FL
Metroplan Orlando	Orlando	FL
Pinellas County Metropolitan Planning Organization	Clearwater	FL
Atlanta Regional Commission	Atlanta	GA
Oahu Metropolitan Planning Organization	Honolulu	HI
Chicago Metropolitan Agency for Planning	Chicago	IL
Indianapolis Metropolitan Planning Organization	Indianapolis	IN
Northwestern Indiana Regional Planning Commission	Portage	IN
Kentuckiana Regional Planning and Development Agency	Louisville	KY
New Orleans Regional Planning Commission	New Orleans	LA
Boston Metropolitan Planning Organization	Boston	MA
Pioneer Valley Planning Commission	West Springfield	MA
Baltimore Metropolitan Council	Baltimore	MD
Southeast Michigan Council of Governments	Detroit	MI
Grand Valley Metropolitan Council	Grand Rapids	MI
Metropolitan Council	St. Paul	MN

Organization Name	City	State
East-West Gateway Council of Government	St. Louis	MO
Mid-America Regional Council	Kansas City	MO
Capital Area Metropolitan Planning Organization	Raleigh	NC
Mecklenburg-Union Metropolitan Planning Organization	Charlotte	NC
Metropolitan Area Planning Agency	Omaha	NE
North Jersey Transportation Planning Authority	Newark	NJ
Mid-regional Council of Governments	Albuquerque	NM
Regional Transportation Commission of Southern Nevada	Las Vegas	NV
New York Metropolitan Transportation Council	New York	NY
Greater Buffalo-Niagara Regional Transportation Council	Buffalo	NY
Capital District Transportation Committee	Albany	NY
Genesee Transportation Council	Rochester	NY
OKI Regional Council of Governments	Cincinnati	OH
Mid-Ohio Regional Planning Commission	Columbus	OH
Northeast Ohio Areawide Coordinating Agency	Cleveland	OH
Akron Metropolitan Area Transportation Study	Akron	OH
Miami Valley Regional Planning Commission	Dayton	OH
Association of Central Oklahoma Governments	Oklahoma City	OK
Indian Nations Council of Governments	Tulsa	OK
Metro	Portland	OR
Delaware Valley Regional Planning Commission	Philadelphia	PA
Southwestern Pennsylvania Commission	Pittsburgh	PA
Rhode Island State Planning Council	Providence	RI
Nashville Area Metropolitan Planning Organization	Nashville	TN
Memphis Urban Area Metropolitan Planning Organization	Memphis	TN
Houston-Galveston Area Council	Houston	TX
North Central Texas Council of Governments	Arlington	TX
Capital Area Metropolitan Planning Organization	Austin	TX
El Paso Metropolitan Planning Organization	El Paso	TX
San Antonio-Bexar County Metropolitan Planning Organization	San Antonio	TX
Wasatch Front Regional Council	Salt Lake City	UT
Hampton Roads Planning District Commission	Chesapeake	VA
Richmond Area Metropolitan Planning Organization	Richmond	VA
Puget Sound Regional Council	Seattle	WA
Southeastern Wisconsin Regional Planning Commission	Waukesha	WI

APPENDIX B—REVIEW OF STATE DEPARTMENT OF TRANSPORTATION PLANS

State/Plan Title	2007	2009 Review
Alabama—Alabama Statewide Transportation Plan	No mention of climate change. No mention of the 4 stressors.	2008 update mentions storm surges in discussion of evacuation routes.
Alaska—Vision 2020, Statewide Transportation Policy Plan	Considers environment as a planning factor. No mention of stressors.	Not available.
Arkansas—Broad Strategic Goals	No mention of climate change.	Arkansas Statewide Long Range Intermodal Transportation Plan 2007 Update—no mention of climate change or stressors.
Arizona	Mentions environment. No mention of stressors.	Not available.
California –Transportation Plan 2025	Mentions sea-level rise, storm frequency, and intensity.	Also mentions precipitation change and temperature change. No mention of adaptation.
Connecticut—Long Range Transportation Plan	Mentions risk assessment in response to climate change issues	Focused on mitigation. Discusses transportation/infrastructure planning but only as a means of reducing vehicle miles traveled.
Colorado—2030 Statewide Transportation Plan	No mention of climate change or stressors.	No mention in 2035 plan.
Florida—2020 Florida Transportation Plan	No mention of climate change.	No mention in 2025 plan.
Georgia—2005-2035 Georgia Statewide Transportation Plan	No mention of climate change.	No mention of climate change.
Iowa—2007-2011 Iowa Transportation Improvement Plan	No mention of climate change.	Iowa in Motion 2020—no mention.
Idaho—2006 Strategic Plan	No mention of climate change.	Idaho’s Transportation Vision—no mention.
Indiana—INDOT 25 Year Long Range Plan 2003 Update	No mention of climate change.	2030 Long Range Plan—no mention.
Kansas—Long Range Transportation Plan	No mention of climate change.	Discusses adaptation planning for climate change, as well as four stressors: precipitation, temperature, storm surges, and more powerful wind loads (Ch. 8, “A Look Beyond”).
Kentucky—Long Range Statewide Transportation Plan (Draft)	No mention of climate change.	No mention.
Louisiana—Louisiana Transportation Plan	No mention of climate change.	No mention.

State/Plan Title	2007	2009 Review
Maryland—A Blueprint for Maryland's Transportation Future	No mention of climate change.	2009 Maryland Transportation Plan—discusses climate-change adaptation, including sea-level rise, temperature rise, and storms.
Michigan—Michigan Transit Strategic Plan 2000-2020	No mention of climate change.	Michigan Transportation Plan—no mention.
Montana—Montana Strategic Plan 2003	No mention of climate change.	No mention.
Missouri—MoDOT's Long Range Transportation Plan	No mention of climate change.	No mention.
Montana—Tranplan 21	No mention of climate change.	No mention.
North Carolina—North Carolina's Long-Range Statewide Multimodal Transportation Plan	No mention of climate change.	No mention.
North Dakota—North Dakota's Statewide Strategic Transportation Plan	No mention of climate change.	2007 TransAction II—no mention.
Nebraska—Long Range Transportation Plan	No mention of climate change.	No mention.
Nevada—NEVPLAN Nevada Statewide Long Range Multimodal Transportation Plan	No mention of climate change.	Moving Nevada through 2028—discusses adaptation, including temperature and increased rain/flooding.
New Jersey—Statewide Transportation Plan	No mention of climate change.	Transportation Choices 2030 (Draft)—no mention.
New Mexico—Long Range Comprehensive Transportation Plan Update	No mention of climate change.	No mention.
New York—NY State's Transportation Master Plan for 2030	No mention of climate change.	No mention.
Ohio—Access Ohio 2004-2030	No mention of climate change.	No mention of climate change. Identifies hurricanes as a potential threat.
Oklahoma—2005-2030 Statewide Inter-modal Transportation Plan	No mention of climate change.	No mention.
Oregon—Oregon Transportation Plan	Reduce emissions to reduce climate change.	Discusses sea-level rise.
Pennsylvania—Statewide Long range Transportation Plan	No mention of climate change.	No mention.
Rhode Island—Progress Report 2004-2005	No mention of climate change.	No mention.
Tennessee—Strategic Direction 2004-2006	No mention of climate change.	No mention.
Texas—Strategic Plan for 2007-2011	No mention of climate change.	2009-2013—no mention.
Utah—Utah Transportation 2030	No mention of climate change.	No mention.

State/Plan Title	2007	2009 Review
Virginia—Strategic Plan	No mention of climate change.	No mention.
Vermont	No mention of climate change.	Statewide TIP (2008-2011)—no mention.
Washington—Transportation Plan 2007-2026	Mentions climate change, increased temperature, and sea-level rise.	Same.
West Virginia—Six Year Summary	No mention of climate change.	No mention.
Wyoming—Statewide Long range Transportation Plan	No mention of climate change.	No mention.

**APPENDIX C—REVIEW OF METROPOLITAN PLANNING ORGANIZATION
TRANSPORTATION PLANS**

MPO/Plan Title	2007	2009 Review
Atlanta Regional Council— Mobility 2030	No mention of climate change.	No mention of climate change.
Baltimore Metropolitan Council	No mention of climate change.	Transportation Outlook 2035— climate change mentioned related to GHG but not addressed in document.
San Francisco Bay Area	Presentation mentions climate change. Mentions temperature rise, sea-level rise, and precipitation change.	Same.
Boston—Regional Transportation Plan 2004- 2025	No mention of climate change.	Journey to 2030—climate change mentioned in regard to GHG-reduction efforts.
Chicago—2030 Regional Plan	Climate change.	Chicago Metropolitan Agency for Planning (newly created)— Updated 2030 Regional Transportation Plan—climate change mentioned (one mention).
Delaware Valley—The Year 2030 Plan for the Delaware Valley	No mention of climate change.	Destination 2030—no mention of climate change.
Houston-Galveston	No mention of climate change.	“Transportation and Climate Change” section in 2035 RTP.
Maricopa—Regional Transportation Plan 2007 (Draft)	No mention of climate change.	No mention of climate change.
Metropolitan Council (St. Paul)	No mention of climate change.	2030 Transportation Policy Plan—climate change mentioned in regard to impact from burning fuel.
Metro Washington Council of Governments	Not available.	Constrained Long Range Transportation Plan—no mention.
New York Metropolitan Transportation Council	Not available.	2010-2035 Regional Transportation Plan—climate change mentioned several times in regard to energy and GHG.
North Central Texas Council of Governments	Mobility 2030 is under review and will be approved in spring 2007.	No mention of climate change.
New Jersey Transportation Planning Authority—Access and Mobility 2030	No mention of climate change.	No mention of climate change.
Puget Sound Regional Council—Destination 2030	No mention of climate change.	No mention of climate change.
San Diego Regional Council— Regional Transportation Plan 2030	No mention of climate change.	2030 San Diego Regional Transportation Plan—climate change and energy linked.

MPO	2007	2009
Southeast Michigan Council of Governments—2030 Regional Plan	No mention of climate change.	No mention of climate change.
Southern California Association of Governments—Destination 2030	No mention of climate change.	2008 RTP: Making the Connections—air quality and climate change mentioned.
Southwestern Pennsylvania Commission—2030 Transportation and Development Plan for Southwestern Pennsylvania	No mention of climate change.	2035 Transportation and Development Plan for Southwestern Pennsylvania—no mention of climate change.
Broward County, Florida, Metropolitan Planning Organization—2030 Long Range Transportation Plan	No mention of climate change.	No mention of climate change.
Capital Area Metropolitan Planning Organization (Texas)—CAMPO 2035 Regional Growth Concept (this plan has not been approved yet; current plan is CAMPO Mobility 2030 Plan)	No mention of climate change.	No mention of climate change in 2030 plan.
Cincinnati-Northern Kentucky Metropolitan Planning Organization—2030 Regional Transportation Plan	No mention of climate change.	No mention of climate change.
Denver Regional Council of Governments—2030 Regional Metro Plan	No mention of climate change.	2035 Metro Vision RTP—no mention of climate change.
East-West Gateway Coordinating Council—Legacy 2030	Climate change.	Legacy 2035—no mention of climate change.
First Coast Metropolitan Planning Organization—Long Range Transportation Planning	Not available.	Not available.
Greater Buffalo-Niagara Regional Transportation Council	Not available.	2030 Long Range Plan—climate change mentioned.
Hampton Roads Planning District Commission—2026 Transportation Plan	No mention of climate change.	2030 Long Range Transportation Plan—no mention of climate change.
Indianapolis Metropolitan Planning Organization—Indianapolis Regional Transportation Plan 2026	No mention of climate change.	2030 Indianapolis Regional Transportation Plan—no mention of climate change.
Metro—2035 Regional Transportation Plan	Plan is under revision, to be finished November 2007.	Not available.
Metroplan Orlando—Year 2025 Long Range Transportation Plan	No mention of climate change.	No mention of climate change.

MPO	2007	2009
Miami-Dade Metropolitan Planning Organization—Transport 2030	No mention of climate change.	No mention of climate change.
Mid-America Regional Council—Transportation Outlook 2030	No mention of climate change.	No mention of climate change.
Mid-Ohio Regional Transportation Planning—2030 Transportation Plan	No mention of climate change.	Capitol Ways T-Plan 2008—climate change and GHG mentioned.
Nashville—Long Range Transportation Plan	No mention of climate change.	No mention of climate change.
Northeast Ohio Areawide Coordinating Agency—Connections 2030	No mention of climate change.	No mention of climate change.
Palm Beach County Metropolitan Planning Organization—2030 Long Range Transportation Plan	No mention of climate change.	No mention of climate change.
New Orleans Regional Planning Commission—Metropolitan Transportation Plan	No mention of climate change.	No mention of climate change.
Regional Transportation Commission of Southern Nevada—RTP 2006-2030	No mention of climate change.	2009-2030 RTP—no mention of climate change.
Sacramento Area Council of Governments	Not available.	Climate change and mitigation of GHG emissions mentioned.
San Antonio-Bexar County—Transportation Plan	No mention of climate change.	No mention of climate change.
Southwestern Wisconsin Regional Planning Commission—Year 2035 Transportation Plan	No mention of climate change.	Not available.

APPENDIX D—SURVEY INSTRUMENT

Thank you for accepting our invitation to participate in this important survey conducted for the Southwest University Transportation Center by the Institute for Science, Technology and Public Policy at Texas A&M University. We’re conducting research on how state Departments of Transportation and Metropolitan Planning Organizations are considering adaptation to climate change impacts in transportation planning and decision processes. We are also interested in how decision makers view science-based information on climate change and what role it may play in their decision making.

Your responses are important to this research and will remain confidential. The University releases no information as to how any particular individual answers the survey and does not sell or give away the lists of respondents who participate in our research.

If you have questions about the survey and our research, please contact Dr. Eric Lindquist, Institute for Science, Technology and Public Policy at Texas A&M University, (979) 862-3857 or e-lindquist@tamu.edu

First, we would like to get some background information.

Q1. What is your current title?

Q2. How many years have you been in your current position?
Please record actual years _____.

Q3. In what area is most of your academic training?
1. Engineering
2. Planning
3. Social Science
4. Environmental Science
5. Physical Science
6. Business
7. Other [*please specify*] _____

Q4. In which of the following do you do most of your work?
1. Urban or Rural Planning
2. Public Transportation
3. Public Administration
4. Economic Development
5. Resource Management
6. Environmental Impact Assessment
7. Transportation Planning
8. Other [*please specify*] _____

Q5. What is the most important issue or problem your agency is currently facing?

Q6. In your opinion, what is the most important issue that will face your agency over the next 50 to 100 years?

Now, we would like to ask your opinion on the general state of knowledge about global warming and climate change. By “global warming” we mean a general tendency shown for the globe to warm over the last 30 years. By “climate change,” we mean the climate changes that can be expected when such warming occurs.

Q7. How would you rate global warming as it currently affects the following aspects of U.S. society? Use an 11 point scale where 0 means Not a Problem at All and 10 means Very Significant Problem.

1. Social well being _____
2. Economic well being _____
3. Public Health _____
4. Environmental well being _____
5. Transportation reliability _____

Q8. How well do you think climate scientists understand global warming and climate change?

1. Very well
2. Moderately well
3. Not well
4. Not at all

Q9. How well do you think members of the media understand global warming and climate change?

1. Very well
2. Moderately well
3. Not well
4. Not at all

Q10. How well do you think policy makers—such as elected officials—understand global warming and climate change?

1. Very well
2. Moderately well
3. Not well
4. Not at all

Q11. How well do you think transportation professionals understand global warming and climate change?

1. Very well
2. Moderately well
3. Not well
4. Not at all

Q12. How well do you think the general public understands global warming and climate change?

1. Very well
2. Moderately well
3. Not well
4. Not at all

Q13. How informed do you consider yourself to be about global warming and climate change? Place yourself on a scale from 0 to 10, with 0 indicating *Not at All Informed* and 10 indicating *Very Well Informed*.

0 1 2 3 4 5 6 7 8 9 10
Not at all informed ————— *Very well informed*

Q14. In your opinion, what is the most useful format for receiving information on global warming and climate change? What is the second?

1. Briefings with scientists
2. Scientific reports explaining the mechanics of global warming and climate change
3. Interactive databases
4. Agency websites
5. Articles in mainstream magazines and newspapers
6. Targeted media coverage such as television specials
7. Other [*specify*] _____

Now we would like to ask you questions regarding climate change as it relates to your agency and the decisions and policies you are involved with.

Q15. On a 10-point scale where 0 is *Not Relevant at All* and 10 is *Very Relevant*, how relevant do you consider global warming and climate change to be to the work you do?

0 1 2 3 4 5 6 7 8 9 10
Not relevant at all ————— *Very relevant*

Q16. Is your agency currently considering climate change as a factor in its decision making or planning processes?

1. Yes
2. No

If yes, why?

If no, why?

Q17. Current research on climate change impacts on transportation infrastructure focus on four main stressors: sea level rise, changes in precipitation, changes in temperature, and changes in the frequency and magnitude of storms. Which of these, if any, do you consider to be the most significant for your agency?

1. Sea level rise
2. Changes in precipitation
3. Changes in temperature
4. Changes in the frequency and magnitude of storms

Why?

Now, I would like to ask you about adaptation in regard to potential impacts from climate change on transportation.

Q#18. If adaptation is defined as adjustments in natural or human systems in response to climate change conditions or effects, is adaptation something your organization considers in its decision making? Use the following scale where 0 means *Not at All* and 10 means *Very Much a Topic of Discussion*.

0 1 2 3 4 5 6 7 8 9 10
Not at all _____ *Very much a topic of discussion*

Adaptive responses can be categorized into three main types:

Protect (measures to preserve the transportation infrastructure in its existing location and condition)

Accommodate (measures to adjust to climate change impacts such as raising a roadbed)

Retreat (abandon existing facilities)

Q19. Are you aware of any policies or projects in your agency aimed at adapting transportation infrastructure or services to the impacts of climate change? Briefly describe.

Q20. What scientific information on climate change are you using for these activities?

Q21. Are there specific thresholds or tipping points that are important to the decision and planning process in regard to adapting to climate change impacts? If so, can you briefly describe these?

Q22. Are you aware of any projects in other agencies aimed at adapting transportation infrastructure or services to the impacts of climate change? If so, where and what kind of projects?

At this point, we would like to ask some questions about the relationship between climate science and decision makers like you.

Q23. On a scale of 0 to 10 where **0 is Never** and **10 is Very Frequently**, how often do you use science-based information on global warming and climate change to evaluate policy alternatives?

0 1 2 3 4 5 6 7 8 9 10
Never _____ *Very frequently*

Q24. What types of information on climate change do you use most often?

Q25. On a scale of 0 to 10 where 0 is *Never* and 10 is *Very Frequently*, how often do you contact scientists for information related to global warming and climate change?

0 1 2 3 4 5 6 7 8 9 10
Never _____ *Very frequently*

Q26. Prior to this survey, has anyone ever asked you for your opinion on global warming?

1. Yes
2. No

Q27. Who asked you for your opinion? Check all that apply.

1. Co-workers
2. Supervisors
3. Research Department
4. Others in Respondent's Professional Community
5. Friends or Family
6. Neighbors
7. Other [*please specify*] _____

DEMOGRAPHICS

- Q34.** What is the highest level of education you have completed?
1. Elementary or Some High School
 2. High School Graduate/GED
 3. Trade or Vocational Certification
 4. Some College/Associates Degree
 5. College Graduate
 6. Post-Graduate Degree
 7. Other [*please specify*] _____
- Q35.** How old are you?
Please record your actual age _____
- Q36.** Which of the following categories best describes your political views?
Would you say that you are:
1. Strongly liberal
 2. Liberal
 3. Slightly liberal
 4. Middle of the road
 5. Slightly conservative
 6. Conservative
 7. Strongly conservative

APPENDIX E—INTERVIEW GUIDE

Introduction

"I am from the Institute of Science, Technology and Public Policy at Texas A&M University, and we are conducting a study about the role of climate change in transportation planning and decision making at the state and regional level. In particular we are interested in adaptation to the possible impacts of climate change and how these are being addressed in your agency.

This project is sponsored by the Southwest Region University Transportation Center at Texas A&M University.

Should you choose to participate in our interview, your answers will remain confidential. The University releases no information as to how any particular individual answers. You can refrain from answering any questions that make you feel uncomfortable, and you can end the interview at any time.

[Get full contact information. Ask the interviewee for residency, length of residency, occupation/expertise, and training]

Perspective on Climate Change and Variability: Problems & Solutions

In an open-ended format and without prompting, solicit R's perception(s) of climate change, in general, the range of short and long-term climate impact problems facing his/her state or immediate region (for MPO respondents)

Specific lead-in questions should be: "What is your perception on climate change in general? What is your perception of climate change as a potential problem for transportation? What is your perception of adaptation in response to potential climate change impacts on transportation."

This may be followed by more directed questions:

- "In your opinion, are there climate impacts that need, or will need attention in your area?"
- Is climate change currently being discussed as a potential problem in your area of responsibility?
- If yes, by whom? If no, why not?
- What are the potential impacts presented by climate change in this area? [prompt for sea level rise, changes in precipitation, changes in temperature, and increased frequency and magnitude of storms]
- What data describes these impacts (probe for metrics, especially performance metrics)?
- Where will these impacts be most evident (generalized or localized, location, distribution)?
- When do you see these impacts occurring (now, constant, seasonal, occurring only under some conditions)?
- Which of the 4 stressors will have the most/least significant impact in your state or region?

Decision Process

In an open-ended format, and without prompting, ask R about the planning and decision processes they utilize or apply in their area of responsibility.

1. Describe the general decision and/or planning processes most relevant to your area of interest or responsibility. Describe your actual role in making transportation decisions.

2. Which individuals, offices, agencies or organizations shape, or try to shape, your decision making?
3. What degree of autonomy do you possess when you make a decision?
4. Can you describe your relationship with these groups (Trust and other attitudes)?
5. What temporal framework is of concern to these groups? Does this period correspond to the 25-30 year planning process typical of transportation planners, or to the 50 to 100 year period typical of climate change scientists?
6. Can you describe how you receive and process information in regard to your decision and planning processes?
7. What kinds of information does the respondent use to make decisions about their transportation facility and/or system responsibilities?
8. Can you describe the current metrics or measurements you refer to when making a transportation decision about climate impacts?
9. At what point or points do you make the decision to no longer carry on as usual and initiate or develop policy alternatives?

Adaptation to Climate Change

In an open ended format and without prompting, ask R about adaptation to climate change as an alternative solution and policy approach to climate change stressors in their agency. The following are some definitions that should be presented to the R:

- Adaptation can be defined as: as adjustments in natural or human systems in response to climate change conditions or effects
- Adaptive responses can also be categorized into three main types:
 - Protect (measures to preserve the transportation infrastructure in its existing location and condition)
 - Accommodate (measures to adjust to climate change impacts such as raising a roadbed)
 - Retreat (abandon existing facilities)

Considering these definitions direct the R to the following questions:

1. Are you aware of any policies or projects in your agency aimed at adapting transportation infrastructure or services to the impacts of climate change? Briefly describe.
2. What scientific information on climate change are you using for these activities?
3. Are there specific thresholds or tipping points that are important to the decision and planning process in regard to adapting to climate change impacts? If so, can you briefly describe these?
4. Are you aware of any projects in other agencies aimed at adapting transportation infrastructure or services to the impacts of climate change? If so, where and what kind of projects?