Considering the Environment in Transportation Planning: Review of Emerging Paradigms and Practice in the United States

Adjo Amekudzi and Michael D. Meyer

Abstract: Several state Departments of Transportation (DOTs) and metropolitan planning organizations (MPOs) in the United States are considering environmental issues in the early stages of the transportation planning process, recognizing that there are benefits to be gained from better decisions, reduced public controversy, and shortened times to project implementation. This paper examines the current practice of such consideration, with special emphasis on best case examples. The study was conducted through a literature review, a survey of state DOTs and MPOs, and the identification of best case examples. The findings indicate the emergence, both in the literature and in practice, of more formal recognition of the need to consider environmental factors earlier in the planning process. State DOTs and MPOs agree that air quality, land use, socio-economic, environmental justice, and community cohesion impacts are of greatest concern today, and will be so in 10 years. Different approaches for considering environmental factors in planning include scenario analysis, environmental analysis of plans, environmental performance measures, consideration of equity issues, new data and analysis tools, and innovative institutional partnerships.

DOI: 10.1061/(ASCE)0733-9488(2006)132:1(42)

CE Database subject headings: Environmental issues; Transportation management; Public policy; State government.

Introduction

Transportation planning provides information to those making decisions on investments in the transportation system. This information not only relates to expected changes in system performance for different scenarios and levels of investment, but also to the corresponding consequences that can be expected for the natural and human environment. Ever since the late 1960s, when the U.S. Congress passed several environmental protection laws, environmental impacts have been primarily considered as part of the project design process. Environmental impact statements (EISs) are the most well known example of this type of project-specific analysis. However, waiting until this stage of transportation decision making to seriously consider environmental concerns can create significant delays in project completion when issues, which could have been resolved earlier in the process, are raised as part of project design. In addition, the sequential and disjointed nature of environmental regulations often leads to duplicative efforts in several technical tasks simply because regulatory policy requires separate analysis at multiple stages of the decision-making process. Thus, an important question for the profession is: Can environmental issues be considered earlier in systems planning so that better projects result from the planning process (where “better” is defined as serving a defined transportation need, but doing so in a way that minimizes environmental disruption and costs or even enhances the environment)?

This paper presents the results of research on the experiences of state departments of transportation (DOTs) and metropolitan planning organizations (MPOs) with the early consideration of environmental factors in the transportation systems planning process. By assessing current practice in state DOTs and MPOs, one can identify both the motivation for, and the constraints faced, in considering such factors in transportation planning. The next section sets the context for a closer relationship between environmental considerations and transportation planning based on the literature. Next, the results of a survey of state DOTs and MPOs are presented to illustrate how such agencies are considering environmental factors in transportation planning. The following section then presents examples of the strategies and approaches that some state DOTs and MPOs are using in such considerations. The final section presents findings and conclusions regarding current and future approaches toward the systematic consideration of environmental factors in transportation planning.

Evolving Professional Context

Transportation planning occurs within a societal and legal context that largely influences both the substance and approach toward planning. As Meyer and Miller (2001) note, historically, transportation planning has reflected the policy concerns and issues of the times in which it was occurring. For example, the large-scale, regional transportation studies of the 1950s in the United States
focused almost exclusively on highway network expansion. Elected officials at the time were anxious to accommodate the tremendous increase in automobile use, and also take advantage of federal aid that was available for highway construction. In the 1960s and 1970s, the U.S. policy context for transportation planning began to expand to include concerns for a “balanced transportation system,” one that explicitly considered the social, economic, and environmental impacts of system performance. During the 1980s and 1990s, national and state transportation policies continued to emphasize mobility, accessibility, and economic opportunity within fiscal and environmental constraints. The most recent policy context for transportation plans and programs involves security, that is, how to prevent disruptions to the transportation system, and how to handle people and goods movements if such disruptions occur.

The National Environmental Policy Act (NEPA) of 1969 was one of the most important motivations for considering environmental factors in transportation decision making in the United States. This law required environmental assessments of each project alternative in a federally supported project when significant impacts were expected. Not only was this law a major benchmark in the relationship between transportation and environmental policy, it also institutionalized an approach toward the consideration of environmental factors that was, in essence, reactive. That is, project alternatives were first identified and defined in sufficient detail that were then subject to environmental and community impact analysis. Very little effort was made earlier, such as the transportation planning process that preceded project development, to identify environmental issues, or areas that might influence the definition of these alternatives to begin with.

This is not to say that environmental factors were ignored in the systems planning process. The strong relationship between the construction and operation of the transportation system and the resulting impacts on the natural environment have led to a variety of approaches for considering environmental issues in transportation planning. One of the first major research efforts on this subject was sponsored by the National Cooperative Highway Research Program (NCHRP) in the 1970s and culminated in an NCHRP report (NCHRP 1975). This study concluded that (1) the overall process through which social, economic, and environmental considerations are brought into transportation planning and decision making is as important as the particular techniques used for predicting impacts; (2) issues of social equity must be explicitly recognized and taken into consideration in transportation decision making and thus transportation systems planning; and (3) different groups of people can be expected to have different interests and different priorities.

The report was also one of the first to note the disconnect between the disaggregate level of data analysis and the prediction of impacts that occurs during project development as compared to that undertaken during system-level planning. This occurs primarily due to (1) the longer time horizon for transportation system planning, and hence, the greater uncertainty associated with impact predictions; (2) the spatial nature of impacts at the systems level that are often spread over large expanses of metropolitan areas; (3) the analysis challenges of determining spatial or temporal interrelationships among impacts; and (4) the localized characteristics of some impact categories (e.g., noise) that might not be available when systems planning occurs. One environmental impact category, however, has received considerable policy and planning attention at the systems planning level ever since it first came to the attention of policy makers. Air quality has a long history of being considered at the metropolitan or urban air basin level. In particular, transportation policy and planning has been closely linked to national, state, and metropolitan efforts to reduce the level of air pollution in metropolitan areas. This has occurred primarily because early research showed conclusively that motor vehicle pollutant emissions contributed significantly to air pollution problems in metropolitan areas. In response, national policy required metropolitan transportation plans, programs, and projects to be in “conformance with” a region’s air quality plan. However, similar in nature to the project-level NEPA analysis, the approach taken in almost every metropolitan area where air quality has been a problem has been to prepare plan alternatives, evaluate them against defined criteria, and then choose which one (or combination) best meets local goals. In other words, the assessment of air quality impact was largely reactive.

Several books and articles in both transportation and environmental science have begun to raise questions about the connections between the transportation system, and the natural and built environments. For example, Meyer and Miller (2001) view transportation as one system that relates to, and is part of, many other systems, e.g., land use and ecological systems. This perspective leads to important planning questions reflecting the interaction among transportation and higher-level systems such as social, ecological, and economic systems. The book also examines the difference between the “traditional planning process” and one that is concerned with sustainability, emphasizing the movement away from piecemeal, retroactive, and short term decisions to broader systems-based, proactive, longer term, and multimodal views for the provision of transportation systems. In particular, transportation system impacts on the ecosystem are highlighted as an important emerging issue in transportation planning.

The relationship between ecosystems and the built environment has been the topic of many books and articles in the environmental literature for many years (see, e.g., Kress and Barrett 2001). Two important ideas emerge from this literature: (1) the physical environment should be considered as an ecosystem with all of the interrelationships and linkages this implies and (2) ecosystems have a carrying capacity that determines their ability to sustain life. The concept of a carrying capacity, closely linked with the viability of ecosystems, refers to the ability of an ecosystem to be disturbed sometimes irreversibly, while carrying out its basic natural functions. In both cases, a defining characteristic of the concept is the relationship between different components of the total system. For example, how does disturbing a small portion of a stream during road construction affect other parts of the watershed, which in turn can affect the living conditions for human and wildlife populations and vegetation? Thus, in the context of transportation planning and project development, one of the first steps that would seem likely given an “ecosystems perspective” on the natural environment is to identify where sensitive ecosystems exist and to avoid as much as possible any negative disruptions to ecosystem function.

One of the more interesting developments in the environmental literature, and one that adds several layers of complexity in understanding these relationships, is the idea of the “city” itself as an ecosystem (Archibugi 1997). In this paradigm, the city is conceived as a dynamic and complex ecosystem where the social, economic, and cultural systems have as complicated relationships as those found in nature (Tjallingii 1995; Newman and Kenworthy 1999). Based on this concept, policy and planning principles can be developed to guide both governmental and individual decisions relating to community development and urban design. These concepts lend weight to the idea that environmental and community concerns need to be considered early in the com-
munity development decision-making process so that these critical elements can be addressed proactively and on a comprehensive (i.e., systems level) basis.

Another focus of both the environmental and city planning literature that is an important professional context for transportation planning has been sustainability or sustainable development. Although sustainable development has many interpretations, perhaps one of the most appropriate definitions for this paper comes from Roseland (1997) where sustainable development is defined as “economic and social change to improve human well being while reducing the need for environmental protection.” This definition supports a proactive approach toward considering environmental impacts and social equity issues very early in the community development decision-making process. Sustainable development has become a stated policy goal for many nations (Facheux et al. 1996), and the defining characteristics of sustainability have been adopted as a “design concept” in such fields as (1) architecture (Van Der Ryn and Cowan 1996; Wines 2000); (2) city planning (Platt et al. 1994; Maser 1997; Kivell et al. 1998); and (3) manufacturing (Allenby and Richards 1994; McDonagh and Braungart 2002); and as a “planning concept” for transportation, water and sewer, and building systems (Gudmundsson 2000; Black et al. 2002; Balkema et al. 2002; Pearce and Vanegas 2002; Deakin 2001).

There are several examples of how the concept of sustainability is entering into the transportation sector. The Organization for Economic Cooperation and Development (OECD), for example, has integrated environmental concerns into transport policies through the development and use of indicators. OECD has adopted the following definition of environmentally sustainable transportation: “Transportation that does not endanger public health or ecosystems and that meets needs for access consistent with (1) use of renewable resources at below their rates of regeneration; and (2) use of non-renewable resources below the rates of development of renewable substitutes” (OECD 1999). Based on the Sustainable Transportation Performance Indicators project in Canada, Transport Canada (TC) has adopted an initial set of 14 sustainable transportation performance indicators (TC 2001). In the United States, a number of state DOTs have captured sustainability either directly or indirectly in their visions or mission statements, most usually through the adoption of a DOT environmental policy. In the state of Washington, for example, the Washington State DOT (WSDOT) has adopted an environmental policy statement that commits to the following actions:

- To implement and maintain an environmental management system that embraces all the Department’s program functions;
- To establish, maintain, and make available to the public appropriate performance indicators of the Department’s exercise of its environmental stewardship and to consistently review these indicators as a basis to improve the Department’s performance;
- To comply with all environmental laws and regulations applicable to our business and activities;
- To assure that employees of the Department receive training appropriate to their functions concerning the Department’s environmental responsibilities;
- To communicate to contractors, designers, consultants, and other participants in the Department’s work the management practices and compliance requirements established to further the aims of this policy statement;
- To encourage employees and all other citizens to communicate with the Department about ways to increase the effectiveness of Department’s practices supporting its mission of environmental stewardship; and
- To make every reasonable effort to also protect the cultural and historic resources of the state (WSDOT 2001).

The previous paragraphs have focused on the policy or professional context for transportation planning. New approaches and methods for a more environmentally sensitive transportation planning and project decision-making process have also been developed. The concept of a strategic environmental assessment (SEA) has been adopted by many countries in the world. A SEA considers environmental concerns in a formal way in the systems level planning for transportation and other civil infrastructure. This approach, particularly prevalent in European countries since the early 1970s, is a process of considering potential environmental effects of strategic investment decisions at the policy, plan, and program levels, rather than wait until the project development phase. The European Commission’s (EC) first environmental action program in 1973 emphasized the importance of a comprehensive environmental assessment of all plans so as to prevent environmental damage. In 2001, a SEA directive was adopted by the European Parliament and the European Council that required the preparation of an environmental report that identifies, describes, and evaluates the likely significant effects on the environment of implementing a proposed plan, program, or policy, as well as reasonable alternatives to avoid such effects (EC 2001).

To date, SEAs have been performed in a variety of sectors including transportation, energy, and land use. Recent developments in transportation design and project planning in the United States suggest that some transportation professionals have begun to think differently about how environmental factors should be considered in project planning and design as well. For example, the Federal Highway Administration (FHWA), American Association of State Highway and Transportation Officials (AASHTO), Bicycle Federation of America, National Trust for Historic Preservation, and Scenic America (1998) have produced a design guide entitled Flexibility in Highway Design that encourages highway designers to consider environmental and community concerns earlier in the project development process. The movement toward a more environmentally and community-sensitive project development process has come to be known as “context sensitive design” (CSD) or more recently “context sensitive solutions” (CSS). CSS refers to a process in which a transportation project is developed in a collaborative process involving many different stakeholders, each of whom may have different perspectives on what the project should be and how it ought to impact the surrounding natural and social environments. The term CSS refers as much to an approach or process as it does to an actual outcome (FHWA 2004; MnDOT 2000; Neuman et al. 2002).

This evolving policy and professional context for considering environmental factors in transportation planning and decision making suggests a need to better understand the current practice in the United States. For example, the “systems” perspective is a key point of departure for examining environmental impacts and understanding the relationship among transportation systems, ecological systems and the built environment. This perspective encourages agencies to incorporate systemic environmental concerns, such as air quality and watershed impacts, into the transportation planning process. Coupled with scenario planning and multiattribute decision making methods that include environmental attributes or constraints, this systems perspective presents a potentially powerful tool for including the environment in the
analysis of alternative plausible plans. Are there examples where such a systems approach has been adopted?

The United States has made important, yet relatively targeted, progress in examining environmental and community factors earlier in the project development process. This is most notable in the context sensitive solutions movement that has emerged in the past decade in many state and regional transportation agencies. The success in moving projects forward in a way that results both in meeting safety and mobility objectives, and at the same time satisfying community and environmental goals, represents an important evolutionary step forward for transportation agencies.

Survey of Practice

To develop a better understanding of the state-of-the-practice in considering the environment in transportation planning, a survey was administered to state DOTs and MPOs. Respondents answered specific questions on policies and regulations driving the consideration of environmental factors in their agencies, the types of environmental factors being considered, the data and analysis tools being used, ongoing activities to better integrate the planning and project development phases (including environmental streamlining activities), and obstacles to considering the environment early in the planning process. The survey, conducted mainly via the Internet, was supplemented by phone calls and e-mails to survey participants to increase the response rate. The survey was used not only as a means of determining current practice, but also as a way of identifying best case examples of how states and MPOs have considered environmental factors in the planning process.

The survey was sent to 51 members of AASHTO (one for each state DOT and for the District of Columbia) and to the 340 members of the Association of Metropolitan Planning Organizations. A total of 42 responses was received from the state DOTs (82% response rate), and 45 responses from MPOs (13% response rate). Although standard questions were used to allow for comparisons on key topics, respondent-specific questions were also included. Although the low response rate from the MPOs could raise questions on the representativeness of this data, it is important to note that the 45 responses included the largest MPOs in the United States and thus reflect the environmental concerns that would most likely be found in large metropolitan areas. Because of the ability of large MPOs to confront a broad range of environmental issues, the survey should represent fairly well the current state-of-the-practice in environmentally sensitive transportation planning.

Findings

The survey asked a variety of questions concerning the degree to which environmental factors are considered in transportation planning, and the relative importance of the different environmental concerns.

Importance of environmental considerations: The survey findings indicate that 38% (20) of the state respondents and 38% (17) of the MPO respondents felt that environmental considerations were “somewhat important” to “very important” (rated 4 or 5 on a scale of 1–5) in the development of their most recent long-range transportation plan. This percentage increased to 45% (23) for state DOTs and 52% (23) for MPOs when they were asked how important environmental factors were likely to be in the update of the plan 10 years into the future. Generally, there seemed to be a consensus that incorporating environmental factors earlier in the planning process leads to better decisions and shortens the time to project implementation. Several DOTs were able to identify specific examples where incorporating environmental factors earlier in the planning stages had resulted in tangible benefits. Several important findings from the survey are presented in the following.

Importance of individual environmental factors: Table 1 shows which environmental factors were considered most important by state DOT and MPO officials for the most recent transportation plan, and those anticipated to be most important for the transportation plan 10 years in the future. The environmental factors listed in the survey came from the U.S. Environmental Protection Agency guidance on which factors are to be considered in environmental impact statements. Given the strong emphasis in U.S. public policy linking air quality to transportation investment decisions, it is not surprising that air quality was identified by state DOT officials as the most important environmental factor today and in the future (MPO officials ranked it as second most important). Again, not surprisingly, given the strong linkage between land use and transportation planning at the metropolitan level, MPO officials ranked land use as the most important environmental factor in the most recent transportation plan and likely to remain so in the future plan.

Change of environmental factor importance 10 years in the future: It is interesting to note from Table 1 that the five most

<table>
<thead>
<tr>
<th>Table 1. Most Important Environmental Factors in Transportation Planning in Order of Importance, State DOTs and MPOs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>State DOTs</strong></td>
</tr>
<tr>
<td>Air quality (3.40)</td>
</tr>
<tr>
<td>Land use (3.15)</td>
</tr>
<tr>
<td>Socio economic (3.10)</td>
</tr>
<tr>
<td>Environmental justice (3.00)</td>
</tr>
<tr>
<td>Community cohesion (2.95)</td>
</tr>
<tr>
<td>Cultural resources (2.75)</td>
</tr>
<tr>
<td>Wetlands (2.74)</td>
</tr>
<tr>
<td>Human health (2.72)</td>
</tr>
<tr>
<td>Aquatic ecology (2.70)</td>
</tr>
<tr>
<td>Water quality (2.65)</td>
</tr>
</tbody>
</table>

Note: Average scores are based on a scale of 1–5, where 5 is most important and 1 is least important. The top ten are listed in order.
important environmental factors as they relate to the transportation planning process are not expected to change over the next 10 years. Air quality, land use, socio-economic factors, community cohesion, and environmental justice are considered by both state DOT and MPO officials as the five most important environmental factors for transportation planning. In addition, the level of importance, as determined from the average rating for each of these factors, increases when comparing the future transportation plan with the most recent one. The same is true for the second five most important environmental factors, although in this case, the factors are not the same between the most recent plan and the future plan.

Most widely used tools and methods: Table 2 shows the most widely used tools and methods for considering environmental factors in transportation planning. According to the state DOT respondents, the most commonly used tools were data trend analysis, geographic information systems (GIS), environmental impact-specific models, surveys, and focus groups. According to MPO respondents, the most commonly used tools were data trend analysis, GIS, overlay maps, and environmental-impact specific models. Sixty-six percent (34) of the responding state DOTs and 52% (23) of the MPOs were of the opinion that only some of the data types needed for considering environmental factors in transportation planning were currently available.

Major obstacles: Table 3 shows the reported major obstacles for more seriously incorporating environmental factors into transportation planning. Just over three-quarters (39) of the state DOT respondents and 64% (29) of the MPO respondents selected “competing priorities that distract from environmental issues” as an obstacle to considering environmental factors in transportation planning; 53% (27) of the DOT respondents indicated that a lack of appropriate planning analysis tools was an obstacle. Just over 64% (28) of the MPO respondents indicated that “competing priorities that distract from environmental issues” are an obstacle to considering environmental factors in transportation planning; 58% (26) of the MPO respondents indicated that the lack of appropriate analysis tools was an obstacle as well.

Actions already taken: Table 4 shows the reported actions that have been taken to promote the consideration of environmental factors earlier in the planning and decision making process. Eighty-eight percent (45) of the DOT respondents indicated that they had taken action to promote the consideration of environmental factors prior to the project development stage. Just over two-thirds (31) of the MPO respondents indicated that they had taken action to promote the consideration of environmental factors prior to the project development stage. Most DOTs and MPOs had identified “define purpose and need earlier” as the most used action for the earlier consideration of environmental factors.

Benefits of early consideration of environmental factors: Table 5 shows the reported benefits to state DOTs and MPOs of considering environmental factors earlier in project development. For

### Table 2. Important Methods and Tools for Considering Environmental Factors in Transportation Planning, State DOTs and MPOs

<table>
<thead>
<tr>
<th>State DOTs</th>
<th>MPOs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Data trend analysis (76%)</td>
<td>1. Geographic information systems (75%)</td>
</tr>
<tr>
<td>2. Geographic information systems (68%)</td>
<td>2. Overlay maps (69%)</td>
</tr>
<tr>
<td>3. Environmental impact-specific models (59%)</td>
<td>3. Data trend analysis (69%)</td>
</tr>
<tr>
<td>4. Surveys (55%)</td>
<td>4. Environmental impact-specific models (61%)</td>
</tr>
<tr>
<td>5. Focus groups (55%)</td>
<td>5. Surveys (47%)</td>
</tr>
<tr>
<td>6. Socio-economic assessment (50%)</td>
<td>6. Socio-economic assessment (41%)</td>
</tr>
<tr>
<td>7. Expert opinion (42%)</td>
<td>7. Community impact analysis (41%)</td>
</tr>
<tr>
<td>8. Community impact analysis (42%)</td>
<td>8. Focus groups (40%)</td>
</tr>
<tr>
<td>9. Overlay maps (39%)</td>
<td>9. Expert opinion (40%)</td>
</tr>
<tr>
<td>10. Risk assessment methods (14%)</td>
<td>10. Global positioning systems (12%)</td>
</tr>
<tr>
<td>11. Remote sensing technologies (14%)</td>
<td>11. Risk assessment methods (6%)</td>
</tr>
<tr>
<td>12. Global positioning systems (11%)</td>
<td>12. Remote sensing (6%)</td>
</tr>
<tr>
<td>13. Ecosystem models (0%)</td>
<td>13. Ecosystem models (3%)</td>
</tr>
</tbody>
</table>

Note: Percentage of respondents answering such a tool is used; n=42 for state DOTs and n=45 for MPOs.

### Table 3. Major Obstacles Faced by State DOTs and MPOs When Incorporating Environmental Factors into Transportation Planning

<table>
<thead>
<tr>
<th>State DOTs</th>
<th>MPOs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Competing priorities (60%)</td>
<td>1. Competing priorities (63%)</td>
</tr>
<tr>
<td>2. Lack of tools (51%)</td>
<td>2. Lack of tools (58%)</td>
</tr>
<tr>
<td>3. Lack of data (39%)</td>
<td>3. Lack of data (46%)</td>
</tr>
<tr>
<td>4. No regulations (6%)</td>
<td>4. No regulations (27%)</td>
</tr>
</tbody>
</table>

Note: Percentage of respondents identifying this obstacle; n=42 for state DOTs and n=45 for MPOs.

### Table 4. Actions to Promote the Consideration of Environmental Factors Earlier in the Project Development and Planning Processes

<table>
<thead>
<tr>
<th>State DOTs</th>
<th>MPOs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Define purpose and need earlier (88%)</td>
<td>1. Define purpose and need earlier (68%)</td>
</tr>
<tr>
<td>2. Reorganize or restructure environmental/planning process (73%)</td>
<td>2. Hire external environmental experts (41%)</td>
</tr>
<tr>
<td>3. Enter into agreements with environmental resource agencies (71%)</td>
<td>3. Develop environmental documents earlier (31%)</td>
</tr>
<tr>
<td>4. Hire external environmental experts (66%)</td>
<td>4. Reorganize or restructure environmental/planning process (29%)</td>
</tr>
<tr>
<td>5. Develop new standard operating procedures (66%)</td>
<td>5. Enter into agreements with environmental resource agencies (18%)</td>
</tr>
<tr>
<td>6. Pay for environmental resource agency staff (66%)</td>
<td>6. Develop new standard operating procedures (13%)</td>
</tr>
<tr>
<td>7. Hire new DOT environmental staff (61%)</td>
<td>7. Pay for environmental resource agency staff (13%)</td>
</tr>
<tr>
<td>8. Conduct fatal flaw analysis earlier in process (45%)</td>
<td>8. Conduct fatal flaw analysis earlier in process (10%)</td>
</tr>
<tr>
<td>9. Develop environmental documents earlier (42%)</td>
<td>9. Develop database software relating to environmental assessment (10%)</td>
</tr>
<tr>
<td>10. Develop database software relating to environmental assessment (19%)</td>
<td>10. Hire new MPO staff (4%)</td>
</tr>
</tbody>
</table>

Note: Percentage of respondents identifying this action; n=42 for state DOTs and n=45 for MPOs.
DOT respondents, the most important benefits include making better decisions and implementing projects faster. MPO respondents identified many more benefits for earlier consideration of environmental factors, with better decision making, improved linkage between planning and project development, and reducing public and agency concern with environmental impacts leading the list.

### Discussion of Findings

In general, the survey results suggest that state DOTs and MPOs recognize the importance of considering the environment in transportation planning, but that in most cases, the state-of-the-practice is more oriented toward environmental impact-specific issues at the project level rather than applying systemic approaches during planning. The environmental impacts considered of greatest importance today and 10 years from now were very consistent for both state DOT and MPO officials. These included air quality, land use, socio-economic, environmental justice (equity), and community cohesion impacts. All of these can be considered at the systems level, although certainly each can have project-related impacts as well. In almost every case, the level of importance for each environmental impact was greater in the 10 year time frame as compared to today. This suggests that both state DOT and MPO officials believe that the environment will become even more important in transportation planning in the future.

What was surprising from the survey results was the large number of state DOT and MPO agencies that were making some effort to consider environmental factors earlier in the planning process. Close to 90% of the state DOTs and just over two-thirds of the MPOs had defined “purpose and need” earlier in the process. This effort is an important one in that it relates directly to regulations guiding the development of environmental impact statements in the United States. Some examples were found where agencies, especially state DOTs, had implemented actions to streamline the project development process. Larger numbers of state DOTs and MPOs had adopted a wider range of actions to promote the consideration of environmental factors earlier in project development and planning. This is not surprising given the project development mission of state DOTs as compared to the planning mission of MPOs. It was interesting, however, to note that two-thirds of the state DOT respondents had paid for environmental resource agency staff, hired external environmental experts, entered into agreements with environmental resource agencies, reorganized or restructured their agencies to make the environmentally planning process more efficient, and as noted previously, defined purpose and need earlier in the process.

Importantly, as seen in the survey responses, a common reason given by state DOTs and MPOs for considering environmental factors earlier in the process was that it resulted in better decisions. MPO officials also identified a greater range of benefits associated with doing so than did DOT officials. These included promoting a better linkage between planning and project development, reducing public concerns with a project, developing a constituency for plans and projects, and faster project implementation. The most important obstacle for earlier consideration of environmental factors identified by both DOTs and MPOs was the existence of competing priorities.

### Examples of Strategies for Incorporating Environmental Factors into Transportation Planning

The survey was also used to identify examples of where environmental factors had been considered early in the transportation planning process. The following sections describe some of the state DOT and MPO practices for doing so.

#### Scenario and Capacity-Based Planning Methodologies

Scenario planning is a method of examining the impact on plan alternatives of an uncertain future. Thus, rather than forecasting conditions with assumed future conditions, several plausible future scenarios are considered and the robustness of various decisions under these scenarios is evaluated (Zegras et al. 2004). Environmental scenario planning and capacity-based planning methodologies are based on the concept of the “city as an ecosystem,” as described by Archibugi (1997), Tjallingii (1995), and Newman and Kenworthy (1999), and the scenario planning methodology to address inherently uncertain futures as discussed by Schwartz (1996). Two regional planning agencies, the Cape Cod Regional Planning Commission (CCRPC) in Massachusetts and Portland Metro in Oregon used scenario methodologies in the most recent update of their long-range transportation plans. In addition, CCRPC used environmental capacity constraints to set performance standards for the transportation plan.

Cape Cod is one of the nation’s most environmentally sensitive areas. In response to what residents considered to be growing problems associated with development, the CCRPC was established in 1990 to guide development on the Cape while preserving the natural and undeveloped areas. The Commission is responsible for preparing and overseeing the development of a regional land use policy plan. The Policy Plan, updated every five years, establishes broad goals to guide the development of more specific policies and plans, such as the Cape’s transportation plan. In addition, the Plan includes minimum performance standards for future development.

The 2001 update of Cape Cod’s Regional Policy Plan was based on the concept of the “capacity” of the Cape to handle new population. This capacity was determined in reference to water supply, transportation, natural systems, and municipal fiscal resources. Some of the objectives of this approach were to protect...
sensitive resources such as quality ground and surface water, wetlands, and plant and wildlife habitats. Using a methodology established by the Commission for examining capacity limits, two studies of different areas of the Cape concluded that both areas were severely constrained by the transportation infrastructure and water supply. Management options used in the studies included identification and protection of environmentally sensitive areas such as future well sites, potential zoning changes, land acquisition, transit and travel demand management, and purchase or easements on sensitive resource areas to protect habitat and open space. One of the studies directly brought environmental considerations into transportation planning through the use of an environmental sensitivity index to identify the quantity and proximity of environmental resources to critical transportation facilities.

Portland Metro, responsible for Portland, Oregon’s land use, transportation and environmental plans, typically generates and evaluates alternative development scenarios for impacts to the region’s neighborhoods, transportation system, natural resources, and key urban services. In the 2040 regional plan for example, four growth concepts or scenarios were developed and tested based on different philosophies of regional growth management: (1) continuation of development patterns occurring between 1985 and 1990, which would result in the greatest expansion of the urban growth boundary (UGB); (2) growing out (which would include significant expansion of the UGB with peripheral growth mostly in the form of housing); (3) growing up (which would include no UGB expansion but rather accommodate growth through the development of existing land within the UGB); and (4) neighboring cities (which would entail moderate expansion of the UGB with growth focused in centers, corridors, and neighboring cities). These scenarios were tested to explore how the region could grow and analyzed for effects on several quality of life factors such as land consumption, travel times and distances, open spaces and air quality, and various urban landscapes.

**Environmental Analysis of Transportation Plans**

A number of states have laws requiring an environmental analysis of both state and metropolitan transportation plans. Examples from Wisconsin, California, and Oregon are discussed.

The most recent Wisconsin State Highway Plan was evaluated with a process called “Systems Plan Environmental Evaluation (SEE).” Environmental evaluation criteria were established through a public process and each transportation system alternative was then evaluated against these criteria. The environmentally related criteria in the latest plan evaluation included: air quality, energy consumption, sensitive water resources, indirect land use impacts, economic development consequences, and community and neighborhood impacts. Different types of mitigation strategies were then identified for each impact category. Given the broad nature of transportation system alternative definition, very uncertain.

California state law specifically prohibits the California Transportation Plan from being project specific, whereas at the same time, it requires regional transportation plans to include information on regional environmental issues and air quality documentation needs. Further, the California Environmental Quality Act, adopted in 1970, requires all regional transportation planning agencies to conduct an environmental assessment of the regional transportation plan. Air quality and social equity considerations are major factors in the development of all regional transportation plans. Similar to the process followed in Wisconsin, the environmental assessment of transportation plans in California is based on a set of evaluation criteria that are applied in very broad terms.

In Oregon, the Oregon Department of Transportation (ODOT) determined that major investment studies, planning efforts that were required in the 1990s as a precursor to project development, did not provide a sufficient basis for removing alternatives from consideration. As a result, ODOT developed the concept of a Tiered EIS. In such an approach, EISs are conducted at varying levels of detail at different stages in the planning and project development process where major transportation initiatives are expected to have notable impacts on the environment. Early in the planning process, a “Location EIS” is prepared using coarse and existing data to address broader level issues such as facility type, type of modal investment, and locations where sensitive environmental resources might be affected. Later in the process, a “Design EIS” is prepared at a more detailed level as designs are considered in specific corridors. This process has come to be known as ODOT’s National Environmental Protection Act (NEPA) Planning Process (see Fig. 1).

The NEPA Planning Process involves a close transition between the transportation systems planning and project development processes, with environmental issues identified and addressed at appropriate levels of detail along this continuum. In essence, just as a high level of aggregation in the analysis is inappropriate at the detailed project level, a high level of detail in the analysis tends to be inappropriate at the early stages of planning where several issues, such as the project location, may be uncertain.

These three examples illustrate how three states are considering environmental factors earlier in the planning process. Each approach requires a broad planning process, the identification of appropriate evaluation methodologies, and the production of information related to the types of decisions being made in the early stages of plan and project development.

**Environmental Performance Measurement**

The Minnesota Department of Transportation (MnDOT) refined its statewide transportation planning process in the 1990s in response to new federal transportation legislation. Several new concepts were incorporated, the most important being the use of performance measures to monitor the progress of the statewide DOT district and business plans of the agency. The Minnesota Statewide Transportation Plan (MnDOT 2003) included perfor-
mance measures for air quality, water quality, and land management, indicators to be used by MnDOT officials in determining how the DOT program is affecting the environment and community values. Indicators used for air quality include the percent of MnDOT vehicle fuel consumption defined as cleaner fuels; estimated carbon dioxide emissions from motor vehicles in Minnesota; and outdoor levels of ozone, nitrogen dioxide, carbon monoxide, and particulate matter as a percent of National Ambient Air Quality Standards. Water quality indicators used included the percent of National Pollution Discharge Elimination System permits that result in violations; the ratio of acres replaced by MnDOT to acres of wetlands affected; and the percent of wetlands replaced as planned. Land management indicators include the number of acres planted with native species and the number of undeveloped acres converted to another land use (MnDOT 2003).

In California, all regional transportation plans for areas with populations exceeding 200,000 are expected to identify a set of indicators that can be monitored over time to determine the level of progress associated with transportation investment. Environmental indicators include such things as fuel usage per person, fuel usage per ton, percentage of all trips made by single occupancy vehicle, carpool, public transit, walking and biking, measures of equity and accessibility such as the percentage of the population served by frequent and reliable public transit, and percentage of all jobs accessible by frequent and reliable public transit service (both by income bracket).

The Cape Cod Regional Planning Commission established minimum performance standards to regulate development within an overall environmental capacity-based planning process. Cape Cod’s environmental performance standards specify several targets with respect to encouraging growth and development consistent with the Cape’s carrying capacity, protecting open space and minimizing environmental and community impacts, maintaining the overall quality and quantity of the Cape’s ground water, preserving and restoring the quality and quantity of inland and coastal wetlands, preserving and enhancing wildlife habitats, encouraging energy conservation and improved energy efficiency; and encouraging development that respects the traditions and distinctive character of historic village centers and outlying areas (Cape Cod Commission 2001).

In Eugene, Ore., the Lane Council of Government’s transportation system performance measures for the Eugene-Springfield metropolitan area, (the second largest metropolitan area in Oregon), include environmental variables such as average fuel efficiency and CO emissions; and land use measures such as the acres of zoned “nodal (or center) development,” percent of dwelling units built in nodes, percent of roadway miles with sidewalks, and percent employment with 10 min transit service and bikeway miles and facilities.

**Consideration of Equity in Transportation Planning**

Executive Order 12898 issued by President Clinton in 1994 required agencies to address the social equity impacts of development projects that had federal funding. As shown in the survey results (see Table 1), the consideration of equity (also referred to as environmental justice) was identified as one of the factors most commonly considered by DOTs and MPOs when developing a transportation plan. Typically, equity or environmental justice analysis includes the identification of target populations (based on low income, race, age, disability, and other attributes of concern), public outreach to these populations to ensure that their needs and concerns are included in the planning process (referred to as “procedural environmental justice”), and an equity analysis of the plan itself to determine the distribution of benefits and burdens for these groups (referred to as “substantive environmental justice”).

One of the best examples of such an assessment was undertaken by the Metropolitan Transportation Commission (MTC) in the San Francisco Bay area. Many of the programs recommended in the MTC’s regional transportation plan focus on equitable access to transportation services for low-income persons, elderly persons, and persons with disabilities. Plan alternatives are examined with respect to expected distributive impacts, including the evaluation of benefits and burdens on minority and low income communities. Other programs include the targeting of resources on transportation options for those transitioning from welfare to work, a “Transportation for Livable Communities Fund” that helps revitalize some of the region’s most disadvantaged communities, and a “Low Income Flexible Transportation Program” aimed at increasing the availability and affordability of transportation options to low income communities. As part of the equity review of the plan, a “Lifeline Transit Network,” has been identified that addresses both spatial and temporal transit service gaps in providing low income and minority populations with access to major services at a reasonable level of service. The MTC also performs project-level equity analyses.

**Data and Analysis Tools**

Five types of tools can be used for considering environmental factors in transportation planning, including:

1. Geospatial database technologies (i.e., information systems such as GIS and interactive databases including Internet and intranet-enabled technologies);
2. Remote sensing technologies (providing digital information on land and earth features that can be combined with spectral analysis and GIS modeling to create a powerful screening tool for regional or transportation corridor evaluation);
3. Transportation impact modeling tools/technologies (i.e., models used to evaluate potential environmental effects of transportation projects, e.g., air and water quality, noise and biological resources);
4. Decision analysis tools (such as multivariate utility analysis methods, prioritization and optimization methods, and risk analysis) that can help transportation agency staff define problems, identify appropriate alternatives, identify and quantify uncertainties and their impacts and ensure meaningful involvement of stakeholders; and
5. Computer-based simulation (used to create a three-dimensional visual environment or four-dimensional one including the variable of time used for real-time analysis—to provide insights for master planning (short-range), traffic management, safety analysis, environmental change, and construction management). Potential applications include design of transportation alignments in a “virtual reality” setting incorporating a full set of constraints (NCHRP 2002).

Several DOTs and MPOs are using GIS technology for considering the environment in planning, such as environmental and archaeological resource identification and inventorying, environmental review of the long range plan, and analysis of the equity impacts of plans. The Florida Department of Transportation’s (FDOT) Efficient Transportation Decision Making (ETDM) process, using one of the most advanced GIS tools for environmental considerations in transportation planning in the United States, is an Internet-based GIS application that provides officials with the ability to screen proposed actions (FDOT 2002). In this process,
standardized analyses have been developed by environmental resource agencies and are automatically performed by the Environmental Screening Tool (part of the GIS application) that allows input of information for proposed actions. For example, the tool may compare the location of proposed projects with known locations of environmentally sensitive resources. Where possible, quantitative information is provided by the user (e.g., how many acres of wetlands could be possibly affected). The data can be displayed in various graphical or tabular formats. The tool bridges interactions between transportation officials and environmental resource agency personnel and provides a common forum for environmental issues to be addressed early in the planning process.

MnDOT has developed a GIS-based model for addressing the natural environment in transportation planning decision making. MnModel divides the state into 20 acre squares with 27 layers of information associated with each square. Officials believe this model has a strong potential for identifying archaeological and historic sites, sensitive soils, slopes, and water resources that would be critical for the type of environmental systems planning they envision.

The Cape Cod Commission is one of the nation’s leaders in using GIS tools for identifying environmentally sensitive locations in a study area. The Commission uses GIS methods to locate and plot natural and community resources that should be avoided if at all possible. As such, the Cape Cod Commission provides good examples of the types of environmental factors that can be incorporated into such an approach, and how this information can be used is discussed in the scenario planning section.

**Institutional Mechanisms and Collaborative Partnerships**

Several agencies have developed formal arrangements and mechanisms for involving various environmental resource agencies early in the planning process. These processes generally provide a forum for agency representatives to meet with the DOT or MPO in the early planning stages to identify and address potential environmental issues related to the proposed plan or plan alternatives. In Wisconsin, state DOT officials pointed to the early involvement of environmental resource agencies and interest groups in the environmental issues associated with transportation investment as the major benefit of the SEE process. This process does not replace the “purpose and need” component of project-level environmental impact analyses, but it does provide a forum for stakeholders to address anticipated system-level effects of the plan.

In Oregon, federal and state agencies have developed a Collaborative Environmental and Transportation Agreement for Streamlining (CETAS), which is a formal agreement for streamlining environmental decisions in transportation planning (see Fig. 1). Participants include the Oregon DOT, state environmental resource agencies, and the FHWA. The CETAS process is based on a formal agreement that ensures full communication, participation, and early involvement in ODOT’s major transportation initiatives.

In California, a partnership agreement among the California Environmental Protection Agency, the Resources Agency (RA), and the Business, Transportation and Housing Agency, called the Tri-Agency Agreement, has been established to identify program areas in which additional cooperation among these parties will lead to better integration of state environmental and mobility goals (RA 2001). The purpose of this partnership is to foster cooperative and collaborative program relationships among the stakeholders. The partners to this agreement have agreed that transportation projects need to be delivered in a way that protects or improves the quality of the environment. According to those interviewed, changes in institutional relationships are expected that will improve the scope and pace at which the environment is incorporated into transportation planning.

The MnDOT uses letters of agreement, programmatic agreements, and partnership agreements with environmental resource agencies to establish a streamlined environmental assessment process. The MnDOT also funds environmental agency personnel, has established project/environmental coordinators in DOT district offices, trained DOT staff on environmental protection, and incorporated context sensitive design procedures into agency design guidelines.

**Conclusions**

The approaches identified in this research for considering environmental factors in transportation planning varied substantially. In many cases, agencies were using project-based approaches for environmental mitigation. However, in other projects, agencies had adopted a proactive approach toward identifying environmental concerns early in the process and dealing with them in a proactive and participatory fashion (e.g., using CSD/CSS approaches). For systems planning, the evidence suggests that environmental factors are still primarily considered in a reactive manner, that is, by assessing the environmental impacts of plan strategies after they have been identified. However, several state DOTs had begun the process of placing environmental considerations early in the decision-making process so as to avoid controversy and conflict later in the process (e.g., the Florida ETDM process). Table 6 illustrates these different types of approaches. As illustrated, different approaches or methods can be used for each of the different strategies for considering environmental factors. A causal and comprehensive approach would imply assessing alternative future scenarios (i.e., alternative plans) and their respective environmental impacts (Area A1 in Table 6). By doing so, sensitive environmental areas and issues can be identified early, with steps taken to consider such issues during the alternatives identification process. An impact-based approach would reactively address such impacts during the evaluation process (Area A2 in Table 6). At the project level, the current approach toward environmental assessment falls in Area B2 in Table 6. One of the

<table>
<thead>
<tr>
<th>Table 6. Approaches for Addressing the Environment in Transportation Planning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(A)</strong> Systems (comprehensive view)</td>
</tr>
<tr>
<td><strong>1</strong> Causal (proactive approach)</td>
</tr>
<tr>
<td><strong>2</strong> Impacts-based (retroactive approach)</td>
</tr>
</tbody>
</table>
emerging approaches that takes a more proactive perspective is the context sensitive design/context sensitive solutions approach, which falls in Area B1 of Table 6.

This research also found other characteristics associated with the consideration of environmental factors that are important in understanding current practice. First, the United States and international experiences that more strongly link transportation planning and environmental considerations show that states and countries with strong environmental laws, especially where the laws affect transportation decisions, have shaped how environmental factors are considered in the transportation planning process. The environmental factors that are considered in planning are usually left to the agencies’ discretion, given that they are in the best position to identify the major environmental concerns, needs, and opportunities within their planning domain. However, in some cases such as in Wisconsin, the law is specific about which environmental factors need to be considered. Not surprisingly, legislation that supports the consideration of environmental factors in the transportation planning process (coupled with adequate resources to achieve environmental goals) is one of the most effective ways for enabling and motivating agencies to consider in a structured way environmental factors in such planning.

Second, existing institutional frameworks for planning within a state are also particularly relevant to the types of approaches that can be used to address the environment in planning. States that have made strides in integrating land use and transportation planning (through legislation or formal collaborative partnerships) are in a better position to control environmental impacts stemming from transportation through land use decisions, and better poised to take advantage of useful systems-level methodologies such as scenario and capacity-based planning. Because transportation is largely a derived need, integrated planning environments such as the ones found in the state of Oregon and Cape Cod, offer a potentially more effective framework for addressing the environment in planning, than do decentralized frameworks with segmented land use and transportation decision-making processes. But even where there is a formal separation between the land use and transportation decision-making processes, some states (e.g., Wisconsin and Minnesota) are making strides with formal collaborative partnerships to bring key decision makers to the table early in the planning process and, in so doing, they are integrating what would otherwise remain separate decision-making processes. Although prevailing institutional arrangements are typically viewed as constraints in the short term, they are not constraints in the long term and institutional reengineering can be presented as an important longer-term opportunity for integrating land use and transportation planning.

Third, the survey results show that a majority of state DOT and MPO respondents believe environmental factors will only become more important to transportation planning in future years. Each of the environmental factors received higher scores when ranked for the future transportation plan, as compared to the most recent plan. In addition, there was great consistency among state DOT and MPO respondents in identifying which environmental factors are likely to be the most important, those relating to air quality, land use, socio-economic, environmental justice, and community cohesion issues. Future environmental issues that showed the greatest increase in importance as ranked by both state DOT and MPO respondents for future transportation planning included energy, water quality, and human health.

This paper has provided an overview of what could become a major characteristic of transportation planning in the future. With increasing attention given to environmental quality and sustain-ability, it seems likely that the transportation systems planning process will have to become more sensitive to these issues than has occurred in the past. With new tools (e.g., GIS) available, transportation planners will be able to provide more and better information to decision makers in the development of plans and programs so that environmentally sensitive areas of a state or community can be protected. Trends also indicate that environmental performance measurements, that is, monitoring environmental quality as it relates to specific civil infrastructure provision and operation, will become an important part of agency management in the future.

Acknowledgments

This research was sponsored by the National Highway Cooperative Research Program (NCHRP) under NCHRP Project No. 8:38: Consideration of Environmental Factors in Transportation Systems Planning. The writers are solely responsible for the ideas presented in the paper.

References

Archibugi, F. (1997). The ecological city and the city effect, essays on the urban planning requirements for the sustainable city, Aldershot, Ashgate, U.K.


