

Toward a Sustainable Future

Assessing Transportation's Contribution to Long-Term Environmental Problems

TRB Special Report

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A recent report of the Transportation Research Board examines the contribution of the transportation sector to a specific set of long-term environmental problems: those that are prone to being neglected and have consequences that, accumulated over time, threaten serious and irreparable harm to the environment. Special Report 251, *Toward a Sustainable Future: Addressing the Long-Term Effects of Motor Vehicle Transportation on Climate and Ecology*, emphasizes in particular those disturbances that threaten large and irreversible environmental consequences, but are seldom the subject of preventive actions because these consequences appear so gradually and imperceptibly.

Background

The concepts of "sustainable development" and "sustainability" have come to encompass a wide variety of environmental, economic, and social concerns. The terms "sustainable societies" and "sustainable development" had their origin in the mid-1970s, when concern over the environment and an expanding world population began to grow in many industrialized nations. An often-cited definition of sustainable development is the following, adopted in 1987 by the United Nations World Commission on Environment and Development: "A sustainable condition for this planet is one in which there is stability for both social and physical systems achieved through meeting the needs of the present without compromising the ability of future generations to meet their own needs."

As notions of sustainable development have evolved and been applied in recent years, they have become associated with a wide array of issues and public policy concerns. In the transportation field, a number of conferences, papers, and reports have addressed such issues as the role of transportation in ensuring the future availability of petroleum and other energy supplies, curbing urban air pollution and traffic congestion, providing access to jobs and services for low-income and elderly populations, and creating more inviting and prosperous central cities.

Key Study Findings

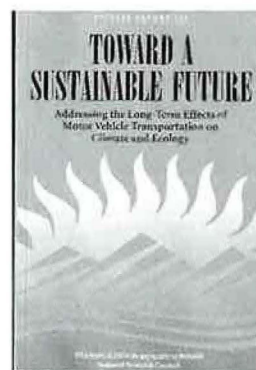
The study findings fall into four broad categories. The key findings are summarized below.

Sustainable Development and the Role of Transportation

A basic aim of sustainable development is to ensure that current generations do not deprive future generations of essential environmental resources. Whereas future generations are likely to develop alternatives to current sources of energy and materials as finite supplies dwindle, they may find it far more difficult to adapt to changes in certain other critical natural resources and processes, such as the earth's climate and biological diversity. If irreplaceable resources such as these are permanently altered or degraded, the consequences for future generations may be serious.

Transportation is a source of several environmental disturbances that present complex challenges for research and policy making. Many of these disturbances, ranging from the emission of air pollutants and noise by motor vehicles to the destruction of habitats by road building, are being managed to varying degrees. Some—such as urban air pollution—are well recognized by the public and are the subject of regulatory programs and other mitigations. Others are more prone to neglect or mismanagement. In the former case, the biggest challenge is often to devise more cost-effective and acceptable mitigation measures. In the latter instance, the greatest challenge is often to build a stronger understanding of the problems and generate public support for addressing them.

As the dominant mode of transportation, motor vehicles pose the greatest challenge and offer the most opportunity for controlling the environmental effects of transportation. Motor vehicles produce most of the carbon dioxide (CO₂) emitted by the transportation sector, as well as most of the other transportation emissions of environmental concern. The road system over which motor vehicles operate is by far the most extensive component of the nation's transportation infrastructure and is a



Special Report 251, *Toward a Sustainable Future: Addressing the Long-Term Effects of Motor Vehicle Transportation on Climate and Ecology*, is available from the Transportation Research Board (see page 48 for ordering information).

source of various environmental disturbances. The United States is a leader in motor vehicle technology and a bellwether of trends in motor vehicle use worldwide. How this environmental challenge is confronted in the United States will have implications elsewhere.

Trends and Outlook in U.S. Motor Vehicle Transportation

Motor vehicles have become integral to the U.S. economy and the daily lives of most Americans. In this century, the motor vehicle has become the principal means of both personal travel and goods movement, accounting for the largest share of transportation energy use, infrastructure investment, and activity. As motor vehicles have grown in use, so has their influence on the national economy and people's decisions about where to live, work, and socialize. Policies to influence motor vehicle transportation are therefore controversial and have important ramifications.

The past half-century has witnessed a sharp growth in motor vehicle travel, which was influenced by a complex assortment of economic, demographic, social, and technological forces, such as increasing affluence, a growing economy, and the influx of women and maturing baby boomers into the driving pool. Since World War II, the U.S. population has grown by three-quarters, motor vehicle travel has increased nearly fivefold, and motor fuel use has more than tripled.

An understanding of how trends in motor vehicle use are likely to unfold over the next several decades will be valuable to managing future environmental effects. During the next half-century, different demographic, technological, and economic forces are likely to emerge as important influences on motor vehicle travel. Moreover, should motor vehicle travel simply grow as fast as the population, Americans will be driving nearly 50 percent more by the middle of the next century, which will intensify already important environmental challenges.

The rest of the world appears to be following the lead of the United States in motor vehicle use and technologies. The United States, Europe, and Japan design and supply most of the world's transportation equipment and technologies, exerting an influence on the characteristics of motor vehicles and fuels used worldwide. Steps taken in the United States and other industrialized nations to influence emissions of greenhouse gases and other environmental effects from motor vehicles will likely have far-reaching consequences.

CO₂ Buildup, Role of U.S. Transportation, and Policy Options

Transportation is an important source of greenhouse gases. In particular, transportation vehicles are major emitters of CO₂, a long-lived greenhouse gas whose concentrations in the atmosphere are growing.

Whereas the long-term environmental consequences of greenhouse gas buildup remain uncertain, and efforts continue to reduce these uncertainties, scientific consensus is emerging that human energy use is changing the earth's climate. The extent to which climate change poses a serious risk to future generations is far more controversial. Given what is known and still unknown about greenhouse gas buildup, the international community is increasingly concerned about this issue and is struggling to find the most prudent combination of research and policy measures.

As a major emitter of CO₂, transportation is, and will likely continue to be, the subject of research and policies to reduce long-term risks from greenhouse gas buildup. Because no single nation or economic sector accounts for a predominant share of total emissions, there is little direct incentive for any one sector to reduce emissions. Nevertheless, the transportation sector is likely to become the subject of increasing attention as policies to influence CO₂ emissions are considered and assessed by the international community. Given its research and technical capabilities, as well as its size and influence, the U.S. transportation sector is positioned to take a lead role in developing and evaluating alternative policies and technologies to control greenhouse gas buildup and its consequences.

Several policy and technology options are available for influencing CO₂ emissions from transportation, though most require further development and evaluation and will not have a significant effect for many years. Most of these options are intended to influence one of two variables: the amount of motor vehicle travel (e.g., policies to increase ridesharing, transit use, and the cost of owning and operating motor vehicles) or the type and amount of motor fuel used per mile traveled (e.g., programs to raise vehicle fuel economy or develop and introduce vehicles that run on alternative, low-emission fuels).

The likelihood that motor vehicle travel will continue to increase, combined with the uncertain and potentially slow influence of many policies and technologies on emission trends, makes early efforts to develop these options important. The initial assessment of options in this study indicates the importance of early action to conduct more

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varied and sustained research on alternative technology and policy options.

Collective Ecological Effects from Vehicle Emissions and Infrastructure

Transportation vehicles and the infrastructure over which they operate are the source of a number of apparently site-specific environmental disturbances that have larger ecological consequences. Because environmental effects are frequently treated on a project-by-project basis, other environmental effects that take place over large spatial and time horizons are often neglected. Occurring gradually and subtly, these disturbances may nevertheless result in permanent ecological changes and losses.

The pollutants emitted by motor vehicles disperse widely and have ecological effects that can be long lasting. During the past three decades, required changes in vehicle technology, fuel composition, vehicle maintenance and inspection programs, and other products and practices have led to progress in controlling these pollutants and their adverse effects on the nation's urban populations. The influence of these emissions on the natural environment outside urban areas, however, has received relatively scant attention. Effects that are not adequately addressed may become more severe.

The road infrastructure has many ecological effects—on species, habitats, terrestrial and aquatic ecosystems, and natural processes—that are long lasting, broadly dispersed, and often cumulative. Understanding and treating these effects from a broader landscape or regional perspective presents a major challenge for research, public education, and mitigation. Acknowledgment of such effects is necessary to generate support for the kinds of data collection and research efforts that will enable well-conceived mitigations.

Next Steps

A prudent course for reducing the uncertainties and risks associated with long-range environmental consequences is to further the understanding and development of policy and technology options, as well as to focus on improving scientific and technical understanding of the causal factors involved. The following are examples of research, education, and information-gathering steps that can be taken.

Research on Determinants of Travel Demand. Research is needed to understand the behavioral,

demographic, and social factors that influence transportation demand.

Long-Range Technology Research and Development. The federal government sponsors a number of research, development, and demonstration activities on alternative transportation technologies and fuels. It is essential that sufficient attention be given to developing a portfolio of high-risk and potentially high-benefit (e.g., low-emission) technological opportunities.

Ecological Research. An escalation in research on the ecological effects of transportation and means of controlling them appears warranted. Better ecological data and fieldwork will be fundamental to an improved understanding of the multidimensional ecological effects of transportation systems and the identification of control measures.

Public Awareness and Understanding. Because the risk of climate change and the other ecological effects of transportation are at present largely imperceptible to the public, special efforts are needed to enhance public awareness and understanding in order to spur dialogue and debate about opportunities for mitigating these effects.

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Profiles

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to the Motor Vehicle Safety Research Advisory Committee, 1986–1989; served as team director for the First International Study Mission to Japan on IVHS for the Technology Transfer Institute; was advisor to the Office of Technology Assessment on transportation of hazardous materials, truck safety technology, and IVHS, 1987–1991; was a member of the Mobility 2000 Steering Group for IVHS, 1987–1991; and served on the Coordinating Council, Intelligent Transportation Society of America, 1994–1997. He is currently a member of the Safety and Human Factors Committee, ITS America. Ervin also has served on several committees of the National Research Council and the Transportation Research Board. Since 1992 he has been a member of the TRB Committee on Transportation Safety Management.