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Grand challenges for high-speed rail environmental assessment in the United States

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ABSTRACT

The comprehensiveness of environmental assessments of future long-distance travel that include high-speed rail (HSR) are constrained by several methodological, institutional, and knowledge gaps that must and can be addressed. These gaps preclude a robust understanding of the changes in environmental, human health, resource, and climate change impacts that result from the implementation of HSR in the United States. The gaps are also inimical to an understanding of how HSR can be positioned for 21st century sustainability goals. Through a synthesis of environmental studies, the gaps are grouped into five overarching *grand challenges*. They include a spatial incompatibility between HSR and other long-distance modes that is often ignored, an environmental review process that obviates modal alternatives, siloed interest in particular environmental impacts, a dearth of data on future vehicle and energy sources, and a poor understanding of secondary impacts, particularly in land use. Recommendations are developed for institutional investment in multimodal research, knowledge and method building around several topics. Ultimately, the environmental assessment of HSR should be integrated in assessments that seek to understand the complementary and competitive configurations of transportation services, as well as future accessibility.

1. Introduction

In accommodating surging intercity transportation demand during an era of unprecedented environmental concern, network improvements and investments must balance efficiency, cost, and the impact on human health and the environment. Analysis to support such investments must therefore be based on models of system costs and benefits, environmental impact, and multimodal interactions, while maximizing mobility and accessibility. In the case of modal investments in the passenger intercity transportation system, understanding the environmental tradeoffs and co-benefits between automobiles, air, and high-speed rail (HSR) requires an understanding of the interrelationships between traveler choice, multimodal network configuration, future energy inputs, changing vehicle technologies, and secondary effects from interconnected systems. As regions in the US consider developing HSR capacity, the evaluation of multimodal intercity transportation systems has received some attention in the research community. Yet, the environmental impacts of a transportation system that includes HSR remains uncertain. The state of knowledge supporting the environmental assessment of multimodal intercity transportation systems

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with HSR is not mature and several gaps persist that are inimical to a sound understanding of how investments should be prioritized to maximize environmental benefits while improving mobility and accessibility, and how HSR can be positioned for 21st century sustainability goals.

HSR in the US can be viewed as a disruptive technology that may help catalyze the deployment of next generation sustainable infrastructure. The discussion of new HSR infrastructure in the US, however, often centers on the outcomes of similarly established systems in Europe or Asia, which can inadvertently position the systems as twentieth century technologies. New HSR (whether that be in the US or the UK), however, has the potential of becoming the first step towards a 21st century sustainable infrastructure investment if it is viewed through a more systematic lens that includes the potential for co-infrastructure investment in, for example, fiber optics for teleworking, renewable energy (Navigant, 2008), smart land use (Nuworsoo and Deakin, 2009), and public transit hubs, to name a few. The successful deployment of next generation sustainable infrastructure has many challenges and we focus on several critical gaps in our knowledge of developing rigorous environmental assessments of future transportation systems in the US.

Towards formalizing the gaps and identifying the research thrusts needed to support environmental assessments of multimodal intercity transportation systems with HSR, the authors performed a synthesis of state-of-the-art knowledge and approaches in aviation and HSR environmental assessments. This synthesis includes over 160 documents spanning decades of research from academia, environmental analysts, and government environmental reviews that either directly assess HSR outcomes or recommend methods for assessing a multimodal system. The synthesis focused on US assessments, but also included European studies when advanced methods not yet applied to the analysis of proposed US systems were used. Of the environmental literature, 68 US and 40 European studies were reviewed. Environmental Impact Statements (EIS) for HSR in California, Florida, and the Midwest were included in addition to the Federal Aviation Administration's (FAA) EIS and Records of Decision for 57 airport projects. The synthesis included 93 journal and conference articles, 30 research reports, 21 government reports, and 10 policy and legal documents from as early as 1973. Other documents that assess HSR feasibility, infrastructure configurations, and demand were also included. The literature is summarized and discussed extensively in ACRP11-03 (2013).

The gaps identified include incommensurate network boundaries between air and HSR systems, a failure to plan for HSR as a complementary mode to air, a dearth of data and methods for estimating future HSR ridership, compartmentalized environmental interests, little research on future vehicles and electricity use, and little understanding of secondary land use impacts that will result from transportation infrastructure changes. Identifying the gaps is an important first step, as they constrain transportation planners and policymakers in estimating future impacts accurately or meaningfully. By identifying these gaps, recommendations can be developed for policymakers and researchers to direct resources to removing the barriers, ultimately resulting in higher quality information for multimodal intercity transportation system decision makers.

Building on the gap analysis, recommendations are developed for research initiatives to build forecasting capabilities for multimodal transportation systems that include HSR and how this research can be supported through federal multimodal transportation policy initiatives. The research initiatives will need support through federal policy because a new focus – one of improving long-distance transportation services and accessibility rather than mode-specific projects – will be necessary. This new focus faces several grand challenges. The term *grand* is used because these challenges are not solved by single, uncoordinated research efforts, but instead will require commitments of support from multiple institutions (i.e., government, academia, and industry) and in some cases a willingness to address shortcomings in environmental policy. They will require (i) new funding models that support multi-stage modeling efforts, (ii) methodological innovations to estimate future transportation network outcomes, and (iii) data collection of passenger preferences as well as vehicle and engine manufacturers. As the US begins to ask questions about long-distance transportation futures – particularly of the role of HSR – an integrated framework to guide transportation planning and investment decisions towards sustainable solutions is necessary.

2. Grand challenges

The Passenger Rail Investment and Improvement Act (PRIIA) of 2008 led to a wave of new research with the goal of understanding the mobility and environmental outcomes of HSR deployment in the US. Research aimed at the development of state-of-the-art methods mobilized quickly and the emergent studies tend to follow approaches that assume HSR is a competitor to auto and air travel, use data on technology performance and adoption from Europe or Amtrak Acela in the US Northeast, and focus on per passenger distance or trip comparisons that do not directly analyze policy outcomes. Research results have produced invaluable insight, however, it has become clear that improved data and methods are needed to support a rigorous understanding of the environmental outcomes (which may occur well into the future) of policies that deploy HSR in different configurations. To develop a comprehensive assessment of the future environmental impacts in a network that includes HSR, it is necessary to know how many vehicles are operating, the performance of these vehicles, the energy sources they use, the routes they cover, their frequency, their passenger loads, and how these characteristics affect future automobile travel and air network operation. There is even discussion of HSR systems transporting freight in addition to passengers (Pazour et al., 2010). To develop these improved data and methods, government–academia–industry collaborations and significant long-term research are needed around five core grand challenges.

Environmental assessments of transportation services consider many different human health, environmental, and resource impacts. We use the term in the broadest sense but given the prevalence of literature that focuses on energy