8.2 ECONOMIC SENSITIVITY OF TRANSPORTATION TO WEATHER AND VALUE FOR WEATHER FORECASTS

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1. INTRODUCTION

Economic analyses are increasingly important to the meteorological community. They help justify and evaluate programs as well as guide programmatic investments, especially as many agencies that support weather and climate services face resource constraints. Nevertheless, weather forecast value and related topics are often touted but rarely studied. An exception is a recent study done by Lazo el al. (2008) of 11 economic super sectors which found that, for the transportation sector, U.S. economic output varies by nearly $10 billion a year ($2000 GDP) due to weather variability.

To further explore weather impacts on the transportation sector, the National Center for Atmospheric Research (NCAR) Societal Impacts Program (SIP) conducted a broad assessment of how the transportation sector uses and values weather forecast information. This assessment will improve our understanding of how the transportation sector is affected by weather as well as the use and value of current and improved weather forecast information. This information in intended to help support public investments in weather observing and forecasting systems and provide improved weather forecast information to the transportation subsector. More generally, this project will help develop baseline knowledge and a valid and reliable socio-economic methodology for assessing the use and value of weather information in all economic sectors.

2. METHODOLOGY

2.1 *Transportation subsectors*

Our assessment is based on the transportation sector as defined by North American Industry Classification System (NAICS) standards; NAICS provides the framework for reporting U.S. economic data. This study focuses on five transportation subsectors—air, rail, water, truck/freight, and pipeline transport. These subsectors are defined as follows (NAICS, 2007):

- Air transport – transportation of passengers and/or cargo using aircraft, including scheduled and nonscheduled transportation
- Rail transport – transportation of passengers and/or cargo using railroad rolling stock
- Water transport – transportation of passengers and cargo using water craft, including inland water and deep sea/coastal transport
- Freight transport – transportation over-the-road of cargo using motor vehicles, such as trucks and tractor trailers
- Pipeline transport – transport of products, such as crude oil, natural gas, refined petroleum products, and slurry using transmission pipelines.

It is important to note that the NAICS definitions of these subsectors do not include private motor vehicle transportation, private and corporate aviation transportation, or traffic and road maintenance operations. Six other NAICS transportation subsectors are not considered in this study (i.e., transit and ground passenger, scenic and sightseeing, couriers and messengers, support activities, warehousing and storage and postal).

2.2 *Expert elicitation*

We conducted this assessment by employing an “expert elicitation” methodology. It consists of asking experts in a field or topic to consider and carefully synthesize (and analyze) the full range of current information, and then provide their expert judgments. This methodology is particularly useful for expressing experts’ judgment about a topic that is not adequately characterized in the existing literature. It is also useful for exploring questions about which no one individual likely has complete expertise, because this methodology allows us to

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acquire input from individuals with a variety of backgrounds and experiences. It helps articulate the nature and extent of agreement within a community. Expert elicitation has been used frequently in the area of climate change to assess experts' judgments about possible climate change impacts (see Morgan and Henrion, 1990; Morgan 2006 and references therein).

2.3 *Expert interviews*

We conducted the expert elicitation through individual, semi-structured interviews with transportation sector experts in academia, the private sector, and government. Prior to the interview, we provided all our experts with a background paper that we developed and iteratively refined. The paper briefly describes the motivation for the study, definitions of the five transportation subsectors, some statistics about the size and revenues of the subsectors, and definitions of some economic concepts pertaining to the study.

The interview protocol, which was also refined iteratively, asks questions of the respondent based on their self-identified subsector of expertise. It includes four main sections of questions: (1) respondents' sector-related background and experience; (2) general activities and economics of the subsector; (3) the nature and extent of weather impacts on the subsector; and (4) perceptions on the use of, needs for, and value of current and improved weather information in the subsector. There are over 50 open-ended questions and sub-questions combined across these sections, providing a detailed collection of information.

To date, we have collected data by conducting interviews with four transportation experts. Two people have expertise in aviation, one person has expertise in rail, and one person has general knowledge about all the subsectors. The four people represent the academic and private sectors. Three interviews were conducted in person and one was conducted by phone. All the interviews lasted approximately two hours.

3. SUMMARY OF INTERVIEWS TO DATE

The four expert interviews we've conducted thus far have already provided us with a wealth of rich information. Table 1 provides a visual of how information from this project could be summarized upon completion. We also provide a preliminary summary of the data we've collected to date about the impacts of weather on the five subsectors.

4. FUTURE WORK

Future work in this area could proceed in a couple ways, contingent upon funding.

First, more information is needed from additional subsector experts through semi-structured interviews. At a minimum, interviews should be conducted with one expert each from academia, government, and the private sector for each of the five subsectors (i.e., 15 people) as well as three interviews from experts with general knowledge about all the subsectors. Thus at least 18 total interviews are necessary.

Upon completing the interviews, a controlled-access, web-based survey could be done with the questions constructed based on the interview protocol. This would allow us to acquire broader input from a greater array of experts.

Conducting this additional research would allow us to fill in the pieces of information from Table 1 that we do not yet have. Moreover—and perhaps more importantly—eliciting information from more experts would provide a sense of the range and bounds of the use and value of weather information, both qualitatively and quantitatively, to the transportation sector.

5. REFERENCES

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Table 1. Schematic of how the data from this project could be summarized upon completion, with preliminary data (shown as an example) about the major impacts of weather based on the four interviews conducted to date.

	Air	Rail	Water	Freight	Pipeline
Major impacts of weather (qualitative summary, as shown)	• Main impacts ○ Safety, including fatalities and injuries ○ Air capacity ○ Efficiency • Key weather: ○ Convective weather (turbulence) ○ Icing ○ Winter weather ○ Hurricanes • Most delays in summer due to convective weather highest demand; winter is second	• Main impacts ○ Safety to employees ○ Service interruptions (slow orders, derailments, track washout) ○ Productivity (yard operations, switching trains) • Key weather ○ Rain/flood (washouts) ○ Wind (blowovers) ○ Snow ○ Fog ○ Extreme heat and cold	• Main impacts ○ Safety ○ Lost goods • Key weather ○ Wind (rough seas) ○ Thunderstorms	• Main impacts ○ Safety ○ Efficiency • Key weather ○ Wind (blowovers) ○ Snow/ice (visibility, traction) ○ Fog (visibility)	• Main impacts ○ Efficiency ○ Safety, hazardous spills • Key weather ○ Temperature (viscosity of material)
Costs incurred due to weather	(data to be summarized quantitatively as a range to characterize uncertainty) →				
Use of weather information	(data to be summarized qualitatively) →				
Value of current weather information	(data to be summarized quantitatively as a range to characterize uncertainty) →				
Value of improved weather information	(data to be summarized quantitatively as a range to characterize uncertainty) →				