Chapter 1. INTRODUCTION

Overview of Current Effort

Hurricanes along the east coast of the United States are potentially very destructive to the transportation infrastructure. A storm becomes a hurricane when it demonstrates a rotary circulation and reaches a constant wind speed of 74 miles per hour. The strength of its winds can cause considerable damage and they range in categories from 1 to 5, with 1 being the weakest and 5 being the strongest. Each category of hurricane has a unique level of damage to a transportation system as is summarized in the Saffir-Simpson Scale in Table 1.1. Hurricane force winds can result in damage that includes destruction of signs, bridges, tunnels, and smart highway equipment.

Table 1.1 Saffir-Simpson Scale

Category	Winds (mph)	Damage
1	74-95	Minimal
2	96-110	Moderate
3	111-130	Extensive
4	131-155	Extreme
5	>155	Catastrophic

A hurricane can be crippling to a regional transportation system such as the Hampton Roads District of Virginia. Preparedness and recovery by the highway agency, in coordination with localities and emergency services, is critical to minimizing the short, medium, and long-term effects of the event. In prior efforts, investigators characterized costs, risks, and benefits of managing spares of signs, signals, and lights in anticipation of hurricane damage (Lambert et al. 1998). In addition, use was made of probabilistic hurricane forecasts for inventory planning and operation. Based on the prior efforts, opportunities were identified for (1) improving the basis for priority setting in recovery efforts; and (2) adoption elsewhere (i.e. in addition to sign-signal-light inventory) in the agency of risk-cost-benefit assessments and evaluation to improve the agency's preparedness and response capability.

The goal of the current effort has been to improve hurricane preparedness and recovery of the Virginia Department of Transportation through the identification of planning and management options and the assessment and evaluation of the associated costs, benefits, and risks. There are seven related objectives: (1) A review of the literature and other agencies' experience; (2) Development of a software based platform for recovery priorities; (3) Identification of additional roads and critical facilities to be used in priority setting; (4) Decision support for resource allocation for hurricane recovery; (5) Time-to-recovery analysis; and (6) Analysis of schedule dependencies among agencies; and (7) Trade-off analysis performed on recovery/preparedness alternatives.

The several components of the effort are described below.

Review of Relevant Literature and Formation of Advisory Committees

A review and evaluation of past studies, theory and methodology, other agencies' experience, and databases that support the proposed effort has been performed.

Incorporation of Localities and Additional Classes of Critical Facilities

In order to prioritize the recovery following a disaster, criteria are needed to base the ordering on. In the past factors such as population, road type and capacity, average daily traffic, and so on have been used. This project uses critical facilities as the primary criteria in determining the order of the recovery. Critical facilities are defined as any facility necessary for the community's well being. They include emergency facilities such as hospitals and fire stations, centers of commerce, schools, and others. Facilities are categorized according to relevance in the short, medium, and long terms of recovery.

Extension of Prioritization Tool to a Software Platform

The effort develops a priority setting tool in a MSExcel spreadsheet and makes it available on-line for the use of VDOT. Arcview GIS and Microsoft Excel are used to make the software comprehensive and straightforward to use. Data including populations, highway mileage, and critical facilities are derived from the Arcview database, and Excel is used to analyze the results. The tool accepts user input including highway damage and severity of the disaster, and the output can be customized to look at short, medium, or long term recovery.

Time to Recovery Analysis

The effort examines the scheduling of the post-hurricane repair process to demonstrate what activities most influence the overall time to recovery. By identifying the relationships among the activities making up the repair process, a critical path of events is identified, which exposes potential bottlenecks in scheduling. An investigation of tradeoffs between time to recovery and pre-hurricane investments of resources suggests how to avoid costly project delays.

Schedule Dependencies in Hurricane Recovery

The effort explores opportunities for reducing intra- and inter-agency schedule dependencies arising in the pre and post-disaster processes. An approach for measuring delay conditions is created in order to compare and identify crucial delays. Descriptive scenarios of opportunities for advancing the schedule in the post-hurricane process have been collected through interviews of the agencies involved. The descriptive scenarios are characterized according to the DOT functions involved. Further analysis suggests areas in VDOT that could be improved to support a higher level of coordination among agencies.

Decision Support for Resource Allocation for Hurricane Recovery

The effort identifies opportunities to improve the allocation of resources for preparedness and recovery. New technology is introduced in the form of a multi-objective chart to offer support for resource allocation.

Tradeoff Analyses for Aspects of Highway Infrastructure

The effort extends the cost-risk-benefit analysis developed in a previous effort (Lambert et al. 1998) to other components of the highway infrastructure. Work done to improve the recovery of highway signs, signals, and lights has been extended to improve the recovery of bridges, tunnels, smart highway systems, etc.

Resources, Databases, and Software

The effort develops, documents, and classifies printed and electronic resources, databases, and software that support the methodology developed in the above tasks and provide a foundation for continuous planning by the agency.

Reports, Presentations, and Workshop

The effort develops progress and final reports, slide presentations, and a workshop to train VDOT districts and residencies in the developed methodology. Reports, presentations, and software conform to the publications requirements of the Virginia Department of Transportation Research Council. Documentation and spreadsheets are provided in electronic form and, in coordination with the proper information-systems committees of VDOT (e.g. the TIMSC), via a prototype internet web site at the University of Virginia.

Overview of Issues and Prior Effort

This effort has employed the use of hierarchical holographic modeling (HHM) in order to achieve its goal of improving VDOT's preparedness and response capability following a hurricane. Hierarchical holographic modeling is used as a way to account for diverse scenarios within VDOT and the community that could occur when a region is affected by a hurricane.

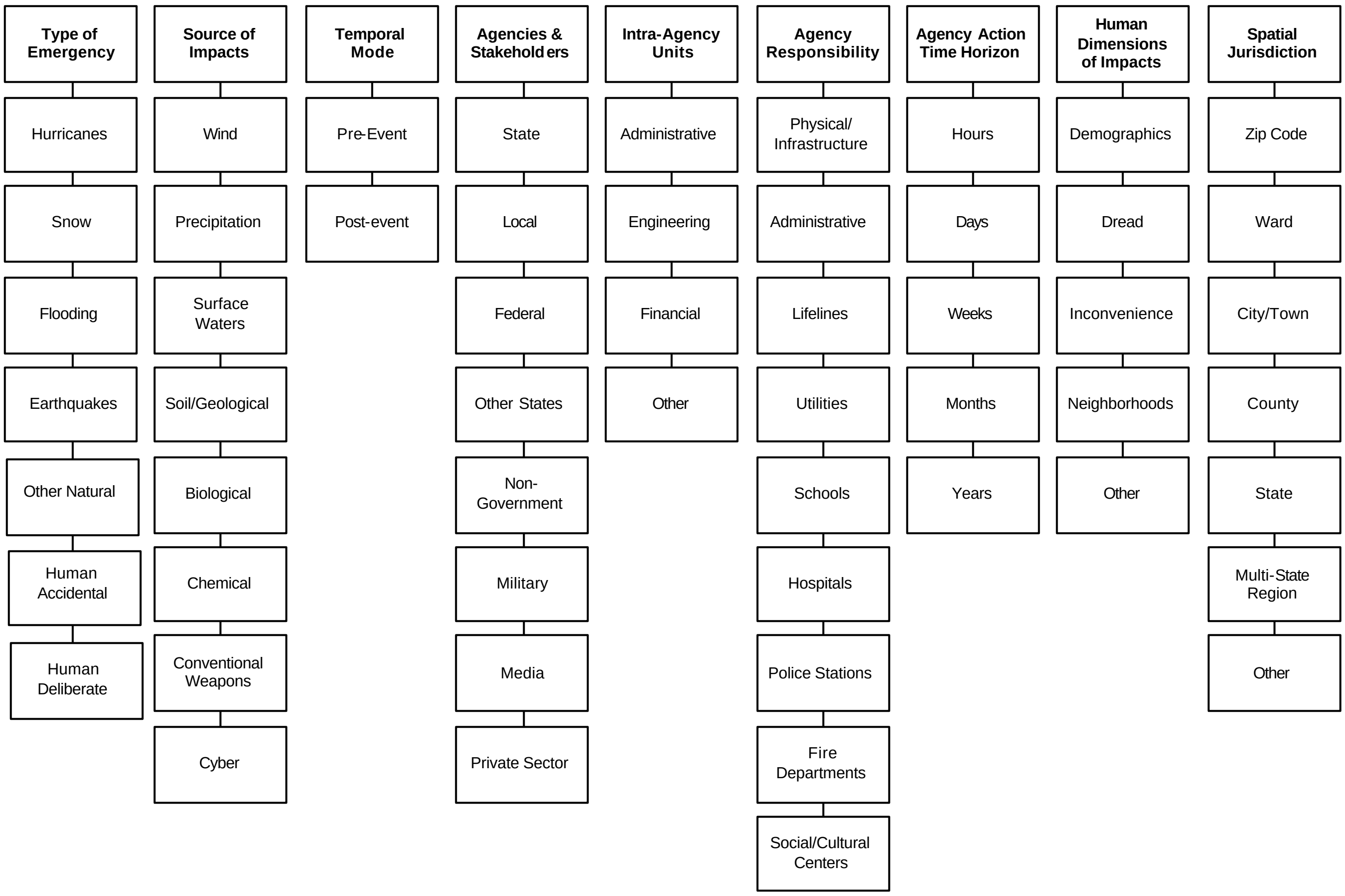

Figure 1.1 Hierarchical holographic model for Virginia transportation hurricane preparedness and recovery

The effort relied in part on the adoption of strategies from prior efforts addressing sign-signal-light inventory levels. A method for performing trade-off analyses has been projected from the sign-signal-light inventory to the current effort. A sample trade-off analysis is shown in Figure 1.2.

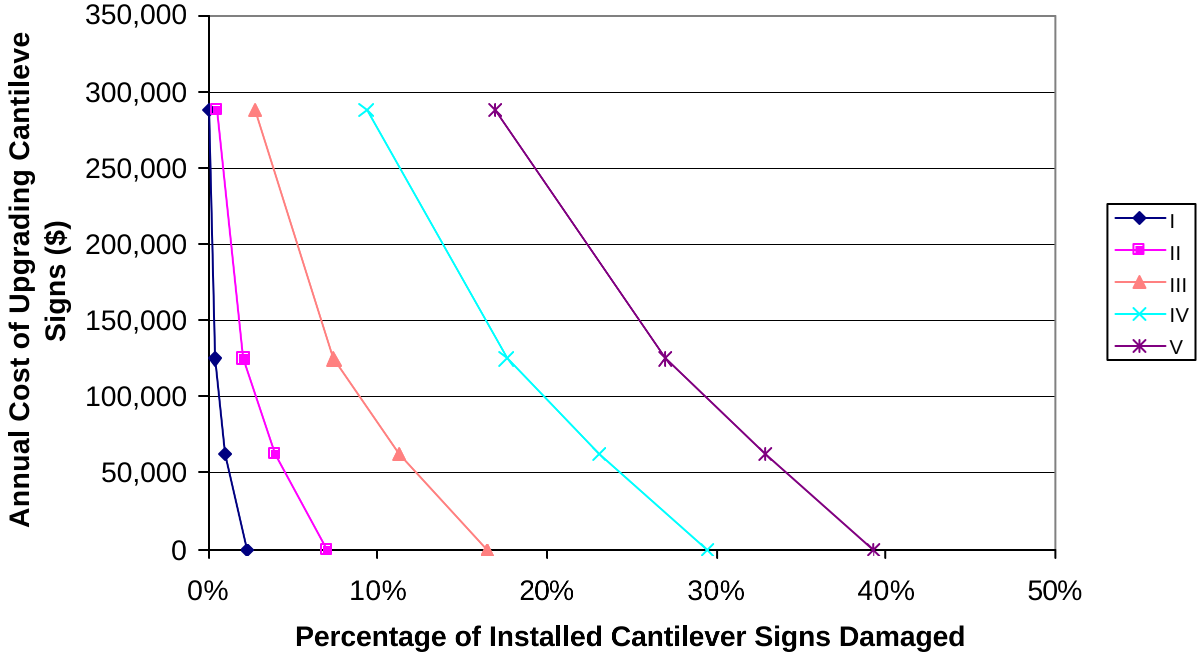

Figure 1.2 Trade-off analysis performed on cantilever signs for all categories of hurricanes (I - V) from sign-signal-light inventory project (Lambert et al. 1998)

In addition to hierarchical holographic modeling and the trade-off analyses adopted from prior efforts, this effort introduces new approaches described below for improving the Virginia Department of Transportation's hurricane preparedness and recovery capabilities.