Geophysical Research Abstracts, Vol. 7, 09304, 2005
SRef-ID: 1607-7962/gra/EGU05-A-09304

Field data collection systems for railway ground hazards

C.G. Sheriff, R.M. Harrap, and D.J. Hutchinson

Department of Geological Sciences and Geological Engineering, Queen's University (Contact Email: sheriff@geol.queensu.ca)

Introduction

Ground hazard incidents such as rock falls, landslides, snow avalanches and floods are among the most costly of train movement accidents, in part because they often take place in remote locations and result in long outage times. As part of the Railway Ground Hazards Research Program, we have undertaken a study of the integration of Global Positioning System and Geographic Information System technology to build digital field data collection tools for geotechnical incident and hazard reporting. This work builds on ongoing attempts Transport Canada, Canadian National Railway (CNR), and Canadian Pacific Railway (CPR) to standardize and extend the process of field data collection, and of requirements that such data be used for significant track safety research in the future.

Field Data Collection Systems

The widespread availability of low-cost field computers, whether palm-sized or notebook-computer sized, represents an opportunity to bring programmable devices into the field that capture field data directly into a database, with appropriate tools and rules to maintain data quality both during capture and during transfer. The availability of inexpensive global positioning system (GPS) receivers likewise represents an opportunity for locations to be transparently collected during fieldwork, and directly captured to the note-taking device in the field or in the office. Taken together, spatial information and descriptive information are the core data components of a Geographic Information System (GIS). GIS tools streamline data collection, map preparation, data storage, and data analysis; the availability of sophisticated spatial analytical tools in particular represents an opportunity to move towards the use of spatial analysis in geotechnical engineering, either on a mobile device or on the desktop.

Institutional Context

An integral part of field data collection for geotechnical hazard identification is the recognition of the institutional setting of field data collection. In order to design useful and relevant field data collection systems it is essential to understand how information flows within an organization. Understanding the practices used for data discovery, collection, storage and analysis leads to the development of tools that conform to the organization's current structure and allows for incorporation into future toolsets and practices. This amounts to determining what framework data, computational and human services, and institutional data standards aid or constrain the process of collecting field data. With this information, useful and relevant field data collection systems can be developed.

Field Data Collection System Design, Development and Implementation

The current research has two main components. The first component represents the development of a detailed workflow analysis of GIS within a railway and the assessment the impact of the institutional capacity and constraints on field data collection for ground hazards. This workflow analysis is conducted using requirements-discovery interviews and scenario-based design techniques. For example, a determination can be made regarding the capacity of the organization to perform the following tasks for field data collection:

- collect historical data to take into the field.

- perform preliminary analysis with historical data to guide the field planning process.

- gather framework data for use in the field.

- integrate new information into an existing archive.

- provide support for follow-up workflow, such as reminders, processing requirements, and analysis tasks using tools not available in the field

- communicate results (both work orders and archival reports) to the organization and to partnered organizations.

The workflow analysis and institutional capacity component of the research provides constraints on a parallel and concurrent, tool development project. The aim of this component is the development and implementation of a PDA/Tablet PC -based field data collection system prototype based on the requirements of a single railway organization. Specifically, the project focuses primarily on beaver control inspection for CNR in Eastern Canada. Implementing on such a scale allows lessons learned within the context of this project to be incorporated into the broader RGHRP framework, including operations at CPR and Transport Canada.

The design process involves consultation with railway personnel, and in particular with a geotechnical engineer to provide both direct (experiential) and indirect (consultative) feedback on the scope of tools and their use. Both interview-style and field-observation style steps are needed early in this process, after which design by reference to prototype interfaces and scenarios can follow.

In workflow terms, it is crucial that the pre-fieldwork, during-fieldwork, and post-fieldwork context for data elements, knowledge elements, and transformations that take place during work be recognized. This involves ’field-observation’ both in the office setting (to establish pre- and post-fieldwork settings) and in the geotechnical field context. An early output of this process is a series of detailed scenarios and workflow sketches that capture the essential details of work processes. Once scenarios and design scope are established, implementation of a proof-of-concept tool on actual field hardware can take place. This involves both software- and hardware- suitability tests, and includes parallel operations tests on other tools that field engineers make use of (e.g. email, web-browsing, geotechnical software). This recognizes the often overlooked fact that computer users typically rely on a suite of tools, not single applications, and these tools must interoperate.

The goal is to develop a prototype that makes use of a standardized form interface, integrates archived field and framework data (base map and regional railway data), and current regional data (weather, train scheduling). The use of real-time GPS for positioning and the inclusion of such key field data capture features as updates, synchronization, and partial completion with reminder rules are key components of the prototype development. This will contribute to the longer term goal of standardized field data collection and geotechnical data workflow in RGHRP. In addition, it will facilitate superior initial data quality and enable quicker response through increased prediction and analysis capabilities.

Conclusion

This study demonstrates that field data collection on PDA or portable field computers (Tablet PC) is possible, but that significant hurdles exist for the railways; many of these center around making the data collection and data use workflow in these organizations more transparent so that software may be constructed against a known organizational process for incident reporting and response.

The Railway Ground Hazard Research Program (RGHRP) is a five-year program jointly funded by Transport Canada, Canadian National Railway (CNR), and Cana-

dian Pacific Railway (CPR). Natural Resources Canada provides annual in-kind contributions. NSERC provided a Collaborative Research and Development grant in April 2004. Activities are conducted under the direction of the Centre for Risk Assessment and Geohazards Studies (CRAGS) at the University of Alberta. The current research was conducted by researchers at Queen’s University in Kingston, ON, Canada.