From "Digital Mapping Techniques '10—Workshop Proceedings"
U.S. Geological Survey Open-File Report 2012–1171
http://pubs.usgs.gov/of/2012/1171/

Assessing Early Stages of a Landslide Inventory

By Matthew M. Crawford and William M. Andrews, Jr.

Kentucky Geological Survey
228 Mining and Mineral Resources Building
Lexington, KY 40506
Telephone: (859) 323-0501
Fax: (859) 257-1147
email: *mcrawford@uky.edu*

Introduction

The Kentucky Geological Survey (KGS) is actively collecting data for a statewide landslide inventory and database. Steep topography, variable bedrock geology, and surficial deposits have combined to result in several areas of Kentucky being highly susceptible to different styles of landslides. To better document the distribution and context of Kentucky's landslide problems, KGS has begun a landslide inventory program.

A landslide inventory that can address remediation and repair costs and ultimately reduce the risk of landslides is the primary goal. Incorporating vast amounts of data in an organized, effective manner is a challenge. The early stages of work consist of prioritizing data collection from a wide variety of sources of landslide locations, sources such as active field mapping, light detection and ranging (LiDAR) analysis, preexisting landslide maps, State and county agencies, and anecdotal information (fig. 1).

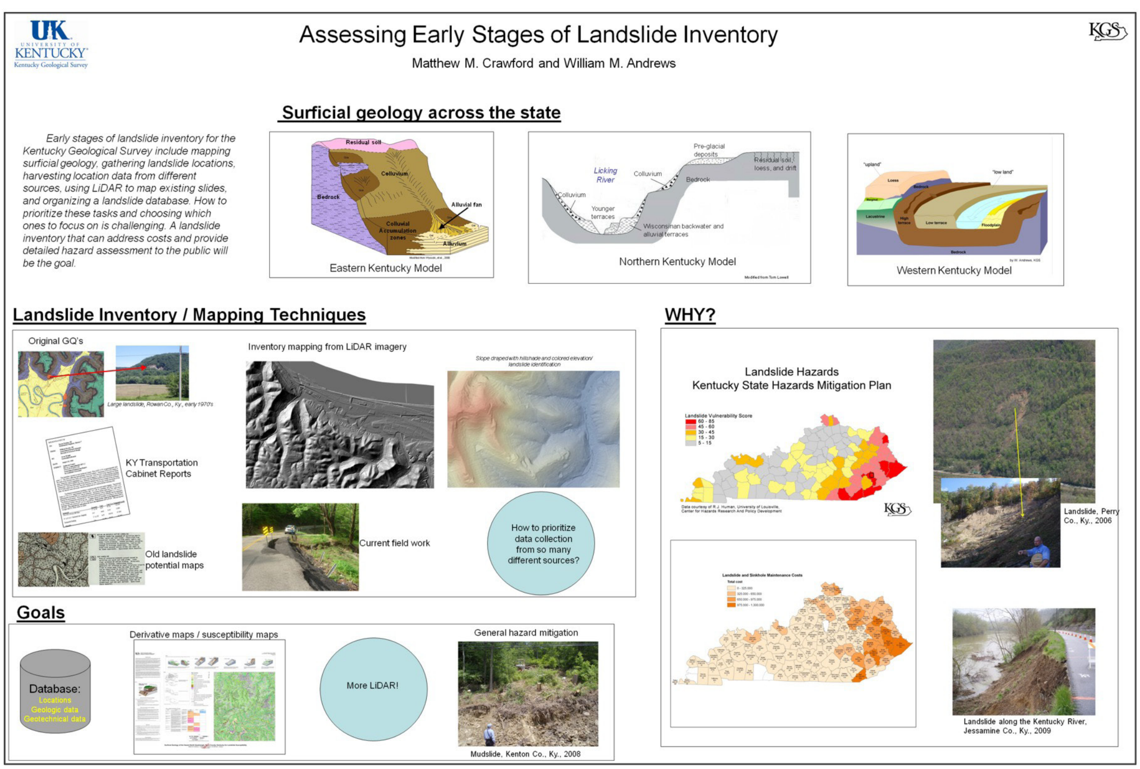

Figure 1. Page-size version of DMT '10 poster showing process of developing the KGS landslide inventory; see full-resolution image at *http://ngmdb.usgs.gov/Info/dmt/DMT10presentations.html*). Poster includes images modified from Wysocki and others (2000) and Potter (1996).

Purpose and Goals

Landslides are a major cause of property loss and infrastructure damage in Kentucky. The natural geology and soils combined with human activity put many places at risk, causing financial hardship for property owners and challenges for the government agencies that may be responsible for assisting. Since the early 1970s, the Kentucky Transportation Cabinet and the Kentucky Transportation Center have documented over 3,000 landslides (approximately 25 percent of those have geotechnical reports and are accurately located). Costs for repair of infrastructure damaged by these landslides exceed $2 million annually; however, there remain hundreds that are unreported, and many of these may not be related to transportation corridors. In addition, the Kentucky Office of Emergency Management spent $617,466 solely on acquisition of landslide-impacted homes from 2004 to 2007 (Kentucky State Hazard Mitigation Plan, 2007, p. 115).

An understanding of surficial deposits and the underlying bedrock is critical to the structure of the inventory and what data will be collected. Early construction of a database of landslide locations (their coordinates) is complete, and populating it with the associated geologic and geotechnical attributes is in progress. Because of a wide range of ages for these landslides and the limited time available for field checking, not all landslides in the database have a full set of attributes. In addition to the landslide inventory database, using the landslide locations, existing 1:24,000-scale geologic mapping, slope, and other datasets in a GIS, derivative maps or other products that the public can access will be created to address specific landslide issues.

Surficial Geologic Settings

Landslides occur statewide in Kentucky. All physiographic regions contain varying extents of steep slopes, bedrock lithology, and complex soils. For the purposes of understanding and mapping landslide potential, Kentucky can be broadly divided into three regions of distinctive surficial geologic conditions.

Eastern Kentucky

This large area lies east of the Cumberland Escarpment and within the Eastern Kentucky Coal Field of the Appalachian Basin. The topography is characterized by steep slopes with broad to very narrow valleys. Bedrock lithologies include sandstone, shale, siltstone, coal, and clay of variable thickness. The bedrock weathers to form complex surficial deposits of colluvium, alluvium, and residual soils (fig. 2). The steep slopes, heterogeneous bedrock lithologies, and variable thicknesses of the surficial deposits create a dynamic terrain highly susceptible to landslides.

Western Kentucky

Low-relief bedrock uplands are separated by broad alluvial valleys (Andrews and others, 2006). Bedrock lithologies include sandstone, shale, siltstone, coal, and clay of variable thickness. Surficial materials primarily consist of Pleistocene loess on the uplands and thick deposits of Pleistocene and Holocene alluvial and lacustrine sediment in the valleys. The

Figure 2. Photograph showing surficial geologic deposits typical in eastern Kentucky.

variable thicknesses and lithologies of the deposits create properties and behaviors that have a direct impact on slope stability. Areas where KGS has completed surficial geologic mapping primarily lie in the Green and Ohio River corridors of the Western Kentucky Coal Field of the Illinois Basin.

Northern Kentucky

The surficial deposits in this area are mainly glacial sediments, hillslope colluvium, residual soils, alluvium, and lacustrine deposits. The northern extent of this area is bounded by the glaciated Ohio River Valley, which served as an outlet for glacial meltwater, creating outwash deposits, slackwater sediment, and high-level terraces along the tributaries (Potter, 1996). Topographic relief averages approximately 500 feet, ranging from steep slopes along the Ohio River, gently sloping uplands, and broad dissected valleys. Shaly bedrock in the region weathers easily and produces thin to thick, clayey colluvial soils. Landslides typically occur within the colluvium or along the colluvial-bedrock contact.

Data Collection

Sources

Landslide locations came from a variety of sources: active field mapping, published geologic maps, LiDAR visualization, Kentucky Transportation Cabinet geotechnical landslide reports, the Natural Resource Conservation Service, Division of Natural Resources–Mine Reclamation and Enforcement, Division of Abandoned Mine Lands, media reports, and individuals.

Presently there are approximately 2,100 landslides with accurate locations inventoried across Kentucky. As resources permit, selected landslides are visited to collect key ground-condition information; to date, approximately 40 sites have been visited. For historic or other older landslides in the inventory that cannot be investigated in the field, the database will be populated with as many data as possible from a variety of information resources.

Attributes and Priority

The KGS landslide inventory database was designed on the basis of common attributes collected by other states with active inventories and landslide hazard assessment programs, as well as data fields necessary to collect and store information on recurrence and associated costs and losses. Landslide attributes have been devised to represent the conditions common to most of Kentucky's landslides and to capture information that is essential to hazard assessment.

Developing a comprehensive inventory of landslides in a state with widely varying geologic conditions is a challenge. Landslide hazards impact public infrastructure and lands as well as many private residences. Among the many landslide locations for which there is very little information, which ones should be focused on? Which of the many types of landslide inventory source records might be most amenable to field verification? For example, an old landslide related to a transportation route may have a good x,y location in the database, but it may not be identifiable in the field or may not have a geotechnical report available. The current data collection process includes converting the landslide locations from very different sources into one standardized database. Choosing the attributes (fig. 3) to focus on is important in order to gather as much information as possible while keeping in mind the goals and potential products. For example, would it be more effective for landslide susceptibility analysis to focus on a relatively few landslides that can be visited in the field in order to gather information for all the attributes? The emergence of LiDAR data across different parts of the state may dictate which areas to focus on. The availability of an inventory that has sufficient geologic and geomorphic information associated with landslides and that can address costs and ultimately reduce the landslide hazard risk is the ideal goal.

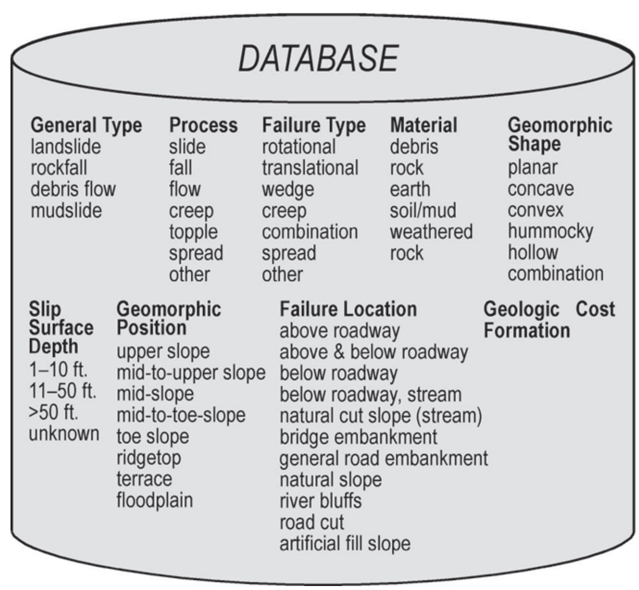

Figure 3. Selected attributes and values for landslides entered into the inventory database. Geologic formation and cost values are not listed.

Conclusion

The Kentucky Geological Survey is actively collecting data for a statewide landslide inventory and database. Constructing the database and collecting data associated with each slide is critical to successfully using an inventory to begin to analyze landslides for risk. The variety of sources of landslide locations, the age range for different landslides, the availability of information for each slide, and variable geologic conditions make this a difficult task. Once an inventory is constructed and data can be collected efficiently for landslide locations, new and old, then a wealth of information can become available in the form of maps, reports, or GIS files to address cost and ultimately reduce risk.

References

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