The Kentucky Geological Survey Landslide Program: An Overview

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Kentucky Geological Survey

2015 Geohazards in Transportation

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Outline

• National background

• Landslides in Kentucky

• 2015 landslides YTD in Ky.

• Research and data delivery
  ➢ Landslide inventory
  ➢ Landslide Information Map
  ➢ Research projects

• Summary

Rockfall, 4/2015, Hwy52, OH
• Responsible for $2-3 billion in damages annually (direct & indirect), rivaling annual flood losses

• Deadliest landslide in U.S. history, March 2014, Oso, WA

• No systematic catalog of occurrence or impact maintained in U.S.
  • Damage is poorly documented, considered part of another triggering event (flood, earthquake, tropical storm)
  • No insurance plans exist

• Hazard assessment is difficult:
  • No standard model for hazard assessment. No earthquake model.
  • Quantifying risk and loss reduction strategies are different for different types of landslides (variability in site conditions and slide behavior)

• USGS Landslides Hazards Program is funded ~3.5 million/year

• State geological surveys COMBINED spending on landslides is ~$900k per yr.
Landslides in Kentucky

- KY spends ~$10 million/yr. on landslide mitigation and repair (mostly direct)

- 2003-2013 KYEM-FEMA landslide mitigation projects (homes) ~ $5.3 million

- Variable geology, soils, slope morphology, slope development
Hickman, KY., Fulton Co. along the Mississippi River

1996-2000
$17 million in federal funding

Soil nails, shotcrete, deep anchors, aggregate geogrid
Translational slide / Debris avalanche

Google Image of same area

Nola Sizemore – Harlan Daily Enterprise

Harlan Co.
6/13/13
Breathitt Co., eastern Ky.
March 2015
Campbell Co., northern KY.

Recycled railroad rail
2008
Campbell Co.

Urban landslides

2011
2015 Landslides, YTD
Precipitation departure for first half of year – 8 to 15”
Rainfall YTD, 39.3” in Jackson, KY

- March-April totals
  - 13.3 Johnson Co
  - 13.3 Knox Co

- July 2015, wettest on record
  - 9.73” in Johnson Co
  - 11.23” in London, KY.
• ~100 landslides to date
  • Debris flows
  • Slumps
  • Rockslides
  • Rockfalls
  • Road washouts

Haywood Branch, Floyd Co., eastern KY.
Haywood Branch, Floyd Co., eastern KY.
Little Paint Creek, Floyd Co., eastern KY.
Little Paint Creek, Floyd Co., eastern KY.
Paintsville, Johnson Co., eastern KY.
Paintsville, Johnson Co., eastern KY.

Above homes

Below homes
Paintsville, Johnson Co.
Perry Co., 2015 eastern KY.
Cut and fill, old landslide
Pike Co., eastern KY.

Debris flow; destroyed church and damaged home
Research and Data Delivery
Landslide Inventory Database

- Known landslide locations
- Areas susceptible to debris flows
- Various sources
- Various attributes

Total = 2,443

<table>
<thead>
<tr>
<th>Geologic Formation</th>
<th>Landslides</th>
</tr>
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<tbody>
<tr>
<td>Pikeville Formation</td>
<td>474</td>
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<tr>
<td>Kope Formation</td>
<td>334</td>
</tr>
<tr>
<td>Hyden Formation</td>
<td>285</td>
</tr>
<tr>
<td>Landslide deposits</td>
<td>186</td>
</tr>
<tr>
<td>Four Corners Formation</td>
<td>156</td>
</tr>
<tr>
<td>Grundy Formation</td>
<td>68</td>
</tr>
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<td>Fairview Formation</td>
<td>62</td>
</tr>
<tr>
<td>Clays Ferry Formation</td>
<td>43</td>
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<tr>
<td>Princess Formation</td>
<td>53</td>
</tr>
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<td>Bull Fork Formation</td>
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<td>21</td>
</tr>
<tr>
<td>Paragon Formation</td>
<td>19</td>
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</table>
KGS Landslide Information Map

- Known landslide locations
- Areas susceptible to debris flows
- Landslides located from LiDAR and aerial photography
- LiDAR hillshade layer (where available)
- Create highly customized maps
Landslide Information Map

Landslide attributes
- Source desc
- SourceID
- County
- Quad
- Latitude83
- Longitude83
- Route
- Date Observed
- Failure Date
- Field Checked
- Material
- Failure Type
- Track Length
- Width
- Head scarp height
- Slip surface depth
- Geomorphic position
- Bedrock Formation
- Failure location
- Contributing factor
- Damage
- Comments
Research Projects

Geologic, geotechnical, geophysical landslide investigations

- Landslide characterization
- Groundwater conditions
  - Soil moisture, suction, pore pressures
- Rainfall data
- Slide movement
- Electrical resistivity
- Lab data
  - Index properties
  - Shear strength
Meadowview Landslide
Boyd Co., northeastern KY.

- Landslide characterization
- Piezometers
- Inclinometers
- Electrical resistivity
Doe Run Landslide, Kenton County
Inverted electrical resistivity sections, Herron Hill landslide

July 2014

Clay shale, soft

failure zone?

Weathered shale

March 2015

Need more time-lapse ER data
From Devita and others, 2012

Use the extended Mohr-Coulomb failure criterion to calculate unsaturated soil stress state variables

\[ \tau_f = c' + (\sigma - u_a) \tan \varphi' + (u_a - u_w) \tan \varphi^b \]
What is a “heavy downpour?” A 2-day precip total that is exceeded on avg. once in a 5-yr period.

Source: Kenneth Kunkel, National Climate Assessment, Cooperative Institute for Climate and Satellites-NC
Summary

• Landslides in Kentucky damage roadways and infrastructure with mitigation costing millions of dollars per year in damages.

• KGS landslide inventory and map service assists investigations and allows for better determination of where future landslides may occur.

• KGS conducts research projects investigating hydrologic conditions, movement, and structure, and how geophysics may be used as a tool to support slope stability assessments.

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