Peeks Creek Debris Flow

Landslide Hazards in North Carolina
Landslides and Landslide Risk: Needs for the Next Decade
National Research Council
Board on Earth Sciences and Resources
Special Workshop  February 24, 2015

Rick Wooten
North Carolina Geological Survey
NCGS Landslide Geodatabase

- 3,457 Landslides
- 2,102 Slope Movement Outlines
- 3,200 Debris Deposits
- 410 Ground Rupture Lines

Watersheds
Appalachian Landslide Consultants

600+ Responses
Requests for Landslide Information

230+ Presentations
Realtors, Homebuilders, Planning Boards, Universities, Environmental, Civic, Scientific & Engineering Groups

Landslide Hazard Mapping

Counties
NCGS (2006-2011)

Blue Ridge Parkway

NCGS Landslide Geodatabase

- 3,457 Landslides
- 2,102 Slope Movement Outlines
- 3,200 Debris Deposits
- 410 Ground Rupture Lines
2,100 triggered by August 13-14, 1940 tropical cyclone.

Since 1940: 136 structures, mainly homes, have been built in paths of 1940 debris flows.
NCGS Response to Landslide Events

43 Informational
36 Urgent
7 Emergency

Planning Resources
Geodatabase
Reports
Maps

Landslide Response
Technical Support
Safety Assessment

Data Collection and Analysis
Update Geodatabase

Debris Deposits

Legend
- Process Points
- Shear Movement Outlines
- Known debris flow pathways
- Potential debris flow pathways
- Areas of past debris flow activity

Stability Index
Map Units
Relative Hazard Ranking
- Unstable
- Upper Threshold
- Lower Threshold
- Normally Stable
- Moderately Stable
- Stable
High
Moderate
Low
Rainfall Rate-Duration Thresholds for Landslides on Modified vs. Unmodified Slopes

Unmodified slopes
- Ivan 1940 6 hr max
- Aug 1940 6 hr max
- Gunter Fork

Central Blue Ridge, Virginia
- Nov 1977 2-hr max
- Ivan 2004 6 hr max

San Francisco Bay Area
- Bear Trail 1.2 hr max
- Ghost Town 2-hr max
- Nov 1977 20 hr max
- Ghost Town 18.5 hr max
- Bear Trail 20 hr max

Modified slopes

Rainfall Duration (hr)
0 2 4 6 8 10 12 14 16 18 20 22 24

Rainfall Rate (in/hr)
0 0.5 1.0 1.5 2.0 2.5

Adapted from Wieczorek, et al., 2009
* Gunter Fork Rainfall Data – Duke – UNCA
Frequency and Magnitude of Selected Historical Landslide Events in the Southern Appalachian Highlands of North Carolina and Virginia: Relationships to Rainfall, Geological and Ecohydrological Controls, and Effects

RM Wooten, AC Witt, CF Miniat, TC Hales, JL Aldred
Cooperative Research Partnerships

- Colorado School of Mines
- USGS
- NASA – Univ. Maryland
- Univ. OK-Norman

USDA-Forest Service
Coweeta Hydrologic Laboratory
Bent Creek Experimental Forest
Nantahala National Forest

Site testing and monitoring
- Rainfall
- Soil Moisture
- Soil Suction
- Soil Strength

Advancing Multi-scale Landslide Hazard Prediction by Integrating High Resolution Remote Sensing Data and Subsurface In-situ Monitoring
Cooperative Information-Sharing Partnerships

NOAA – NWS
- Landslides - Operational Considerations
- Calls to Action – Landslide advisories in flood and flash flood warnings and watches

National Environmental Modeling and Analysis Center
UNC-Asheville
- Buncombe County Multi-Hazard Risk Tool
- Western North Carolina Vitality Index
  http://www.wncvitalityindex.org

Great Smoky Mountains National Park
Duke Univ. & UNC-Asheville
- High elevation rain gauge network – landslide occurrence

Appalachian State University
James Madison University
NOAA – National Weather Service
USDA-Forest Service
U.S. Geological Survey
Kentucky Geological Survey
NCDENR – NC Geological Survey
VA Dept. of Mines, Minerals and Energy

NCDOT
Geotechnical Unit
Materials & Testing Unit
Opportunities – Needs - Challenges

LiDAR Digital Elevation Models – Nationwide

Cooperative Federal – State Landslide Mapping Program
(not at the expense of STATEMAP funding)
• Landslide Inventories /Geodatabases - GIS
• Landslide Hazard and Risk Mapping

Model Development, Testing, Applications
• Scaling-Up Models
• Rainfall Data - High Elevation Gauges – Rainfall distribution and recharge relationships

Public Lands – Public Safety
• Geohazards: Laws, Regulations, Plan Requirements (NCGS Input into forest plans: Pisgah and Nantahala N. F.)

Private Lands
• Incentives

Public Education
• Earth Science Education
• Understanding Risk