Landslides
High Hazard Dams
Abandoned Mines
Arsenic
Sinkholes
Earthquakes
Coastal Hazards
N.C. Slope Movement – Slope Movement Deposit Database

Slope Movement vs. Slope Configuration
(including 409 Aug. 1940 Deep Gap Debris Flows/Slides)

- Unmodified
- Modified

N=798

Slope Movement vs. Slope Configuration
(excluding 409 Aug. 1940 Deep Gap Debris Flows/Slides)

- Unmodified
- Modified

N=389

Online at:
http://www.nconemap.com

June 2006 - 2000+ Entries
Recurring Weather Patterns
July 15-16, 1916 Flood

http://www.photolib.noaa.gov/historic/nws/nwind13.htm

Asheville

ASHEVILLE, UNDER WATER: THE GREAT FLOOD OF 1916
A major flood of the French Broad River leaves 5 feet of water and mud in the Southern Railway depot July 16, 1916. Six died in Asheville, and damage exceeded $3 million.

NORTH CAROLINA COLLECTION, UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL
“Approximately 5,376,548,571 gallons of water changed hands.”

S.W. McCallie

~ 298,938 cfs ~ 50 mph

2.1 mi. - Wintergreen Falls

5.7 mi - Lake Jocassee

6.9 mi - N.C. / S.C. Line
To calculate velocity (Chen, 1987):

$$ v = \left[ g \, r_c \, \tan \beta \, \cos \delta \right]^{1/2} $$

where:
- \( v \) = mean velocity in direction of flow
- \( g \) = gravitational acceleration
- \( r_c \) = centerline radius of curvature
- \( \beta \) = superelevation angle
- \( \delta \) = channel gradient

To calculate discharge (Fetter, 1994):

$$ d = v \, A $$

where:
- \( d \) = discharge
- \( v \) = mean velocity in direction of flow
- \( A \) = cross sectional area of debris flow
OUTFLOW

Velocity
~50 mph

Discharge
~298,938 cfs
erosional contacts

imbricated boulders

87,500 yd³ boulder deposit
Deep Gap Debris Flows  Watauga County
August 10-17, 1940

Watauga County  Shaded Relief Map
August 28-31, 1940
Cullowhee, Caney Fork, Canada – Jackson County
Landslide Fatalities:
Albert McCall and two children, Vessie Mathis
*Sylva Herald – Lynn Hotaling*
Lands Creek Debris Flow
December 23, 1990

18,000 ft³/sec

13,800 ft³/sec

Velocity ~23 mi/hr (10 m/sec)
Superelevation Angle = 13°
Scour Line
Top of Deposit

Velocity ~10 mi/hr (4.5 m/sec)
Superelevation Angle = 2.5°
Scour Line
Top of Deposit

Scour - Erosion
Erosion > Deposition
Deposition > Erosion
(~10,000 cubic yards of transported debris)
Lands Creek Debris Flow I

Dec. 23, 1990
Swain County
Frances & Ivan

- 140+ Slope Movements
- 5 Fatalities
- 27 Homes Destroyed

Landslides triggered by Hurricanes Frances and Ivan
September 2004
Blue Ridge Parkway
Hurricane Frances
Embarkment Failure–Debris Flow

Photos Courtesy
USFS and NPS
Peeks Creek Debris Flow

- Debris slide began near top of Fishhawk Mtn. (elev 4,420’).
- Mobilized into debris flow.
- Traveled ~2.25 mi to the Cullasaja River.

When:
10:10 p.m. Sept. 16, 2004 Hurricane Ivan.

Damage:
- 5 people killed
- 2 seriously injured
- 16 homes destroyed
- Bridge and road destroyed
Debris Flow Deposits
New and Old

$^{14}$C 23,260

$^{14}$C 370 - 390

Cross Section K-K'
Peeks Creek, Macon County, NC
October 27, 2004

View looking upstream
Velocity and Discharge

<table>
<thead>
<tr>
<th>Section</th>
<th>Velocity (mi/hour)</th>
<th>Discharge (ft³/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>K-K'</td>
<td>20.3</td>
<td>27,700</td>
</tr>
<tr>
<td>A-A'</td>
<td>29.4</td>
<td>22,900</td>
</tr>
<tr>
<td>C-C'</td>
<td>31.3</td>
<td>26,600</td>
</tr>
<tr>
<td>E-E'</td>
<td>22.0</td>
<td>24,700</td>
</tr>
<tr>
<td>G-G'</td>
<td>26.8</td>
<td>20,800</td>
</tr>
<tr>
<td>H-H'</td>
<td>33.2</td>
<td>72,200</td>
</tr>
<tr>
<td>T-T'</td>
<td>19.7</td>
<td>103,000</td>
</tr>
</tbody>
</table>

Peeks Creek Debris Flow
Velocity and Discharge Values

Gullusaja River
Fishhawk Mountain
June 15, 1876

LiDAR
Light Detecting And Ranging
6m pixel resolution
Macon County Pilot Study

Legend
Slope Movements
- Deposit
- Process

Updated: June 21, 2006

Scale
Stability INdex MAPping
Pack, Tarboton, Goodwin, 1998

Macon County SINMAP Rev.2 - LiDAR

SINMAP Stability Index Map Units
- **Defended**: Cannot model stability with given parameters.
- **High**: Optimistic upper range of values needed for stability. PFS ≤ 1 > 50%
- **Moderate**: Pessimistic lower range of values needed for instability. PFS ≥ 1 > 50%
- **Quasi-stable**: Range of values cannot model instability. Minor destabilizing factors can lead to instability.
- **Moderately stable**: Range of values cannot model instability. Moderate destabilizing factors can lead to instability.
- **Stable**: Range of values cannot model instability. Significant destabilizing factors can lead to instability.

Deposit
Undiff. Movement
Composite
Weathered-Rock Slide
Debris-Earth Slide-Flow
Creep
Rock Fall-Rock Slide

n=105

7% 3%
12% 12%
54%
Soil Properties in Debris Flow Initiation Zones
Debris Flow Hazard Zone Map
Acknowledgements

- County Planning – GIS Groups
- State – Local Emergency Management
- N.C. Floodplain Mapping Program
- NCDOT
- National Weather Service
- N.R.C.S.
- U.S. Forest Service
- U. S. Geological Survey
- U.S. Park Service
- James Madison University
- N.C. General Assembly