USGS Seminar – Landslide Monitoring Preliminary Report
Atlantic Highlands Borough Hall
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Meeting Notes taken by Carolyn Broullon

Spring and late summer are historically when these slides occur. Deep slides are 100s of feet and small slides are 1-10 feet. As our hills are sandy soil not bedrock, plantings of certain types of trees will not help. A combination of short in height, deep rooting, native NJ trees and shade loving ground cover will help best. Terracing or creation of any flat surface exacerbates the landslide probability. Re-foresting and re-vegetating is key as most slides happen where no trees or other vegetation is present.

Block A [Ocean Boulevard Bridge above the Henry Hudson Trail] deep landslide was in 1782. Block B [Mt. Mitchell Scenic Overlook] deep slide was in 1970. Current geologist suggests there is a higher danger of slides in the future. There have been multiple small slides from 2000-2014. When we have a significant continuous rainfall event resulting in over 4 inches of rain, landslides are more probable.

QPF [Quantitative Prediction Forecast] products were installed at Blocks at A [1] and B [2]. These monitoring sensors are described in the following pages. Approximately 8 mm of movement was recorded by a cable extension transducer (CET) at the Ocean Boulevard Bridge (OBB) site between September 10, 2015 [when it was installed and programmed], and July 31, 2016.

The total station survey targets were installed on June 12, 2015 on the Mount Mitchill Scenic Overlook slope and on September 11, 2015 at the OBB site. Our survey hub (the location the total station is set up on) was disturbed by activities along the Henry Hudson trail at the OBB site, so surveying data there are only reliable between May 24, 2016 and present.

Formation of a Geologic Hazard Abatement District was encouraged. Information on California's GHAD can be found here: http://www.conservation.ca.gov/cgs/rghm/Pages/haz_abatement.aspx

A more detailed report is due to be published in June of 2017.

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Landslide Monitoring in the Atlantic Highlands Area, New Jersey

Landslides in the steep coastal bluffs of the Atlantic Highlands and Highlands, NJ have been recurring, episodic events since 1782. Recent landslides have occurred in this area during large storm events with exceptionally heavy rainfall (Figure1). These landslides have resulted in extensive damage to residential property and local infrastructure and threatened human lives.

Documented landslides in the area (Figure 1 and 2), consist of shallow debris-, and earth-flow types as well as deep-seated rotational slumps (Minard, 1974). Landslides of these types can be triggered on unstable slopes by intense and/or sustained rainfall, rapid snowmelt and changes in groundwater levels. Increased pore-water pressure has been shown to reduce soil shear strength and initiate movement, but landslide size, speed and potential destructiveness can vary widely. Deep-seated landslides can move very slowly, but shallow landslides can commence suddenly and accelerate rapidly prior to termination.

Figure 1. Photographs of three recent shallow landslides in Atlantic Highlands, NJ; A. May 2012 landslide, B. April 2014 landslide, C. One of three landslides in Highlands that occurred during Tropical Storm Irene in August 2011.

Prior research by Minard (1974) provided a general understanding of landslide initiation mechanisms in the Atlantic Highlands area, but the critical relationship between rainfall, pore-water pressure and landslide movement has not been determined. The U.S. Geological Survey is currently monitoring hillslopes within the Atlantic Highlands area of NJ to better understand the hydrologic and meteorological conditions associated with shallow landslide initiation.

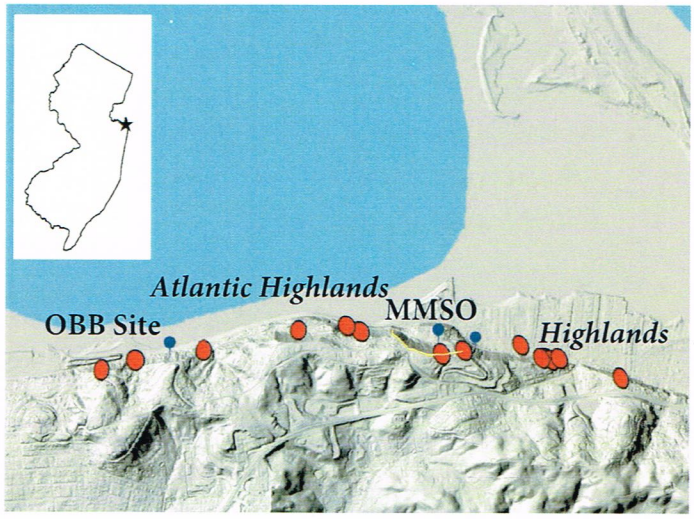

Figure 2. Shaded relief map of the Atlantic Highlands area, New Jersey, showing historical shallow landslides (red circles; NJDEP, 2016), and locations of Mount Mitchill Scenic Overlook (MMSO) and Ocean Boulevard Bridge (OBB) monitoring sites (blue circles).

Current Landslide Monitoring Sites

USGS landslide monitoring efforts within the Atlantic Highlands area currently focus on collecting data on rainfall, soil moisture, and groundwater conditions that could potentially destabilize a hillslope.

Two historical landslide locations within the Atlantic Highlands area (figure 2) are currently being continuously monitored by the USGS. The amount of

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downslope movement is recorded by a cable extension transducer that can detect movement and ground deformation. Groundwater and soil moisture conditions on the hillslopes are monitored by vibrating wire piezometers and soil moisture sensors, respectively. On-site rain gauges record rainfall in both forested and open areas. Data are collected continuously and recorded every 15 to 60 minutes.

Scientists at the USGS hope that monitoring these hillslopes will help define the hydrologic processes that trigger landslides by:

- **Evaluating the seasonal response of soil moisture and pore-water pressure to storms of varying duration, intensity and cumulative amounts.**
- **Identifying the role of antecedent soil moisture conditions and groundwater levels on landslide susceptibility, and**
- **Quantifying the amount of rainfall that results in land movement on hillslopes.**

For More Information Contact:
Francis Ashland
U.S. Geological Survey
Landslide Hazards Program
703-648-6923
fashland@usgs.gov

Pamela Reilly and Alex Fiore
U.S. Geological Survey
New Jersey Water Science Center
609-771-3900
jankowsk@usgs.gov, afiore@usgs.gov

For more information or to report a landslide online visit the USGS Landslide Hazards Program webpage at:
http://landslides.usgs.gov

Potential for a Landslide Forecasting Network

The ultimate goal of this work by the USGS Landslide Hazards Program and the USGS New Jersey Water Science Center is to help protect lives and property from potential landslide hazards.

A primary objective of this study is to incorporate data obtained from the ongoing monitoring on hydrologic response and movement during major storms into a regional landslide movement forecast model. The ongoing monitoring provides critical insight into the hydrologic controls on landslide movement that is essential for forecasting. Ultimately this data will also be used to assess the feasibility of setting up a landslide early warning system.

Warning the public of potential or impending landslide hazards will require a concerted effort by local, state, and federal agencies to inform the general public about these hazards. The immediate detection of critical hydrologic and meteorological conditions provided by real-time systems can be crucial in making timely decisions about safety during and after storm events. A future real-time landslide monitoring network could be set up to alert and transmit data directly to emergency managers and other officials.

Real-time systems can be crucial in saving lives and protecting property. Traditional field observations, even if taken regularly, cannot detect changes as they occur.

References

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New Jersey Department of Environmental Protection, New Jersey Geological and Water Survey (NJGWS), Landslides In New Jersey, Series DGS06-3, Available online at: http://www.state.nj.us/dep/njgs/geodata/dgs06-3.htm

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USGS Authors
Pamela Reilly, Francis Ashland, Alex Fiore