UNIVERSITY OF PITTSBURGH | SWANSON SCHOOL OF ENGINEERING | CIVIL & ENVIRONMENTAL

Exploring Approaches to Managing Landslide Risks

Summary Report

November, 2019

IRISE Consortium

Impactful Resilient Infrastructure Science and Engineering

PITT | IRISE

Technical Report Document Page

1. Report No: IRISE-19-P20-01-01	2. Report Date: November, 2019
3. Report Title: Workshop: Exploring Approaches to Managing Landslide Risks Summary Report	4. Authors: Dr. Anthony Iannacchione, Emily Adelsohn, Nathan Buettner, James Bumstead, Taylor DaCanal and Charles Donnelly
5. Performing Organization Name and Address: Department of Civil & Environmental Engineering 742 Benedum Hall University of Pittsburgh Pittsburgh, PA 15261	6. Sponsoring Organization Name and Address: IRISE: Department of Civil & Environmental Engineering 742 Benedum Hall University of Pittsburgh Pittsburgh, PA 15261
7. Abstract: With the proliferation of landslides impacting transportation systems in western Pennsylvania, PennDOT Districts 11 and 12, the Central Office, FHWA and other members of the IRISE consortium identified the need for a forum to discuss recent/ongoing activities. The workshop aimed to develop consensus on needed landslide research and development activities that will help state and local transportation systems direct their limited resources to the highest risk problem areas. The design of the workshop stressed current work to identify, anticipate, and remediate landslides. It provided an opportunity to share experiences and discuss best practice approaches. In the end, a discussion of future needs helped to prioritize activities and focus on the best use of available technology and resources to mitigate this critical regional problem. 121 individuals representing over 40 organizations in the public, private and academic sectors participated in the workshop. Presentations during three workshop sessions addressed the following topics: Historical Perspective and Identification, Prediction, Remediation & Prioritization, and Managing Risks. The workshop concluded with a discussion of future needs by a panel consisting of leaders of western Pennsylvania government and academic institutions.	
8. Key Words: Landslides, Landslide Prediction, Landslide Remediation, Geohazards, Geotechnical Asset Management, Weather Vulnerability, Landslide Risk Management	9. Distribution: Report available at: https://www.engineering.pitt.edu/IRISE/Research-Projects/Completed/

Workshop: Exploring Approaches to Managing Landslide Risks Summary Report

November 2019

Authors

Anthony Iannacchione, Ph.D., *University of Pittsburgh*; Emily Adelsohn, *University of Pittsburgh*; James Bumstead, *University of Pittsburgh*; Nathan Buettner, *University of Pittsburgh*; Taylor DaCanal, M.S., *University of Pittsburgh*; and Charles Donnelly, *University of Pittsburgh*.

Technical Reviewers

The report was reviewed by those who made presentations or served on the closing future needs panel: Amit Acharya, Carnegie Mellon University; William Beaumariage, PennDOT District 12; Ryan Gordon, Southwest Pennsylvania Commission; James V. Hamel, Hamel Technical Consultants; Ken Heirendt, Pennsylvania Turnpike Commission; Brian Henzl, Gannett Fleming; Vikas Khanna, University of Pittsburgh; James Martin, University of Pittsburgh; Cheryl Moon-Sirianni, PennDOT District 11; Jonathan Moses, PennDOT District 11; Dennis Neff, PennDOT Central Office; Eric Setzler, City of Pittsburgh; Stephen Shanley, Allegheny County Department of Public Works; Joe Szczur, PennDOT District 12 and Doug Zimmerman, PennDOT Bureau of Planning and Research.

IRISE

The Impactful Resilient Infrastructure Science & Engineering consortium was established in the Department of Civil and Environmental Engineering in the Swanson School of Engineering at the University of Pittsburgh to address the challenges associated with aging transportation infrastructure. IRISE is addressing these challenges with a comprehensive approach that includes knowledge gathering, decision making, material durability and structural repair. It features a collaborative effort among the public agencies that own and operate the infrastructure, the private companies that design and build it and the academic community to develop creative solutions that can be implemented to meet the needs of its members. To learn more, visit: https://www.engineering.pitt.edu/irise/.

.

Acknowledgements

The authors gratefully acknowledge the financial support of all contributing members of IRISE. In addition, we are indebted to the advice and assistance provided by Dr. Julie Vandenbossche, Mr. Gary Euler and the IRISE Steering Committee.

Disclaimer

The views and conclusions contained in this document are a fair and accurate representation of the discussion at the workshop and should not be interpreted as representing official policies, either expressed or implied, of the Pennsylvania Department of Transportation, the Pennsylvania Turnpike Commission, Allegheny County, Golden Triangle Construction, Michael Baker International or the University of Pittsburgh.

Table of Contents

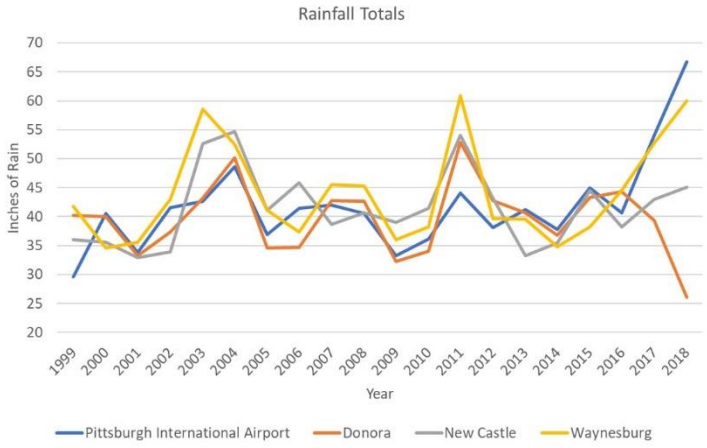
`STATEMENT OF PURPOSE

IRISE (Consortium for Impactful Resilient Infrastructure Science and Engineering) was established in the Department of Civil and Environmental Engineering at the University of Pittsburgh to develop solutions to transportation infrastructure durability and resiliency problems. With the proliferation of landslides in western Pennsylvania, PennDOT Districts 11, 12 and the Central Office, FHWA and other IRISE consortium members identified the need for a forum to discuss recent/ongoing activities. IRISE is singularly poised to address this naturally occurring hazard that impacts transportation, housing, development and more, especially as extreme weather presents a greater threat each year to an already overburdened infrastructure. Our goal for this inaugural workshop is to build consensus toward needed landslide research and development activities that will help state and local transportation systems direct limited resources to the highest risk problem areas.

SO WHAT'S THE PROBLEM?

1. Southwestern PA is a land of relief, covered with slopes, many at their angle of repose. Wikipedia states that the native Indian word for Monongahela, Unami, means "falling banks", in reference to the geological instability of the river's banks.
2. The strata cropping out within these slopes contains a high percentage of weak claystone and shales that weathered into colluvial, unstable soil.
3. Our region contains very diverse forms of landslides, ranging from rotational slump features to debris flows. Some move rapidly and unexpectedly like rock falls to creeping or flow soil. All of these various forms require different monitoring and repair strategies. So, there is no 'one response' fits all landslide occurrences.
4. The last glacial episode in our region helped to produce landslides. These old/ancient landslide areas are recognized by their extensive hummock ground caused by earthflow and earth and rock slumps. They often lack clear evidence of active sliding. Relatively stable in natural, undisturbed state, old landslides can be re-activated by excavations, surcharge loading, or changes in groundwater and surface water conditions.
5. As our region has grown and developed, civil works (Roads, buildings, etc.) have covered the surface, disturbing the slopes and altering water drainage patterns.
6 Southwestern PA is known as a major center for energy development. As such, the abundant occurrence of both oil and gas and mining operations can, and have, disturbed the stability of surface slopes.
7 Recently, there has been an increase in precipitation over the last decade. 2018 produced record amounts of precipitation at the Pittsburgh Airport and Waynesburg stations (see figure below).


New Castle
District 11
Pgh Airport
Donora
District 12
Waynesburg


Rainfall Totals
Inches of Rain
70
65
60
55
50
45
40
35
30
25
20
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Year
Pittsburgh International Airport
Donora
New Castle
Waynesburg

WHO SIGNED-UP FOR THE WORKSHOP

One-hundred and twenty-one persons signed up for the workshop. Approximately 20 persons didn't attend the workshop. Fifty-four from civil engineering companies, forty-four from government, and twenty-one from local universities.

Organization	Total	Government	Academia	Industry
A&A Consultants	3			3
Ackenheil Engineers	2			2
AECOM	1			1
Allegheny County	6	6		
American Geosciences	1			1
American Geotechnical & Environmental Services	4			4
Borough of Heidelberg	1	1		
Borton-Lawson	2			2
Carnegie Mellon University	1		1	
Carnegie Museum of Natural History	2		2	
City of Pittsburgh	2	2		
Civil & Environmental Consultants	2			2
D'Appolonia	2			2
DiGioia Gray & Associates	3			3
FHWA	2			2
GAI consultants	5			5
Gannett Fleming	2			2
GeoBuild	1			1
Geostabilization International	3			3
Hamel Geotechnical Consultants	1			1
HW Lochner	1			1
Kent State University	1		1	
Lochner	1			1
Michael Baker International	3			3
ms consultants	1			1
Navarro & Wright	2			2
North Huntingdon Township	2	2		
Office of Surface Mining and Reclamation	3	3		
P. Joseph Lehman	1			1
PA Dept. of Environmental Protection	9	9		
PA Turnpike Commission	5	5		
PennDOT	16	16		
Pennsylvania Soil and Rock	1			1
Red Swing Group	1			1
Sci-Tek Consultants	2			2
SPC	1			1
SPK Engineering	1			1
Stahl Sheaffer Engineering	2			2
Tetra Tech	1			1
University of Pittsburgh	17		17	
USDA/NRCS	1			1
Vibra-Tech Engineers	1			1
None	2			
	121	44	21	54
	%	36.4%	17.4%	44.6%
	Count	8	4	29

WHAT WAS DISCUSSED*

**Caveat – Presentations, questions, and responses were written without electronic equipment or recording devices and are therefore an interpretation of actual statements. In addition, these statements have been edited to improve readability.*

Session 1 – Historical Perspective & Identification

Presentation 1: Four Famous Historic Landslides of the Pittsburgh Area - James Hamel

Landslides in the Pittsburgh area result from geology, topography, climate, and history. Together these factors have produced masses of marginally stable colluvium (loose, unconsolidated sediments) on many hillsides. These masses are often re-activated by heavy precipitation and/or construction activities, i.e., toe excavation, fill placement, surface and subsurface drainage changes. Extensive Pleistocene age rock slide remnants and associated colluvium were not recognized during investigation and design of a section of Interstate Route 79 (I-79) north of the Ohio River in the 1960's. When the toes of old slide masses were excavated during construction in 1968-69, these slide masses were reactivated for a distance of a mile along the valley wall. Large quantities of slide debris were excavated to stabilize slide masses. Portions of these slide masses have been creeping ever since but pose no threat to the highway. Site grading for a commercial complex in Kilbuck Township on mile southeast of the I-79 slide area involved placement of extensive fill over unrecognized colluvium. In September 2006, a landslide 1,000 ft wide and extending 600 ft upslope dumped 500,000 cubic yards of material on four lanes of Pennsylvania Route 65 and two of three railroad tracks between this road and the Ohio River. The road was reopened in two days and railroad one day later. Portions of the slide continued moving until at least 2012.

Presentation 2: PennDOT Extreme Weather Vulnerability Study - Doug Zimmerman

A study to examine the impact of extreme weather was initiated in 2017. The study contained 10 years of data including flooding on PennDOT roads, FEMA floodplain maps, and NOAA weather data. It focused primarily on flooding concerns but also included the secondary effects of landslide failures. A risk assessment was developed for these assets based on the categories of exposure, sensitivity, and consequence. This data is currently being utilized to update design guides and inform future hydrologic and hydraulic studies. In the future, this study hopes to: 1) include missing data sources; 2) utilize asset management strategies for the identified slides; 3) assess prediction and prioritization methods; and 4) examine appropriate mitigation strategies.

Presentation 3: Landslide Susceptibility GIS Model for the SPC Region - Ryan Gordon

There has been a large financial impact of landslides on transportation. There are currently about 70 million dollars spent in landslide remediations. SPC estimates there are 123 active landslides in District 11 and 250 in District 12. They estimate it would cost almost 350 million dollars to remediate. New federal standards stress the importance of improving civil development resilience. SPC's GIS-based platform was developed to assess the vulnerability of the current transportation system. Many factors are considered including groundwater and rainfall data necessary to trigger landslides for the SPC Region.

Presentation 4: Allegheny County Landslide Portal - Steve Shanley and Eli Thomas

Allegheny County created a web-based landslide portal to be used as a tool to help municipalities prepare for and deal with the landslide problem. The portal provides background information of causes and types of landslides. It also included examples of warning signs and preventive maintenance, as well as guidelines/ordinances for maintaining streams and steep slopes. The Allegheny County landslide portal (http://bit.ly/LandslidePortal) also contains an interactive map with the locations of recent and historic landslides.

Questions:

1. Was the fill compacted properly for Kilbuck site?
2. Addressing slides before they take out a traffic lane can greatly simplify design and reduce costs by ~50%. This could reduce the contracting as well as negating the need for a GC in many cases.
3. How were the soil properties developed for the GIS model? Is regional geology and deposition considered?
4. Education is key, what can educators do to better prepare our students so incidents like the Kilbuck landslide are not repeated?
5. Is there a list of longitude and latitude locations/dates reported for the 911 and DPW landslides that is publicly available?
6. Making landslide data available to municipalities is great, but are there any safeguards in place to ensure the resource is used?
7. Why are permits only environmental and not related to geologic hazards prior to development approval?
8. The biggest limitation I have seen with GIS landslide susceptibility models is that inevitably they seem to reproduce some broad generalizations (i.e. - all steep slopes in stream/river valleys are highly susceptible). Are there any future plans to refine these models to better help asset managers/planners make specific decisions like the location of mitigation measures?

9. Can/Should GIS data be used by municipalities to limit development or remediation (relocate people/close streets) to reduce current and future financial burden of landslide prone areas?
10. Why have owners/developers been allowed to dictate the extent of subsurface investigation?
11. Is data from TPC boreholes drilled throughout the state available in a data set?

Summary of Question Answers:

- The geotechnical community needs to learn about past landslide failures and methods of remediation that are generally effective to ensure that problems are not repeated. Education should begin with students at colleges, but it is also important to remember that engineering requires lifelong learning.
- Soil data gathered and incorporated into the GIS models is available to the public through USGS
- A list of locations (longitudes and latitudes) of past and current landslides is being compiled. While this list is not yet available to the public, it should be made public in the future.
- Permitting for development in landslide prone areas is an issue that will need to be addressed moving forward. Allegheny county does not have the ability to force municipalities to create restrictions on development but urges the development of safeguards.
- As engineers, we must stress to our clients the importance of thorough subsurface investigations to ensure that we are getting enough data to make sound design decisions.

Session 2 – Prediction, Remediation, and Prioritization

Presentation 1: Toward Landslide Forecasting from Images and Mechanics - Amit Acharya

Over the past year, there has been record rainfall in the Pittsburgh area which has greatly contributed to an increase in landslide failures around pavement structures. At-risk roads that have the potential to fail can be characterized by existing pavement cracking, overturned guide rails, and visible flooding and debris accumulation. However, since this is a widespread problem, there is not enough funding available to efficiently locate at-risk sites and perform required structural analyses. This presentation proposed the use of 2D images that are collected by vehicles equipped with a series of cameras to quickly collect visual data of the Pittsburgh area. Using machine learning and computer vision technologies, a large database of 2D images can be used to then locate signs of landslides. Once located, a 3D image can be developed for further visual analysis and used to monitor the change in slope conditions. These images can also be incorporated into both limited equilibrium and cohesive-zone based finite element failure analysis including available geologic data, to assess the structural integrity of the surrounding area and determine its landslide potential.

Presentation 2: Landslide Impacts to Infrastructure - Brian Heinzl

Landslide failures have had a detrimental impact on Pennsylvania infrastructure, particularly roads and their adjacent slopes. This presentation summarized the current practices for slide mitigation and repair/retrofit strategies. In doing so, information on the critical items considered during the repair and their economic impact were discussed. The first steps is a site visit where the surrounding soil and bedrock, the presence of water and its flow patterns, and critical structures are assessed. During this time, it is also important to note the presence of colluvial slopes, mine subsidence, and weak and weathered claystone. After this, an assessment based on costs and public impact (road closure time and detour length) of the proposed repairs is made. One example of landslide mitigation was provided that described a road closure due to excessive settlement. The implemented repair included removing the existing colluvial material, and constructing a submerged, caisson reinforced wall. To limit the lateral pressure on the retaining wall, lightweight geofoam was used in place of conventional backfill. The typical cost ranking of commonly used, mitigation strategies was presented: **Low-cost** - soil nails, rock embankment, **Mid-cost** - retaining walls and caissons **High-cost** - a combination of low and mid cost strategies. Retaining walls and caissons are typically a last desired option due to their long-term maintenance requirement.

Presentation 3: Rating and Prioritizing Geohazards in District 11 - Jonathan Moses

Given the limited funding and resources availability to address the significant amount of at-risk or existing landslide failures, it is paramount to have an effective hazard rating system in place in order to prioritize remediation projects. In this presentation, District 11 spoke on

their current prioritization procedure for ranking landslide severity to assess remediation importance. First, each landslide or at-risk site, is mapped and entered into a database, based on its location. Beaver and Allegheny county were quickly determined to be the most common locations. Then, within a master, Excel SpreadSheet, various site parameters are documented and an impact assessment is made. Typical site parameters included, Average Annual Daily Traffic (AADT) of the road, length of damaged roadway, roadway status (open, closed, limited access), and surrounding area. The latter takes into account the critical buildings in proximity and public concern, such as if the road is on a school bus route, or if its closure will result in severe isolation of the surrounding area. A numerical value is applied to each category and then totaled finally sorted into a low, medium, or high priority classification. In this way, the highest priority landslides can be remediated first. One challenge noted was the lack of a yearly metrics. For example, there are stated goals for number of repairs for roads or bridges. No such goal exists for landslides. Perhaps this is due to uneven distribution of landslides in different PennDOT districts.

Presentation 4: Rating and Prioritizing Geohazards in District 12 - William Beaumariage

In District 12, 265 slides had occurred, resulting in 5 road closures, and 58 lane closures. In 2018, 3.6 million dollars of maintenance funds were spent on landslide. The figure in 2019 is already 2.7 million dollars. On average there are 25 new landslides inventoried in District 12 each year; however, in 2018 alone there were 100 new slides due to the record amount of rainfall. To address this, a two-tier approach has been adopted. Often, PennDOT will perform some of the work, with the rest contracted to local service companies. Similar to the previous presentation, District 12 presented their current prioritization method. Each landslide is located in a GIS database the remediation efforts recorded for future analysis. Similar to District 11, criteria included factors like AADT and detour length. Potential environmental impacts to surrounding properties are assessed. Supplementary data was also included in the master SpreadSheet, including links to job site photos, and preliminary costs estimations based on the required repair method. This prioritization process was particularly helpful in unifying data tracking across counties within the district, which previously was noted to vary significantly.

Questions:

1. Is the geohazard inventory and rating systems public? If so, what is the website?
2. Are you aware of a landslide occurring on a previously remediated slope? Are the tools we have enough to fix it for good?
3. Can these images produced from photographs be used to monitor for changing conditions?

4. Were there appreciable cost savings associated with using image forecasting vs simplified 2D modeling?
5. For PennDOT: How are you incorporating your rockfall hazard rating system database into the geohazard lists?
6. Are there discussions that happen surrounding rapid response structural measures (buttress fills, piles, nails, etc.) or invasive drainage measures to "save" a road from an impending landslide or is the design-bid-build project delivery method rigidly adhered to? How are environmental assets considered?
7. Does PennDOT contract with industry for remediation? What has been the most successful remediation efforts for "true landslides" on roadways?
8. Once a slide is remediated, would you continue to monitor? Onsite inspections?
9. Are the cost date design-bid-build or design-build or a mix?
10. Why go with caissons and geofoam rather than a retaining wall or soil nail wall?
11. How would subsurface conditions be modeled for a hard, competent layer underlain by a weak layer? The weak layer such as claystone could be modeled as soil with representative parameters but the stability of the hard rock may be governed by jointing rather than the rock mass strength properties.

Summary of Question Answers:

- The general consensus of the panel was that currently we are in a reactive phase, not necessarily a proactive phase in terms of dealing with the current landslide dilemma. Given the tremendous number of landslide remediation projects, two general remediation strategies are commonly used:
    - Implement repair strategies that are designed with an infinite life, finite life solutions are not ideal
    - Some remediations are only done to put roads back in service. Fixing the landslide itself may not be within the scope unless future ground movements are expected
- Generally, rock slopes and adequate benches yield infinite life solutions. Retaining walls should be a last resort since they're typically finite and require continuous maintenance. Rock slopes are the most preferred solution.
- Most repairs are not continuously monitored, unless the solution was particularly risky with a small factor of safety. Sometimes sites are visited, but most often are monitored through GIS or photologs.
- District 11/12 geohazard rating system is not public though information but can be retrieved upon request. It was also noted that industry contracts were typically performed on a design-build process, with the design work performed by PennDOT.
- The press officer for the districts will have to decide if the geohazard rating system will be able to be released to the public.

- Typically slide sites are not revisited unless a final design was not completed and a temporary fix was used to keep a road open.
- Data associated with rock falls is a current focus at PennDOT, especially in District 11.
- In general, the permitting process is a critical path concern, whereas the remediation design is not.
- Slopes with rock reinforcement (rock boulders) have been successful but it depends on the project. Cassions have been used when the right of way was an issue.
- Continued monitoring is not always done after a remediation because the factor of safety is typically high enough to adequately provide long-term slope stability.
- Most cost data comes from design, bid, build projects.

Session 3 – Managing Risk

Presentation 1: Visioning a Statewide Geotechnical Asset Management Program (GAMP) at PennDOT - Dennis Neff

PennDOT is currently reviewing and analyzing the risk of all its assets. The geotechnical assets include slopes, embankments, subgrade inclusions, monitoring instrumentation, data, and knowledge. The methods of failure include landslides, rockfalls, sinkholes, erosion, scour, subsidence, and settlement. The risks for these failures include safety, service, cost, and loss of confidence. Through the initial survey phase, differences in personnel, geology, assets, and rating methods were discovered across the state. It was also determined that there are hundreds of actively unstable slopes, thousands of marginally unstable slopes, and tens of thousands of possibly vulnerable slopes throughout the state. In order to proceed with Geotechnical Asset Management Program (GAMP), PennDOT is looking to identify a champion within each district and the central office. There is also a need for multidisciplinary teams to facilitate collaboration, training, and oversight activities. Improvements in data collection, retention, and analysis is also necessary to proceed with GAMP.

Presentation 2: System-Level Approaches for Landslide Management and Assessing Economic Impact - Vikas Khanna

This presentation used a system-based approach for mitigating landslide risk. It is recognized that various facets of the infrastructure are interdependent and is therefore detrimental to view specific disasters or parts of the infrastructure as stand-alone issues. Landslides, for example, are often attributed to other disasters, such as major storms, underestimating the damage they cause. A system-level approach accounts for all aspects of infrastructure, taking into account both the indirect and direct costs of landslides. In addition, it provides a method for quantifying risk as a product of consequence, or impact, and frequency. To accurately assess these risks there is a need for more historical landslide data. An ultimate goal is to incorporate accurate risk assessment in regional planning efforts by identifying areas with varying levels of landslide risk.

Presentation 3: Using Risk Based Analysis to Manage Landslide Problems - James Martin

Dean James Martin of the University of Pittsburgh presented on using risk to identify landslide challenges. Due to a number of uncertainties in geotechnical engineering based on soil parameters, a certain level of risk is associated with civil structure. To account for this in design, many have shifted from a deterministic approach using Factor of Safety (FS) to a Reliability-Based Design (Load and Resistance Factor Design - LRFD). Reliability-Based

Design takes into account the probability of failure. As a result, the less uncertainty the more accurate the design. In addition, risks are not always intuitive. The levee failures in New Orleans during Hurricane Katrina was used as an example. In this case, a system-based risk approach showed that building larger storm walls without educating the public generated greater risk because more people lived closer to the levees. This increased the risk associated with failure. In summary, it is important to shift from looking at specific aspects as stand-alone issues and to move towards a system-based process to manage risk. The grand challenge is to take the abstract concept of risk and break it into daily actions.

Questions:

1. Is PennDOT developing a best practice or design manual for preventing and fixing slides?
2. Are there programs in the works to make historical data available for designers?
3. How do you change the mind-set of engineers from the factor of safety to a probability-based system? How long will it take for this mindset to evolve?
4. What are the most important factors to determine who is responsible for a landslide?
5. What are the panels thoughts on managing the true risks vs the perception of those risks?

Summary of Question Answers:

- There are some unforeseen complications with the sharing of data. There may be legal repercussions to sharing historic data with the general public. This needs to be resolved before data is published.
- A probability-based system would be superior to a factor-of-safety-based system since it would incorporate the amount of uncertainty that is part of the design. This type of system is already used in structural design with the LRFD method. Though not significantly more difficult, the probability-based system would be more involved, requiring communication and teaching of these concepts in our colleges.
- Generally speaking, if a landslide occurs on your property, it is your problem. It is also true that a property owner is responsible when the triggering factors came from their property. PennDOT typically takes responsibility for slides if their roads are at the top of the hillside in question.
- The balance of risk and the perception of risk is important. Studies have shown that people perceived the most risk when the media made them amply aware of the problem over other factors such as prior experience, the actual amount of risk, or a personal connection to someone who has been affected by the risk in the past.

Session 4 – Future Needs Panel Discussion

Summary of introductory remarks (Ken Heirendt, Turnpike Commission; James R. Martin, Dean, University of Pittsburgh; Cheryl Moon-Sirianni, District 11 Manager, PennDOT; Eric Setzler, City Pittsburgh; Steve Shanley, Allegheny County; Joe Szczur, District 12 Manager, PennDOT;

Panelist #1

There has been an increase in landslide occurrences, but this crisis can be an opportunity to learn and change the future. Although there is little to be done with existing roads, there is a chance to design new roads that mitigate landslide risk. Minimizing risks focus on reduce the likely of occurrence by knowing what the properties are and applying the appropriate knowledge. Accepting the risk is reactive, not proactive. As such, knowing risk is crucial to minimizing it. Uncertainty reduces the accuracy of the risk assessment, and simply increasing the factor of safety is not a viable solution.

Panelist #2

It is important to study historical data to understand trends moving forward. Models of climatic data show that there is a greater density and severity of major storms north of the equator. This change, caused by increasing ocean temperatures, will likely lead to increased rain in the Northeast section for the United States. As such, it is important to view major weather events not as a stand-alone issue, but instead as an emerging trend.

Panelist #3

Everyone seems to be working independently on the same thing, such as risk assessment and landslide mapping. It would be advantageous to pool resources, and be cognizant of what information can be made public. In addition, appropriate funding is a major facet of effective landslide management. It would be beneficial to discuss new technology more in the future.

Panelist #4

Funding is an issue. Funding requests for landslides remediation has grown drastically since 2015. It is important to bear in mind many older sections of Pittsburgh are built on hillsides that are susceptible to landslides. One way to manage risk in those areas may involve purchasing properties, which is not popular with the public. Similarly, is it justifiable to spend millions of dollars to save single property on a road damaged by landslides? Closing roads may be the best solution, but is also difficult to discuss with the public.

Panelist #5

Funding is needed across the board, which would help manage and respond to landslides. In addition, collaboration across the board would aid in the flow of information and data.

Panelist #6

Funding is based on an old formula which distributes money to a variety of maintenance needs. It could be beneficial to revisit idea of getting geotechnical factored into maintenance formula. In addition, it is clear that landslides are the results of a number of factors, not a single source. Therefore, it would be beneficial to have a "recipe book" for agencies on how to address present issues. With the high rainfall totals, local areas are experiencing larger and more frequent landslides. This may become the new normal. Lastly, landslides may impact how we design pavement structures based on failure experiences. For example, manufactured fills have failed on various interstate and state roads. More assessment may not only impact the way we manage landslides but also how we design structures to mitigate failure.

Questions:

1. What are the action items we should take away from this workshop?
2. How have practices and designs changed overtime? Could current landslide problems be due to poor design decisions years ago. Could remediation efforts be designed to survive 100 years?
3. What can government agencies do to help the consultants working on landslide problems?
4. We're close to having two years of record rainfall, what was the precipitation in the glacial records? Rainfalls values seem to be close to periglacial times
5. Do we need to educate the public better and if so how?

Summary of Question Answers:

- The panelists feel that a series of action items should be taken away from this workshop. A best practices manual is needed for different landslide types and their associated remediation activities. New and creative solutions are needed to work around limited right-of-way and avoid nearby railroads and utilities. They also felt that criteria are necessary for analysis of geotechnical conditions during the permitting and development process.
- Revisit new construction design standards for slopes because recent experience has found that newly constructed slopes, designed according to decade old standards, are failing both during construction or shortly after.
- Educating municipalities and local governments was stressed.
- Due to budget restraints, landslide failures are often fixed with Band-Aids type solutions rather than long-term solutions. This means that the same areas may continue to move, requiring multiple remediation efforts.

- The consultants also had a series of suggestions of ways the government agencies can help with the landslide problems. They felt that identifying the problem areas early will make it easier to create cost effective solutions. Additional collaboration and data sharing between practitioners, consultants, contractors, academics, etc will help develop better outcomes.
- The amount of rainfall that experienced in the last two years is approaching the rainfall values that were seen in Periglacial times (after the last retreat of the glaciers in this area).
- The education of the public has been found to be a difficult process. PennDOT has tried but found the public only seems to care about landslides when it affects them personally. The agencies should focus more on educating the elected officials because they have the ability to supplement funding for remediation.
- We need to develop more proactive approaches.
- The increased use of technology, such as drones and advances in surveying methods, should be important look at during future conference and studies.
- The issue of insufficient funds will always be a problem so items will have to be prioritized to determine if it is worth saving a property or if that property should be purchased.
- Deep seated landslides are often associated with years elevated rainfall events whereas shallow landslides are more associated high rainfall over a few days.
- A "recipe book" on different types of remediation efforts and how to permit emergency landslide projects is needed.
- Not all landslides need a 100-year fix. There isn't enough money.
- Earlier agency involvement often leads to more cost-effective solution.
- Developing shared database would lead to more collaboration between contractors, consultants and government agencies.
- More rainfall events with higher totals should be expected in the future
- A fix involving increased funding for landslides can't be at the expense of other transportation needs
- More technology is needed
- "Best Practice" manual is needed
- The best way to mitigate landslide risk may be to close roads/purchase properties (very difficult to implement)
- Move away from a dependence on factor of safety analysis and adopt more probabilistic based design approaches
- The primary objective needs to be focused on getting roads back in service
- Landslide data systems are being developed in silos, independent of each other
- There should be a focus on educating local municipalities
- Risk management approaches need to be expanded and unified so that actions can be prioritized

- Shouldn’t we, as a professional community, help to educate the public about the landslide problem, and, if so, how should we do this?

University of Pittsburgh

Swanson School of Engineering
Department of Civil and Environmental Engineering
IRISE Consortium
742 Benedum Hall
3700 O'Hara Street
Pittsburgh, PA 15261