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THE NEED FOR ADDITIONAL LANDSLIDE REGULATION: EXAMINING FLOODING THROUGH A CASE STUDY

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INTRODUCTION

Natural disasters are increasing at an alarming rate.[1] As of this writing, the top five deadliest disasters occurred after 1970, and the top five most economically devastating occurred in the years since 2005, with three of them occurring in 2017.[2] These increasing storms are exacerbated by the worsening of climate change and global warming.[3] The problem will continue to increase if federal and state governments fail to properly regulate and prepare for these natural disasters. This Note will specifically discuss the regulation and prevention of landslides by comparing them to the regulation of flooding. Other examples of natural disaster regulation that this Note will not discuss include building codes for earthquake protection and wildfire prevention regulations in the west.[4]

This Note will focus specifically on regulating landslides for three reasons. First, hurricanes and storms are the natural disasters increasing the most due to climate change, so it is imperative to address government shortcomings in this area before damage to infrastructure caused by these storms is irreparable.[5] Both flooding and landslides will worsen

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[1] Daniel Pavlinovic, *Climate and Weather Related Disasters Surge Five-Fold over 50 Years but Early Warnings Save Lives—WMO Report*, U.N. NEWS (Sept. 1, 2021), https://news.un.org/en/story/2021/09/1098662 [https://perma.cc/LJU6-B8U5].

[2] *Weather-Related Disasters Increase over Past 50 Years, Causing More Damage but Fewer Deaths*, WORLD METEOROLOGICAL ORG. (Aug. 31, 2021), https://public.wmo.int/en/media/press-release/weather-related-disasters-increase-over-past-50-years-causing-more-damage-fewer [https://perma.cc/Y6HA-VXW8].

[3] *Id.*

[4] *Seismic Building Codes*, FEMA (Apr. 9, 2022), https://www.fema.gov/emergency-managers/risk-management/earthquake/seismic-building-codes [https://perma.cc/X33R-G6ZZ]; *see* NAT'L FIRE PROT. ASS'N, COMMUNITY WILDFIRE SAFETY THROUGH REGULATION: A BEST PRACTICES GUIDE FOR PLANNERS AND REGULATORS 1 (2013).

[5] Matthew Cappucci & Jason Samenow, *Study Finds Atlantic Hurricanes Becoming More*

because of these storms.[6] Additionally, landslides happen in all fifty states which cannot be said about other natural disasters such as hurricanes and earthquakes.[7] Similarly, flooding also occurs in all fifty states which makes possible regulation comparable.[8] Landslides often go overlooked because they are, thankfully, rarely deadly, with twenty-five to fifty people dying every year from landslide events compared to higher rates in hurricanes and earthquakes.[9]

Second, there are clear adjustments that can be made to fix these problems and make the effects of the storms manageable, rather than tackling a much larger issue such as the regulation of a hurricane. Hurricanes themselves, of course, come with high winds and rain that often immediately put people in danger during the event. However, a lot of damage can actually occur once the storm has already passed in the form of landslides caused by excessive rainfall.[10]

Lastly, landslides often go overlooked, which explains the lack of resources, regulation, and information on the subject.[11] This exposes a gap in potential harm that can be caused by natural disasters. The key to prevention is awareness.

Additionally, it is also evident that most natural disasters are intrinsically intertwined, and it is difficult to discuss landslides at length without also including a discussion about the effects earthquakes have on landslides.[12]

Frequent, Destructive, WASH. POST (Dec. 2, 2021, 11:31 AM), https://www.washingtonpost.com/weather/2021/12/02/atlantic-hurricanes-increasing-frequency-climate/ [https://perma.cc/2EYW-P4JR].

[6] Stefano Luigi Gariano & Fausto Guzzetti, *Landslides in a Changing Climate*, 162 EARTH-SCI. REVS. 227, 228 (2016).

[7] *Can Major Landslides and Debris Flows Happen in All Areas of the U.S.?*, U.S. GEOLOGICAL SURV. [hereinafter *Can Major Landslides*], https://www.usgs.gov/faqs/can-major-landslides-and-debris-flows-happen-all-areas-us [https://perma.cc/ANJ2-J3W2] (last visited Jan. 16, 2023).

[8] *Flood Related Hazards*, NAT'L WEATHER SERV. NOAA, https://www.weather.gov/safety/flood-hazards [https://perma.cc/RZS6-YGGB] (last visited Jan. 16, 2023).

[9] *How Many Deaths Result from Landslides Each Year?*, U.S. GEOLOGICAL SURV., https://www.usgs.gov/faqs/how-many-deaths-result-landslides-each-year [https://perma.cc/8TVN-EWKJ] (last visited Jan. 16, 2023).

[10] See *Landslides and Mudslides Fact Sheet*, CDC & PREVENTION, https://www.cdc.gov/disasters/landslides.html [https://perma.cc/Z3AJ-5D68] (last visited Jan. 16, 2023).

[11] *See* Robert B. Olshansky & J. David Rogers, *Unstable Ground: Landslide Policy in the United States*, 13 ECOLOGY L.Q. 939, 941–42, 949 (1987).

[12] *Landslides*, PAC. NW. SEISMIC NETWORK, https://pnsn.org/outreach/earthquakehazards/landslides [https://perma.cc/VCU9-CENN] (last visited Jan. 16, 2023).

To analyze government regulations in natural disasters, this Note will examine two cases studies: one regarding a landslide incident[13] and one regarding a flooding incident.[14] The landslide case study shows how the lack of government action put lives at risk, which could have been prevented.[15] The flooding case study shows how government action and regulation can be effective and, when applied correctly, could potentially have similar successful outcomes in regards to landslides.[16]

This Note will argue that government intervention is crucial to alleviate the burden caused by the changing climate and the increase of storms. Part I discusses the background of landslides, including the importance of landslide mapping and education. Part II compares landslides to flooding and shows how they can be addressed similarly, yet as of now are treated differently. The Conclusion illustrates gaps in regulation as it stands now and proposes that adjustments should be made. These modifications should focus on preparation of these events by the government instead of reacting to them as they occur.

I. LANDSLIDES

A. Background

Landslides are caused when a slope reaches what is called the critical Coulomb failure envelope.[17] The critical Coulomb failure envelope is a mathematical and scientific model that graphs the shear stress[18] and normal stress[19] of a rock that ends up forming a sideways triangle on a graph.[20] Essentially, if a point on the graph is inside this triangle, the rock will not fail, meaning there will be no landslide in that particular location.[21]

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[13] *See* Matt Walsh, *We Reported on Landslides and the Legislature Responded*, CHARLOTTE OBSERVER (June 29, 2018, 4:52 PM), https://www.charlotteobserver.com/latest-news/article214091764.html [https://perma.cc/Y26C-TUSV].

[14] *Local Flood Analysis*, CATSKILL STREAMS, https://catskillstreams.org/lfa/ [https://perma.cc/L6RR-SWGU] (last visited Jan. 16, 2023).

[15] Walsh, *supra* note 13.

[16] *Local Flood Analysis*, *supra* note 14.

[17] Joseph F. Labuz & Arno Zang, *Mohr-Coulomb Failure Criterion*, 45 ROCK MECHS. & ROCK ENG'G 975, 975 (2012).

[18] Shear stress in this context is the force applied to the rock. *See* KARLA PANCHUK, PHYSICAL GEOLOGY, at 13.1 (1st Univ. of Saskatchewan ed. 2019) (ebook), https://openpress.usask.ca/physicalgeology/chapter/13-1-stress-and-strain [https://perma.cc/4AK3-D98A]. Shear stress is the force acting parallel to the rock. *See id.*

[19] *Id.* Normal stress is the force acting perpendicular to the surface. *Id.*

[20] Labuz & Zang, *supra* note 17, at 976.

[21] *Id.*

However, if the point plotted is outside of this envelope, the rock will fault and there will be a landslide.[22] Since rocks that are outside of this envelope have essentially already failed, scientists are looking for how close rocks and surfaces are to the edge of this envelope.[23] This way, they can calculate how much more can be changed before the rocks fault and cause a dangerous situation.[24]

This calculation is especially important because added weight, pore pressure, or cohesion push the points on the graph closer to the envelope, making them more likely to fail.[25] Weight can be added if something is put on the surface of the rock like a building.[26] Since that force is pushing down on the rock, the rock is more likely fail if the force holding the rock together is not strong enough.[27] Pore pressure is the fluid pressure in the rock.[28] Water can get between the rock particles, making them separate so the rock is harder to be held together.[29] Pore pressure can increase if there is an increase in water, like a rain event, which is why areas that get more rain are more susceptible to landslides.[30] Lastly, the cohesion of the rock is dependent on the type of rock.[31] For example, the cohesion of sandstone is different from clay or granite.[32] Essentially, the stronger the rock, the less likely it is to fail and cause a landslide.[33]

This failure point can be reached when weight, pore pressure, or cohesion is added to the slope, making the slope fail, and causing a landslide.[34] So, landslides become a greater risk when a slope is steep, saturated, and there is added weight on it.[35] Due to increasing infrastructure and development in mountainous areas, combined with increased rainfall due to growing numbers of storms, landslides have become a major problem.[36] In fact, due to increased development, less rainfall is needed

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[22] *Id.* at 975.
[23] *Id.*
[24] *Id.*
[25] *Id.* at 976.
[26] Labuz & Zang, *supra* note 17, at 975.
[27] *Id.* at 975–78.
[28] PANCHUK, *supra* note 18, at 13.1.
[29] *Id.*
[30] Labuz & Zang, *supra* note 17, at 976.
[31] PANCHUK, *supra* note 18, at 13.1.
[32] Labuz & Zang, *supra* note 17, at 978.
[33] *Id.*
[34] *Id.* at 975–76.
[35] *Global Landslide Risks*, NASA EARTH OBSERVATORY, https://earthobservatory.nasa.gov/images/7783/global-landslide-risks [https://perma.cc/AFE5-XXZ4] (last visited Jan. 16, 2023).
[36] *Do Human Activities Cause Landslides?*, U.S. GEOLOGICAL SURV., https://www.usgs.gov

for a slope to fail that has been developed than a slope that has not been modified by humans.[37] And with increasing rainfall, this becomes an even larger problem.[38]

The types of landslides discussed so far in this Note are often described as shallow landslides in which the breakage point occurs in the shallow depths of the land.[39] This typically occurs in the soil level, which is why water has such a huge impact on the increase in landslides and why climate change and an increase in storms make the problem exponentially more worrisome.[40] However, there are also landslides often categorized as deep landslides.[41] These landslides occur deeper in the Earth's crust and are typically not affected by variables such as surface water.[42] These landslides are caused by seismic activity and plate tectonics.[43] They are often more widespread and more destructive than shallow landslides.[44]

Although these landslides are often caused by earthquakes and are not as affected by varying weather events like increased rain, it does not mean climate change does not touch them.[45] It turns out, water usage and drought can have a significant impact on the stress load of the Earth's crust, which can increase seismic activity.[46] This comes in multiple forms; the first is that in times of drought humans pump more groundwater from underground aquifers that promotes lateral stress changes along fault lines, which could potentially lead to increased seismic activity.[47] The second form is in water storage of dams.[48] Scientists have found that the

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/faqs/do-human-activities-cause-landslides [https://perma.cc/8WGA-QRSD] (last visited Jan. 16, 2023).

[37] *Id.*

[38] *Id.*

[39] *See, e.g.*, *Deep-Seated and Shallow-Rapid Landslides: Know the Difference*, WASH. FOREST PROT. ASS'N BLOG (Nov. 17, 2017) [hereinafter *Deep-Seated and Shallow-Rapid Landslides*], https://www.wfpa.org/news-resources/blog/deep-seated-landslides-shallow-landslides-washington [https://perma.cc/555R-T8E4].

[40] *Id.*

[41] *Id.*

[42] *Id.*

[43] *Id.*

[44] *Id.*

[45] Alan Buis, *Can Climate Affect Earthquakes, or Are the Connections Shaky?*, NASA: GLOB. CLIMATE CHANGE (Oct. 29, 2019), https://climate.nasa.gov/news/2926/can-climate-affect-earthquakes-or-are-the-connections-shaky/ [https://perma.cc/WF2N-A5WK].

[46] *Id.*

[47] This is because the boundaries of the tectonic plates are moving in opposite directions, so if one of them has less stress on it than the other, then they are more likely to slip against each other, which causes an earthquake. *See id.*

[48] *Id.*

fluctuation of high storage water dams can lead to increased earthquakes.[49] "Seismicity decreases as the reservoir fills in winter and spring, and the largest earthquakes tend to occur as the reservoir level falls in the summer and fall."[50]

Both of these factors affecting earthquakes can be impacted by climate change.[51] Therefore, if climate change can have the potential to cause an increased number of earthquakes, that means there will be an increased number of landslides. To reiterate, these types of landslides occur deeper in the Earth's crust and are often more destructive in nature, which increases the seriousness of lack of regulation around the problem.[52] With the realization that landslides affect not only hurricane-prone areas but also areas along fault lines, this puts the majority, if not all, of the country at risk without ways of addressing the potentially increased problems.[53]

B. Government Intervention

There are three fundamental phases where government can play a role in regulating natural disasters before they occur; however, these phases do not have to occur in any specific order for them to be effective. First: the public education phase.[54] In this stage, the local, state, or federal government will publish helpful safety materials to keep the public informed about the type of risks that natural disasters pose in their area.[55] This is especially important when it comes to landslides because, unlike hurricanes, they cannot be as easily predicted as they happen quickly and with little warning and time to evacuate a dangerous situation safely.[56] In this important circumstance, the government should inform the public about which places are prone to dangerous natural disasters. That way, it can prevent people from being in those potentially dangerous places long term, making them less vulnerable.[57] Additionally, as it will be discussed later during the subsequent section on mapping, it is

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[49] *Id.*
[50] *Id.*
[51] Buis, *supra* note 45.
[52] *See Deep-Seated and Shallow-Rapid Landslides*, *supra* note 39.
[53] *Can Major Landslides*, *supra* note 7.
[54] FEMA, A CITIZEN'S GUIDE TO DISASTER ASSISTANCE 5-2 (2003).
[55] *Id.* at 5-4.
[56] *Landslides Fast or Slow*, IND. GEOLOGICAL & WATER SURV. IND. UNIV., https://igws.indiana.edu/Hazards/Landslides [https://perma.cc/N9MM-VWVP] (last visited Jan. 16, 2023).
[57] LYNN HIGHLAND, U.S. GEOLOGICAL SURV., LANDSLIDE TYPES AND PROCESSES 4 (2004).

important that the information released is accessible to the public.[58] Essentially, it is not good enough for the government to simply publish the maps that are produced by scientists of areas that are susceptible to landslides, because the general public will not be able to analyze and understand these maps.[59] These maps are often incredibly detailed and contain information that will confuse the public who do not have a background in science and deter people from taking the time to understand the meaning of these maps and the repercussions they can have.[60] The education that should be released to the public needs to be accessible and easily understood by the average person.[61]

The second phase of involvement includes information gathering programs where the government funds projects that help increase our knowledge of scientific information.[62] One of the most common projects is mapping programs.[63] This phase is especially prevalent in the case study regarding landslides discussed later in this Note.[64] Essentially, geologic professionals can use the Coulomb failure envelope equation to determine which areas are most susceptible to landslides and perform a landslide risk assessment.[65] They do this by plugging in all the variables described above, including cohesion of the rock and weight on the land, to see where that point lands in the Coulomb failure envelope.[66] Where it lands will determine how high of a risk to landslides that particular area is at.[67] These maps can be shown in very complicated ways, with variables, graphs, and numbers shown on the map; or they can be watered down to show simply high or low susceptibility in the area.[68] As mentioned before,

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[58] *See* FEMA, *supra* note 54, at 5-4.
[59] *Id.*
[60] *See Maps*, U.S. GEOLOGICAL SURV., https://www.usgs.gov/programs/landslide-hazards/maps [https://perma.cc/YD7T-2NYU] (last visited Jan. 16, 2023).
[61] For an example of accessible and easily understandable educational resources, see generally FEMA, *supra* note 54.
[62] The U.S. Geological Survey's website, *What Is a Landslide Hazard Map?*, is one example of a government-funded project. *See What Is a Landslide Hazard Map?*, U.S. GEOLOGICAL SURV., https://www.usgs.gov/faqs/what-landslide-hazard-map [https://perma.cc/3BRW-PTBZ] (last visited Jan. 16, 2023).
[63] *See Made in America: 12 Things Brought to You by the Interior Department*, U.S. DEP'T INTERIOR (July 17, 2017), https://www.doi.gov/blog/made-america-12-things-brought-you-interior-department [https://perma.cc/72LX-FJ4B].
[64] *See* Walsh, *supra* note 13.
[65] Labuz & Zang, *supra* note 17, at 975.
[66] *Id.*
[67] *Id.*
[68] For examples of both types of maps, see *Maps*, *supra* note 60.

it is important that the maps that are distributed to the public are easy to comprehend for the average person who does not have knowledge of the subject, so they are able to make educated decisions on where to live, build, and so on.[69]

Because every square inch of land cannot be plugged into the Coulomb failure envelope equation, geologists will first determine if landslides have occurred in an area in the past.[70] If an area experienced a landslide in the past, there is a greater chance of one occurring in the same area again.[71] To do this, geologists analyze the terrain to see if there is any scarring or fan deposits of sediment that would indicate past landslides. Areas where there have been past landslides are more susceptible to future landslides.[72] Visually, geologists can identify past landslides because the mountainside is usually barren of vegetation.[73] This occurs because all vegetation would have been rooted up during the landslide event causing the sediments to fan out at the bottom of the mountain, creating a semicircle or fan-shaped ring at the base.[74] It is also possible for there to be a steep drop off in the mountainside that looks unnatural, like a piece is missing from the mountain.[75] That is also a good indication that the missing piece came off in a landslide.[76]

Additionally, these geologists will look for signs of tension in the land, like cracks, to indicate possible, future landslides.[77] Cracks and tension in the ground indicate that the land is already under stress, so if one of the variables is added, like weight or water, it is more likely to have a failure point and create a landslide.[78] Areas with little vegetation are also more susceptible to landslides.[79] This is because the roots from trees and plants not only absorb water but help keep the soil in place.[80] Without

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[69] *Id.*
[70] LYNN M. HIGHLAND & PETER BOBROWSKY, U.S. GEOLOGICAL SURV., THE LANDSLIDE HANDBOOK—A GUIDE TO UNDERSTANDING LANDSLIDES 15 (2008).
[71] *Id.*
[72] *Id.* at 16.
[73] *Id.* at 17.
[74] *Id.* at 16.
[75] *Id.* at 7.
[76] HIGHLAND & BOBROWSKY, *supra* note 70, at 7.
[77] *Id.* at 11.
[78] *Id.* at 13.
[79] *Id.* at 33.
[80] Courtney Bornsworth, *Role of Vegetation in Slope Stability*, PENINSULA ENV'T GRP., INC. (Oct. 20, 2015), https://peninsulaenvironmental.com/ecosystem-restoration/slope-stability-vegetation/ [https://perma.cc/N8UW-MGGS].

vegetation it is easier for the ground to separate because there is not anything holding it together.[81]

With this information, geologists can paint a clear picture of the areas that are at an increased risk of landslide danger, and which areas are likely safe.[82] This phase of government involvement is incredibly important because the government cannot make informed policy decisions unless it knows what the problem is and where the problems could be.

The third phase consists of governmental policy decisions based on the information gathered in phase two.[83] This includes building codes, development restrictions, and disclosure laws.[84] This is when the government would require weight limits of buildings, so as to not increase the risk of a slope failure. This could also include zoning regulations, where residential buildings are not permitted in certain high-risk areas.[85]

Additionally, a common practice in building development, known as undercutting, cuts into the side of the mountain, making a straight edge instead of a gradual slope.[86] While this might look more aesthetically pleasing, this affects the force factor in the equation of landslide risk, causing the force to be instead pointed straight down when naturally it would be pointed in a diagonal direction along the slope.[87] This increases the effect gravity has on the rocks and makes it more likely for there to be a landslide event.[88] Proper policy decisions can reduce this practice, thus reducing landslide risk.

C. Landslide Case Study

In 2004, in North Carolina along Peeks Creek, a debris flow landslide killed five people, seriously injured two people, and destroyed fifteen houses.[89] This landslide was caused by the after-effects of hurricanes Frances and Ivan.[90] This debris flow landslide was particularly destructive

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[81] *Id.*
[82] *See* HIGHLAND & BOBROWSKY, *supra* note 70, at 4.
[83] Olshansky & Rogers, *supra* note 11, at 941–42.
[84] *Id.* at 959.
[85] *Id.*
[86] *Id.* at 961, 961 n.119.
[87] *Id.*
[88] *Id.*
[89] *Landslides*, N.C. DEP'T OF ENV'T QUALITY, https://deq.nc.gov/about/divisions/energy-mineral-and-land-resources/north-carolina-geological-survey/geologic-hazards/landslides [https://perma.cc/ZZ8M-VVNH] (last visited Jan. 16, 2023).
[90] *Id.*

because it trampled through at approximately thirty miles per hour and had a maximum discharge of 45,000 cubic feet per second.[91] In response to this incident, North Carolina implemented a landslide mapping program that would be able to identify potential risks in other areas of the state.[92] This program, however, was cut short due to pressure from developers.[93]

In May of 2018, three people died due to landslide incidents in Polk County, North Carolina, after two back-to-back tropical storms hit the area.[94] The landslides occurred in the Valhalla Valley, an area that lies between two very steep mountainsides, making it extremely susceptible to landslides. This valley was very much loved by the people in the area because of its beauty and tranquility.[95] Nobody was aware of how much danger it could possess, especially after the mapping program that was supposed to reveal its peril was shut down from outside pressures of local developers.[96] The fear of devaluation of property ended the mapping program that was created in 2004, following another tragic landslide event in Macon County.[97]

It was very likely this mapping program would have revealed the instability of the land in the Valhalla Valley; however, that area was never reached.[98] Because of this, the government never made the necessary land assessments to determine safe habitability of the area. This shows the importance of the interaction between phase two and three. Governments need to make policy changes to protect the lives of their citizens based on the gathered science.

Today, greater precautions have been taken.[99] At the time of this Note, the North Carolina Department of Environmental Quality has created a new landslide website that provides critical hazard data.[100] It

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[91] Jonathan R. Lamb, *The Deadly Debris Flow in Macon County NC During Hurricane Ivan*, NAT'L WEATHER SERV. NOAA, https://www.weather.gov/gsp/PeeksCreek [https://perma.cc/XCL4-WCNS] (last visited Jan. 16, 2023).

[92] Andrew Carter & Bruce Henderson, *NC Cut Landslide Hazard Program, Despite Dangers*, CHARLOTTE OBSERVER (June 3, 2018, 5:26 PM), https://www.charlotteobserver.com/latest-news/article212253189.html [https://perma.cc/EG6D-87ZW].

[93] *Id.*

[94] *Id.*

[95] *Id.*

[96] Andrew Carter, '*Shouldn't You Have a Right To Know?' Daughter of Landslide Victim Says Warnings Needed*, RALEIGH NEWS & OBSERVER (June 4, 2018, 9:54 AM), http://www.newsobserver.com/latest-news/article212367984.html [https://perma.cc/V2GS-TVDK].

[97] *Id.*

[98] *Id.*

[99] *Landslides*, *supra* note 89.

[100] *Landslides in Western North Carolina*, N.C. GEOLOGICAL SURV., https://experience.arc

also shows the progress of the mapping program, with seven counties already completed and two in progress.[101] The website allows users to view landslide hazard maps and historical landslide information in North Carolina.[102] The website also gives the option to see landslide outlines, landslide points, landslide deposits, potential debris flow pathways, and probability of sliding.[103]

All of this information is contained in ArcGIS, which is an online version of a GIS system.[104] "GIS" stands for "geographic information system" mapping and is heavily relied on in the geologic world.[105] Essentially, it visually reflects data.[106] To the scientific community, these maps are incredibly interesting and convenient. GIS allows scientists to show a vast amount of information, while having the ability to visually manipulate the data.[107] The implementation of GIS to create this publicly accessible website is a great step in the right direction; however, there is still a large disconnect between phase one (education) and phase two (information gathering) discussed earlier in this Note.

First, the accessibility of this information does not guarantee the reach and comprehension that is needed to make change and positively affect lives. GIS software is user-friendly to a degree in the sense that everything can clearly be seen visually, but these computer programs are still not user friendly enough for the average person. Additionally, most of this mapping occurs by county, and it is difficult to determine what kind of data is actually affecting specific locations.[108] There seems to be a clear disconnect between the science and the public.

Second, the third phase as discussed earlier, has not been addressed. Although these mapping programs are finally being implemented, it does not mean they are being acted on. The maps themselves are informational and impressive, but the general public will not be able to reap

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gis.com/experience/b55c8497d115400aa09d9cb7a27f5dc8/page/page_7/ [https://perma.cc/2QJE-FAM6] (last visited Jan. 16, 2023).

[101] *Id.*

[102] *Landslides*, *supra* note 89.

[103] *Landslides in Western North Carolina*, *supra* note 100.

[104] *What is ArcGIS Online*, ESRI, https://doc.arcgis.com/en/arcgis-online/get-started/what-is-agol.htm [https://perma.cc/5RSM-DD3Z] (last visited Jan. 16, 2023).

[105] *What is GIS?*, ESRI, https://www.esri.com/en-us/what-is-gis/overview [https://perma.cc/AY2Y-LBXR] (last visited Jan. 16, 2023).

[106] *Id.*

[107] *Landslides*, *supra* note 89.

[108] *See WNC Landslide Hazard Data Viewer*, N.C. GEOLOGICAL SURV., https://unca.maps.arcgis.com/apps/webappviewer/index.html?id=e9f79de934f24e40a71bab8db8050612 [https://perma.cc/B3SB-XJE7] (last visited Jan. 16, 2023) (demonstrating mapping by county).

the benefit of this work unless the government creates and adjusts policy in reaction to the scientific findings. This shows the disconnect between the scientific community and government. It is a big step that these mapping programs are being prioritized, and it is important to note that at the time of this Note, they are not completed yet; but the real change does not happen until the gap is closed between the science and the government and actions can be put into play from these scientific discoveries.[109]

II. FLOODING COMPARISON

While flooding seems to be the most similar comparison of natural disasters to landslides, there are some important differences to note before discussing the similarities. Unlike landslides, flooding affects a larger population because it does not require the presence of mountains in order for it to be dangerous.[110] In 2019, floods cost over three-and-a-half-billion dollars in property and crop damage in the United States.[111] The risk of floods are once again increased by the rise of sea level caused by climate change, increased storms caused by climate change, and increased development on land that is not fit to be developed.[112] In fact, a 100-year flood will likely happen every one to thirty years now, when theoretically, there was only a 1% chance of that happening every year.[113]

There are obvious damages to flooding including loss of human life and property damages, but there are also indirect harms like the effect on social activities and interruption of the use of critical infrastructure.[114]

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[109] Johanna Schumacher, Lisa Bergqvist, Floris M. van Beest, Jacob Carstensen, Bo Gustafsson, Berit Hasler, Vivi Fleming, Henrik Nygård, Kristîne Pakalniete, Alexander Sokolov, Marianne Zandersen & Gerald Schernewski, *Bridging the Science-Policy Gap—Toward Better Integration of Decision Support Tools in Coastal and Marine Policy Implementation*, 7 MARINE AFFS. & POL'Y, no. 587500, 2020, at 1, 1.

[110] *Flood Related Hazards*, *supra* note 8.

[111] *Billion-Dollar Disaster: Calculating Costs*, NAT'L CTRS. FOR ENV'T INFO. NOAA, https://www.ncdc.noaa.gov/monitoring-references/dyk/billions-calculations [https://perma.cc/W3XE-VN9T] (last visited Jan. 16, 2023).

[112] Melissa Denchak, *Flooding and Climate Change: Everything You Need to Know*, NAT'L RES. DEF. COUNCIL (Apr. 10, 2019), https://www.nrdc.org/stories/flooding-and-climate-change-everything-you-need-know [https://perma.cc/8LBU-5Y5T].

[113] Jen A. Miller, *Increasing Flood Risk Along the U.S. East Coast and Gulf of Mexico*, PRINCETON UNIV. (Aug. 27, 2019, 9:46 AM), https://www.princeton.edu/news/2019/08/27/100-year-floods-will-happen-every-one-30-years-according-new-coastal-flood [https://perma.cc/X9EW-MKG9].

[114] Robert Nicholls, Barbara Zanuttigh, Jean Paul Vanderlinden, Ralf Weisse, Rodolfo Silva, Susan Hanson, Siddarth Narayan, Simon Hoggart, Richard C. Thompson, Wout de Vries & Phoebe Koundouri, Chapter 2—*Developing a Holistic Approach to Assessing*

Much like the case with landslides, the government has different phases in which it can participate in the regulation of flooding. Similarly, these phases include education, investment in research, and acting on that research in the way of policy changes. The case study below exemplifies how this can effectively be put into practice in a way that can facilitate better regulation that applies to landslides.

A. Flooding Case Study

The Federal Emergency Management Agency ("FEMA") has a program called Risk MAP where they map, assess, and plan for flooding incidents.[115] Through this program, they have found a number of success stories.[116] Success stories are not often publicized on major media outlets because it is difficult to know exactly when incident reactions operate in the best-case scenario. Because of this, FEMA success stories will be the main source of the case study. One that this Note will specifically highlight is a success story from the New York Catskills Watershed.[117]

The Risk MAP program provides an excellent example of how the government is capable of effectively combining the steps outlined above of collecting scientific data, educating the public, and using the data to create legislation, with most of the work focused on the first two steps.[118] The goals of this specific project, with most stories having similar goals, are to "provide technical and program training; answer questions from communities and property owners; and provide flood risk reduction and Risk MAP project updates."[119] This is a great example of collecting scientific data and then presenting it to the public.

This is something that was not seen in the previous landslide case study.[120] First, there was not any public communication when the program

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and Managing Coastal Flood Risk, *in* COASTAL RISK MANAGEMENT IN A CHANGING CLIMATE 9, 26–27 (Barbara Zanuttigh et al. eds., 2015) (ebook), https://www.sciencedirect.com/topics/engineering/flood-damage [https://perma.cc/TWM2-N5VU].

[115] *Risk MAP Products*, FEMA (Feb. 25, 2021), https://www.fema.gov/flood-maps/tools-resources/risk-map/products [https://perma.cc/EU5C-QCRZ].

[116] *Risk MAP Success Story: New York Catskills Watersheds—Partnerships and Products for More Resilient Communities*, FEMA (Feb. 11, 2021) [hereinafter *Risk MAP Success Story*], https://www.fema.gov/case-study/risk-map-success-story-new-york-catskills-watersheds-partnerships-and-products-more [https://perma.cc/T2X2-5WDF].

[117] *Id.*

[118] *Id.*

[119] *Id.*

[120] *See* Carter & Henderson, *supra* note 92.

started or when it stopped.[121] Even with the new landslide mapping program, it is not as user-friendly and interactive. This program answers the public's questions regarding the flood mapping plan, which did not occur in the landslide mapping program.[122]

This specific case study of the New York Catskills Watershed started because of the flooding damage that occurred in the area as a result of Tropical Storm Irene in 2011.[123] This area represents a major risk to severe flooding that will greatly impact the lives of those living there, which is why the area was prioritized in this project.[124] This Risk MAP program includes members from federal, state, and local government.[125] This inclusion of different governing bodies is vital to communication and to make sure all objectives are actively met without any gaps.[126] In regards to landslides, it seems that this is another open space that could use improvement. In the landslide case study above, the mapping program was run by the state and ultimately terminated by the state.[127] The inclusion of federal and local governments could have been vital resources to have in the project. These additional governing bodies could have also provided necessary accountability elements to ensure that the project was actually implemented.[128] As of February 11, 2021, the flood risk assessments are used to determine appropriate funding for infrastructure needs like bridge upkeep, structural elevation adjustments, and building relocations.[129] These assessments have been published based on location with twenty-two local analyses in total.[130] Each paper is over a hundred pages long and details all of the findings in graphs and writing.[131] The findings include potential problem areas and what can be done to reduce the risk of these areas.[132] Examples of suggestions include:

> Removal of the concrete fish barrier at the upper end of the study area (Alternative 6) is predicted to reduce inundation

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[121] *Id.*
[122] *Landslides*, *supra* note 89.
[123] *Risk MAP Success Story*, *supra* note 116.
[124] *Local Flood Analysis*, *supra* note 14.
[125] *Risk MAP Success Story*, *supra* note 116.
[126] *See* Carter & Henderson, *supra* note 92.
[127] *Id.*
[128] *Risk MAP Success Story*, *supra* note 116.
[129] *Id.*
[130] *Local Flood Analysis*, *supra* note 14.
[131] MILONE & MACBROOM, INC., FINAL DRAFT LOCAL FLOOD HAZARD MITIGATION ANALYSIS EXECUTIVE SUMMARY 4–6 (2013).
[132] *Id.*

> of three nearby homes. The cost of the weir removal may be similar to the cost of acquiring the three homes that would benefit from reduced inundation, but removing the weir would also benefit other properties that may be affected by floodwaters . . . [and] [r]eplacement of the Main Street bridge over Huntersfield Creek (Alternative 7) would allow for increased capacity and reduced potential for overtopping. However, modeling demonstrated little overall benefit associated with this alternative.[133]

These examples not only include realistic assessment and suggestions but also illustrate that, although a change could be made somewhere, it is not necessarily worth the resources needed to make that change.

These flood mapping programs make a complicated project seem attainable to the common person who would not be able to understand a map of risk. This program is a great example of created change from the connection between the different phases of government involvement.[134]

It is important to note that while flood standards exemplify how the bar can be raised in regards to landslide preparation, flooding standards themselves often fall short and still continue to cost the country millions of dollars a year.[135] One recent example occurred in Michigan in May of 2020, when a dam failure caused over $175 million in property damage.[136] It became clear that the dam failure could have been prevented if it were properly maintained and up to code.[137] This incident exemplifies that if it is the responsibility of the government to mitigate and analyze the ability of the dams, and they fail to do that, then all of the science showing the effective measures of flood prevention are not helpful.

B. Flood and Landslide Comparison

These two case studies show the differences between an effectively handled project like the flooding project and one that can be improved like the North Carolina landslide project. The government needs to

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[133] *Id.* at 5.
[134] *Id.*
[135] *See* Denchak, *supra* note 112.
[136] Beth LeBlanc, *Judge Allows 25 Lawsuits Against the State over May 2020 Dam Failure to Proceed*, DET. NEWS (May 21, 2021, 5:51 PM), https://www.detroitnews.com/story/news/local/michigan/2021/05/21/lawsuits-state-of-michigan-edenville-dam-midland-flood-sanford/5210108001/ [https://perma.cc/84C9-6FLP].
[137] *Id.*

prioritize spending on mapping programs for landslides so it can then be determined which areas need to be prioritized for infrastructure improvements and perhaps stricter regulations. The good thing is, as mentioned before, that is already in motion.[138]

Because the government does not have unlimited spending power to fund these projects, prioritization is necessary. The New York risk assessment excelled at properly expressing the weight of consideration for applying new regulations.[139] The government should focus on time-sensitive problems where lack of attention could lead to a slippery slope outcome (no pun intended). For example, not all natural disasters are in as much danger from climate change, such as earthquakes.[140] Increasing storms mainly harm the East Coast due to the nature of hurricane formation.[141] It is also apparent that the regions that suffer the most when these incidents occur are poorer communities.[142] This narrows the localities that need the most attention. The government should start with these likely less informed citizens and local communities that would struggle the most from these natural disasters.[143]

Additionally, when deciding where to start with these time consuming and costly projects, it is important to consider the cost-benefit analysis because it is unlikely that the government will make big decisions before consulting what makes financial sense. As stated initially, these natural disasters cost billions of dollars, not just in property damage, but also in lawsuits and litigation costs as we see in both mentioned case studies.[144] Those expenses add up quickly and make taking preventative measures worth it.

Landslide regulation is important because it can have many legal implications.[145] First, in several states, North Carolina being one, the

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[138] *Landslides*, *supra* note 89.
[139] *See* MILONE & MACBROOM, INC., *supra* note 131, at 4.
[140] Buis, *supra* note 45.
[141] Chris W. Landsea, *Why Do Hurricanes Hit the East Coast of the U.S. but Never the West Coast?*, SCI. AM. (Oct. 21, 1999), https://www.scientificamerican.com/article/why-do-hurricanes-hit-the-east-coast-of-the-u-s-but-never-the-west-coast [https://perma.cc/S4VT-3U3S].
[142] Eleanor Krause & Richard V. Reeves, *Hurricanes Hit the Poor the Hardest*, BROOKINGS (Sept. 18, 2017), https://www.brookings.edu/blog/social-mobility-memos/2017/09/18/hurricanes-hit-the-poor-the-hardest/ [https://perma.cc/ES3S-5ZE4].
[143] *Id.*
[144] *See* LeBlanc, *supra* note 136.
[145] *See* Denis Binder, *The Duty to Disclose Geologic Hazards in Real Estate Transactions*, 1 CHAP. L. REV. 13, 13 (1998); STATE OF N.C., RESIDENTIAL PROPERTY AND OWNERS' ASSOCIATION DISCLOSURE STATEMENT 2–4 (2021).

disclosure of previous landslides and other geologic events is not required when selling a house.[146] The legally required disclosure form lists the questions:

> Is there any problem, malfunction or defect with the drainage, grading or soil stability of the property? . . . Are there any structural additions or other structural or mechanical changes to the dwelling(s) to be conveyed with the property? . . . Is the property subject to a flood hazard or is the property located in a federally-designated flood hazard area?[147]

Some of these questions could loosely be tied to the disclosure of previous landslides, but the average person would likely not think to ask, disclose, or examine past landslide activity.

As stated previously, prior landslides are the biggest indication of future landslides in the same location.[148] While flood disclosure is now required in all fifty states, due to lack of education on the topic, many people likely will not realize that a presence of flooding can also indicate a landslide risk.[149] Additionally, even though flood disclosure is required in all fifty states now, the disclosure varies greatly among states, with some states not requiring disclosure in all circumstances.[150]

Another potential implication of the lack of landslide regulation is that landslide insurance is not covered under basic homeowners' insurance.[151] This, combined with the unrequired disclosure, has the potential to cause a lot of financial harm to uneducated people.[152] This leaves a big gap of vulnerability open by regulations that, at least to start with, could have some basic solutions. Especially, once again, because landslides are not a novel occurrence in the United States.[153] These solutions could include

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[146] *See* STATE OF N.C., *supra* note 145, at 3.
[147] *Id.*
[148] SCOTT F. BURNS, TESSA M. HARDEN & CARIN J. ANDREW, FEMA REGION 10, HOMEOWNER'S GUIDE TO LANDSLIDES: RECOGNITION, PREVENTION, CONTROL, AND MITIGATION 7–8 (2017).
[149] *See* NAT'L ASS'N OF REALTORS, STATE FLOOD HAZARD DISCLOSURE SURVEY 1–50 (2019).
[150] *Id.*
[151] Ken Van Vleck, *Landslide Liability Issues*, AM. BAR ASS'N (Apr. 20, 2011), https://www.americanbar.org/groups/litigation/committees/real-estate-condemnation-trust/articles/2011/042011-landslide-liability-tips/ [https://perma.cc/3PAK-ERDV].
[152] *Id.*
[153] *Flood Related Hazards*, *supra* note 8.

the requirement to disclose past geologic activity. Likely because it is along the San Andreas fault line, this is a requirement in California; however, it is not a requirement in Nevada, which is also along the fault.[154] It should also be a requirement in other heavily landslide-prone areas like North Carolina, but it is not. This could be a straightforward legal solution to this one problem.

Another possible solution occurs in the education realm of landslide prevention in making sure homeowners can identify warning signs in the area of previous landslides. Just like most people can easily identify and look for rotting wood or a bad foundation on a house, it can be just as simple to look for red flags in land.[155] An example would be looking at the trees on the land to see if they are tilted or bent.[156]

There are additional legal implications in the form of increased litigation for property damage due to landslides.[157] For example, imagine a situation where a neighbor on a hill or mountainside above puts in a new irrigation system or swimming pool. While there are not immediate consequences of the new installation, a few months or years later, a landslide destroys the mountainside and causes damage to both houses.[158] Could the homeowner below the person with the new irrigation system or pool sue for property damage because the new instillation increased the risk of landslide? The answer to this question is not clear.[159]

CONCLUSION

While this Note explains some possible solutions to an increasing landslide problem, it is mainly meant to highlight the gaps in regulation around landslides and how landslides are often overlooked as a natural disaster. This becomes clear when compared to more highly regulated natural disasters, like flooding. Not only is the public more educated on

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[154] CAL. CODE REGS. tit. 16 §§ 3000–67 (2022). *See* Tony Allen, *Earthquakes in Southern Nevada: Knowing the Risk and How to Prepare*, UNIV. OF NEV., L.V. (July 12, 2019), https://www.unlv.edu/news/release/earthquakes-southern-nevada-knowing-risk-and-how-prepare [https://perma.cc/FG5K-JBGV].

[155] BURNS ET AL., *supra* note 148, at 7–8.

[156] *Id.* at 7.

[157] Gene Johnson, *Washington Landslide Liability Could Win*, CLAIMS J. (Apr. 7, 2014), https://www.claimsjournal.com/news/west/2014/04/07/247020.htm [https://perma.cc/Q9FX-EZFH].

[158] Dale Alberstone, *Damage from Rainwater and Landslides—Who Is Liable?*, APARTMENT OWNERS ASS'N CAL. (Feb. 1, 2016), https://aoausa.com/damage-from-rainwater-and-landslides-who-is-liable-by-dale-alberstone/ [https://perma.cc/HPP4-LNF5].

[159] *Id.*

flooding and potential problems that come with flooding, but there are more laws and regulations put into place by the legislature to ensure a smaller chance of a serious problem when disaster inevitably strikes.

Of course, no solution is an easy solution because, in reality, the government cannot always be as risk averse as people in the science community would prefer; there are budget restrictions and interests of other parties to consider. There is not going to be a clear solution on how to deal with increasing natural disasters caused by climate change. However, prepared or not, these events will continue to worsen, and ignoring them without attempting to make at least small changes will only lead to disaster.