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**SCIENCE AND STRATEGY:
HOW SCIENTIFIC AND TECHNICAL INFORMATION
ARE USED IN DISPUTES OVER LANDSLIDE REGULATIONS
IN SEATTLE, WA**

By

Ana Miscolta-Cameron

Accepted in Partial Completion of the Requirements for the Degree Master of Science

Kathleen L. Kitto, Dean of the Graduate School

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MASTER'S THESIS

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Ana Miscolta-Cameron
May 13, 2016

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A Thesis
Presented to
The Faculty of
Western Washington University

In Partial Fulfillment Of the Requirements for the Degree Master of Science

by Ana Miscolta-Cameron
May 2016

Abstract

This thesis investigates the ways in which scientific and technical information are used to challenge policies regarding development in landslide-prone areas in Seattle, Washington. It examines the values that underlie actor arguments within those challenges, using the theoretical lens of Science, Technology, and Society. Twelve case studies are selected from a set of 90 permitting appeals, court cases, and growth management hearings board appeals between the years of 1990 and 2015, and analyzed to identify the complex ways in which scientific information is used to further actor positions. A narrative analysis approach is used to analyze the case studies, archived news coverage, and interviews with geologists and planners in order to identify actor values and narratives. The results of this project suggest that, despite the science-centered arguments of developers and government, actor decisions are highly influenced by values. Neighbors who oppose development draw their arguments from aesthetic values; developers draw their arguments from values that center on property rights and right to accept risk; and all actors, including government, base arguments on potential economic gains or losses. What can be concluded is that despite hillside development policy being based upon science and technical knowledge, actor arguments and concerns are often based upon values, which cannot be articulated through science and technical information. Though well-resourced actors can influence policy through the leveraging of science and technical information, the prominence of values in debates about landslide regulation indicate that science-based policy approaches that do not consider values may encounter more challenges from the public.

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Chapter 1 – Introduction

On March 22, 2014, a massive mudslide killed 43 people in a small rural settlement of Snohomish County, WA. It became the deadliest landslide in U.S. history. In the aftermath of the landslide, Snohomish County director of emergency management John Pennington said of the hillside, “It was considered very safe. This was a completely unforeseen slide. This came out of nowhere” (Armstrong et al., 2014).

While certain hazards, such as landslide, are natural and inevitable, disasters are not. Social scientists conceptualize disaster as a product of a natural hazard event and of the human conditions that expose a population to hazard. Such human conditions reduce a population’s ability to anticipate and withstand a hazard (Wisner, 2003; Schwab et al., 2006). Hewitt (1983, p. 27) asserts that these human conditions “prefigure” disaster and can be seen as the root cause of it - not the environmental event in and of itself.

Several months after the Oso landslide, Governor Jay Inslee and County Executive John Lovick commissioned a task force of scientists, politicians, and scientists to evaluate response and recovery efforts, to outline ‘lessons learned,’ and make recommendations for how to better prepare for future hazard events. One of the commission’s recommendations was to fund statewide landslide hazard mapping, arguing that it “will provide the foundation for sound public and private land-use planning and decision-making” (Oso Landslide Commission, 2014). In April of 2015, Governor Inslee signed Senate Bill 5088, which directed the Department of Natural Resources (DNR) to complete statewide mapping of geologic hazards using LiDAR, a remote laser-based surveying technology, and to make those maps publically available.

A measure like Senate Bill 5088 presupposes that the collection and dissemination of information about hazard risk will result in policy that can prevent the ‘next Oso.’ The bill, which was unanimously passed by the legislature, also symbolizes, as the Oso Commission described, a ‘lesson learned.’ Statewide mapping of hazard data presents the opportunity to create risk-averse policies in Washington state, yet many scholars within the field of Science, Technology & Society (ST&S) criticize the notion that the production of scientific data necessarily leads to straightforward and socially beneficial policy answers, especially if an issue lacks consensus on the values that underlie the policy (Sarewitz, 2004; Pielke Jr, 2007; Kahan et al., 2012; Kahan, 2012). ST&S instead proposes that policy is more heavily dictated by cultural, social, or economic interests; further, preexisting agendas often supersede alternate recommendations concluded by scientific studies (Sarewitz, 2004; Pielke Jr, 2007; Kahan, 2012). In the case of hazard regulation, policies that prioritize public safety from hazards by restricting development in hazardous areas may be surmounted by policies that prioritize property rights, economic development, and housing availability by allowing development in hazardous areas.

I examine the challenges that exist in translating landslide risk data into risk-based policies, using the Seattle as a case study. In my analysis, I pull from the large body of literature within ST&S, to examine the relationship between science and technical information and decision-making. I analyze the ways in which different actors reconcile their interests with scientific and technical information to illustrate the complex process of translating hazard knowledge into acceptable policy.

Research Questions

I propose to address the following question and sub-questions:

- In what ways do stakeholders use scientific and technical information in public disputes about landslide regulations in Seattle, WA from 1990 to 2015?
 - How do stakeholders use scientific and technical information to support their arguments about hazard regulations or policy decisions?
 - What narratives, or values, contribute to actor arguments?

The goals of this research are twofold. Firstly, I seek to identify how science information is used in disputes, which are defined as legal challenges that revolve around landslide-related regulations, policy-decisions, or hazard outcomes arguments about landslide risk regulation. Secondly, I seek to identify actor narratives, which are defined as broad arguments or views about what landslide risk regulation ought to be.

Science and technical information are often used as a means of legitimizing arguments (Pielke, 2007; Porter, 1995), yet it is unclear the degree to which arguments about development in landslide-prone areas are based upon the technical assessments of the slope stability. Further, it is unclear the degree to which actor values are bolstered by drawing upon arguments using technical data on slope stability. By examining these questions, my work helps to identify the various, contentious conversations about landslide risk happening in Seattle among and between groups with competing interests. It identifies the arguments offered by regulatory agents, developers, technical specialists, and the broader community about how landslide risk ought to be regulated and considers the ways in which various arguments and values are legitimized in the regulatory process.

Geographic and Temporal Scope of Research

100 kilometers to the south of Oso lies the vibrant urban center of Seattle, Washington. In 2013, Seattle was the fastest growing major city in the United States (Balk, 2014), a trend that will inevitably stimulate additional development to accommodate a projected population growth of 120,000 people by 2035 (Department of Planning and Development [DPD], 2014), an 18 percent increase from its current population of 662,000. This projected growth will likely result in higher intensity development, with an estimated need for 70,000 additional households over the next twenty years (DPD, 2014).

Yet, the city is also highly susceptible to landslides. Over eight percent of the city's area is classified as landslide-prone and landslide events are common in the rainy winter months (Seattle Office of Emergency Management, 2014). Most of the city's landslide risk is concentrated in coastal bluff areas, where expensive real estate is often located. Landslide risk in Seattle and in the United States in general contrasts with landslide risk in most developing countries in terms of which populations are exposed to hazard. In many developing contexts, the poor are disproportionately exposed to landslide risk because they are confined to marginal hillside areas on which the wealthy are unwilling to live. In the United States, especially in urban areas, the wealthy are often most exposed to landslide risk because hillside areas are sought after for their views of the landscape. In Seattle, neighborhoods with high landslide risk, including Magnolia, the coastal area of Alki in West Seattle, and Leschi, also have some of the highest median real estate values (American Community Survey, 2013). Though Seattle's landslides are rarely fatal, property damage can amount to millions of dollars. In the winter of 1996-97, damage to public and private properties totaled \$100 million (Conklin, 1999).

Seattle's first citywide landslide studies began in the early 1970s, but Seattle has recorded individual landslides since 1890. In recent decades, the City has developed a comprehensive landslide database. Between 2006 and 2008 eight major research studies on landslides and engineering geology were published (Baum et al., 2008). Because of these studies the "understanding of Seattle's landslide hazard increased significantly," according to the Seattle Office of Emergency Management (2014). Yet, recent studies in Seattle suggest landslide risk could be higher than previously understood (Baum et al, 2008; Schulz, 2007).

In this thesis, I focus on Seattle as a case study because of the city's substantial urban landslide risk, its detailed documentation of landslides, and its proactive solicitation of hazard data from universities, federal agencies, and consultants since the mid-1990s. The existence of extensive scientific studies about the characteristics of landslide risk in Seattle provides an opportunity to analyze how that information is reconciled with actor interests and decision-making.

I analyze the time period from 1990 to 2015. I chose the year 1990 as the starting year for analysis because it marks the beginning of contemporary landslide hazard regulation in Seattle with the passage of the GMA and Seattle's interim environmentally critical areas (ECA) regulations. I exclude the period prior to 1990 to avoid dispute comparison across regulatory paradigms.

To address my research questions, I selected and analyzed twelve disputes, defined as legal challenges that revolve around landslide-related regulations, policy-decisions, or hazard outcomes in Seattle. All 12 fell within my 25-year time period used for this analysis. I collected legal files and relevant news coverage for each dispute and broke down the arguments of the involved actors by interests and type of evidence used. To examine the

broader debate about landslide regulations, I cataloged news coverage of landslides, landslide regulation, and landslide disputes dating back to the early 1990s. I then qualitatively coded their text to draw out actor arguments and interests. I also solicited interviews with scientists and planners and asked them to discuss the relationship between science and policy. Coded news articles and informant interviews helped me to illustrate the greater ideological context in which my selected disputes fall.

I found that the use of science is highly valued in legal disputes about landslide regulation in Seattle, but many ordinary citizens who appeal permitting decisions do not have access to high-level scientific data, or, feel ideologically compelled to argue their interests in terms of values. When used by actors in disputes, science does not necessarily bring consensus. Rather, interpretations of science may vary widely according to an actor's perception of what level of risk is acceptable. Values play an enormous role in determining actor interests, perception of risk, and appropriate regulation. In this light, the production of scientific knowledge about hazards and risk will not necessarily result in risk-averse policy if a community's values conflict with that policy.

Thesis Organization

The following chapter (Chapter 2) details the theoretical literature that informs this project. The field of ST&S is broadly concerned with how the values characteristic to a society relate to the production of scientific information and how scientific information is used by a society. ST&S scholars theorize that information does not always lead to straightforward policy conclusions, as policy is heavily determined by other factors, such as a society's values. In a hazard context, ST&S theory suggests that the production and publication of information about hazard risk may not necessarily lead to responsive, risk-

averse policy, because policy must also respond to values based interests, such as property rights.

Chapter 3 describes the physical characteristics of a landslide, including descriptions of hazard geography, magnitude, speed, and duration. The chapter examines Seattle's landslide hazard in the context of the Puget Sound region's geological history and identifies common landslide types in the Seattle area. It discusses earthquakes, rainfall, and human activity as environmental stressors that often trigger landslides, contextualizing these stressors within the setting of Seattle.

Chapter 4 discusses the history of landslides in Seattle and describes early reactions to landslide losses, including liability lawsuits and expensive structural mitigation projects. It also details the evolution of landslide hazard regulations in the city from the passage of the State Environmental Protection Act (SEPA) in the 1970s, through the 1990s and 2000s, when regulation was strengthened in response to massive landslide losses in 1996-97, and to scientific studies on landslides subsequently published. Finally, Chapter 4 outlines the current regulatory framework for development in hazards area in Seattle, detailing relevant environmentally critical areas (ECA) regulation, different types of regulatory relief, and the appeal process.

Chapter 5 describes the methodology of this project, detailing the sampling of disputes for analysis, the organizational and analytical role of the qualitative analysis software NVivo in the project, the use of interviews of scientists and planners and the coding process by which I perform narrative analysis to draw out actor arguments and values.

Chapter 6 provides short summaries of the twelve disputes sampled for analysis. The chapter also summarizes general patterns identified in disputes, including the actors most likely to prevail, with an explanation of why this may be.

Chapter 7 discusses how applicants for development and government use scientific data to support their arguments in disputes, but neighbors who appeal permitting decisions in opposition of development rarely use scientific data. Appellants in opposition of development are rarely successful in part because they lack scientific data to legitimize their claim. In some cases, different actors use scientific data in a way that supports conflicting conclusions. The chapter identifies broad themes of liability, acceptable risk, and engineering safety as central to the disputes about landslide regulation and policies. These themes help to explain why actors argue for the outcomes that they do.

The thesis concludes with Chapter 8. This chapter returns to the theoretical literature discussed in Chapter 2, and discusses actor interests and preferred outcomes in landslide-related disputes in the context of culture, class, and economics. It discusses the tension between Seattle's 'scientized' landslide hazard policy and the prominence of values in actor decision-making, where the implications of science may misalign with the implications of values. Finally, it provides an outline of limitations and areas of future work.

Chapter 2 – Theoretical Literature

This project is informed by research that examines the challenges of translating science and technical knowledge into policies that shape society. Within this body of literature, which has coalesced under the rubric of S&TS, many scholars argue that scientific or expert knowledge does not necessarily lead to political consensus or clarity on an appropriate course of action. Rather, in some contexts, a greater amount of scientific information may serve to heighten controversy by providing a larger pool of facts and theories from which sides can then selectively choose (Pielke Jr, 2007; Sarewitz, 2004).

The argument that more quantitative data does not lead to clarity of action, and can actually result in more controversy, is evident in issues as diverse as climate change, vaccines, and genetically modified organisms (GMOs). While an overwhelming majority of the scientific community is in consensus that climate change exists and is human-induced, the Yale Project on Climate Communication (2014) found that only 64 percent of the American public believes that climate change exists. Further, both believers and non-believers in climate change are growing more certain in their existing beliefs. Similarly, vaccines are subject to public skepticism, despite extensive scientific assurance of their safety. Vaccines undergo extensive safety testing, typically of over a decade, and are strongly recommended by the health community (CDC, 2015). Though 90 percent of American children do get their primary vaccinations (Reinberg, 2014), some parents choose not to vaccinate their children, with the number of exemptions slightly rising in many states (Gavett, 2011). Some parents opt-out due to fears that vaccines will make their children sick, often citing a long debunked study linking the Measles, Mumps, and Rubella (MMR) vaccine with autism (CNN, 2011). Others believe that illness is a natural part of life, as expressed by

many parents in the film *Vaccine Wars*, which was filmed in a city with a 28 percent rate of unvaccinated or not-fully vaccinated children (Palfreman, 2010). As is the case with climate change beliefs, researchers have found that parents who do not vaccinate their children gravitate even further towards their beliefs when confronted with information meant to correct misconceptions (Diamond, 2015). Finally, many members of the public have strong reservations about the safety of ingesting GMO foods (Ferdman, 2015) despite over 2,000 published studies that suggest bio-engineered foods are as safe to consume as conventional foods (Wendel, 2013). However, opposition to GMOs also stems from values-based concerns about corporate monopoly of the food system through the patenting of seeds (Nemana, 2012) or the ‘restructuring’ of food in a way that is not well understood by average citizens (Lynch & Vogel, 2001). These values-based concerns do not contradict or dismiss science, but find it irrelevant because it does not, and cannot, address their concerns.

Groups that hold positions conflicting with widespread scientific evidence may demand that additional scientific studies be performed. They may be convinced that science supporting a conclusion opposite theirs is flawed and that the results are wrong. The debate around the safety of using Bisphenol A (BPA) in plastic products well illustrates sustained public doubt of scientific studies that conclude the opposite of preexisting public opinion. Numerous studies suggest the sanctioned use of BPA in plastic products does not pose a health threat to humans, yet the public has been reticent to accept these findings, in part because a small, but influential, group of journalists, news sites, and NGOs perpetuate the idea that BPAs are health hazards (Entine, 2012). In 2008, anti-BPA groups demanded that the Obama administration fund additional studies on the effects of the chemical, claiming that existing evidence that BPA was safe was insufficient. One of the resulting studies, led by

the Environmental Protection Agency, concluded that BPA had only weak effects on endocrine disruption. Anti-BPA groups accused the agency of incorrectly setting up their experiments and rejected its results (Entine, 2012).

The controversies surrounding climate change, vaccines, BPAs, and GMOs are current and widely publicized instances of a seeming disconnect between current scientific knowledge and continued, and even heightened, public mistrust of that scientific knowledge. Despite scientific information seemingly pointing the public in one direction, much of the public opinion remains firmly opposed to the seemingly unambiguous outcomes of years of scientific study. Large bodies of scientific information about these issues have not prevented polarization about environmental issues.

Daniel Sarewitz (2004), a prominent S&TS scholar, suggests that polarization over environmental issues is due, in large part, to the ability of an individual to select from the abundance of “facts assembled via a variety of disciplinary lenses, in ways that can legitimately support, and are causally indistinguishable from, a range of competing, value-based political positions” (386). The abundance of information allows anyone to legitimize his or her position, no matter what contrary evidence indicates. March (1982) characterizes information as a critical tool with which strategic actors attempt to achieve their goals. Actors may omit or distort information as a tactic for positively framing their objectives or for negatively framing others. March describes information as “a symbol of competence” (39) that has simultaneously lost value due to the systematic manipulation of it.

Both Pielke Jr (2007) and Sarewitz (2004) argue that in politically contentious issues, opposing sides are often arguing in completely different terms than the other party. Rather than arguing about verifiable facts, values-based conflicts may be masked as science-based

arguments. Because conflict of values is not addressed explicitly, more data leads to a moot point, or political gridlock. Therefore, while some may argue for more science to resolve disputes, additional scientific studies may fail to produce consensus in action (Pielke Jr, 2007; Sarewitz, 2004). Alternatively, science-based arguments may be pitted against values-based arguments. Pielke Jr (2007) demonstrates this type of conflict with the controversy surrounding stem-cell research in which opposition is based in pro-life rhetoric centered on the sanctity of life while proponents cite the scientific benefits to the research in treating a variety of diseases. For opponents, the argument is values-based, and revolves around the politics of abortion. For proponents, the argument is scientific and practical, centering on societal benefits and couched in terms of the advancement of scientific knowledge.

The Role of Cultural Values in Disputes

Science-based versus values-based arguments are highly applicable to policies surrounding landslide regulations. The identification of hazard areas is a scientific process, which usually involves field-testing and remote surveying techniques. Scientists often develop estimates of event probabilities based on geologic evidence of past slides and analysis of environmental triggers like earthquake and rainfall. Scientific data that demonstrates location and probability of hazards may be used by certain actors to call for regulations that restrict development in areas prone to slope failures. Yet, values are not necessarily absent from these science-based arguments. When an individual is arguing against development, citing potential slope failure, they may be expressing values that prioritize public safety. Conversely, values-based arguments may counter that it is the individual's right to live where he or she pleases, or that development is necessary to support population growth and that land use in hazard areas should not be heavily regulated.

The bases on which arguments for and against strict regulation of development in hazard areas do not inherently contradict each other. For example, someone may agree with both of the following statements: a) the science is valid in stating that a slope is prone to fail and b) individuals should have the right to live where they please. However, because opposing sides do not share the same line of reasoning, strengthening one argument does not weaken the other. Reconciliation of opposing sides via their respective arguments is therefore impossible. One cannot challenge the principle of private property rights with geotechnical reports or slope simulation models.

Public polarization on environmental issues, such as natural hazards, can also be explained by an individual's adherence to his or her social or political affiliation. Kahan et al. (2012) explains that cultural cognition, or the influence of our socio-political values on our beliefs, influences how people interpret scientific information and can help explain why scientific controversies are so polarized, despite large bodies of research that often support a broad scientific consensus. According to Kahan et al. (2012), intelligence and educational attainment are not good predictors of how well people's beliefs align with broad scientific consensus. Rather, people are more concerned with holding the belief that those in their social network espouse, and rationally so. People may neglect or re-interpret scientific information in order to maintain the view that will reinforce their social belonging:

For members of the public, being right or wrong about climate- change science will have no impact. Nothing they do as individual consumers or as individual voters will meaningfully affect the risks posed by climate change. Yet the impact of taking a position that conflicts with their cultural group could be disastrous (Kahan, 2012, 255).

Individuals assessing evidence about environmental hazards are more likely to conform to the value and belief system of their respective social group; they will interpret these data in a way that reinforces the existing views of that group.

The importance of social belonging explains why more scientific data may fail to convince the public of a particular viewpoint. An individual is unlikely to accept science-based statements if they are inconsistent with the worldviews and values of the social group upon which they rely for social and economic support.

The Influence of Societal Structure on Risk Perception

The ideas that Kahan et al. (2012) put forth about cultural adherence draw heavily from Douglas and Wildavsky's (1982) work on Cultural Theory of risk, which posits that an individual's perceptions and responses to risk are heavily dictated by the social paradigm in which he or she is situated. Cultural Theory characterizes societies by group (from low to high levels of communitarianism) and grid (from low to high levels of social hierarchy). The theory asserts that the respective values put forth by these societies, to an extent, molds the worldviews of individual members. Douglas and Wildavsky (1982) argue that the way in which an individual understands risk is shaped by the broader moral and social code that characterizes society. These codes are in turn dependent on the long-term goals of that society, as well as the sanctioned methods of attaining those goals.

Douglas and Wildavsky (1982) outlined four cultural types that theoretically encompass, to some extent, all cultures throughout history: fatalistic, hierarchic, individualistic, and egalitarian. Fatalists are characterized by low group and high grid; this typology tend to believe that ills of the world are involuntary and inevitable, and thus accept

risks as unavoidable parts of life. Hierarchical cultures are characterized by high group and grid. This typology depends on institutional order and expertise to guide risk through rulemaking. Individualists are characterized by low group and grid and are concerned most with preserving individual liberties, especially economic freedom; thus, this typology supports risks that coincide with their goals. Egalitarians, characterized by high group and low grid, value equality and fairness and often distrust market and government institutions, perceiving that these exacerbate inequality. Egalitarian cultures are often at odds with individualist cultures because the latter seeks to maximize individual benefit regardless of the expense to others.

Cultural Theory has been broadly applied since its introduction by Douglas and Wildavsky (1982) in the early 1980s. Rayner & Cantor (1987) used Cultural Theory typologies to demonstrate how different organizational settings affect how its members understand and react to risks of nuclear technology, with particular emphasis on issues of fairness and equity in risk distribution. The authors conducted interviews in three distinct organizational settings: utilities companies, public utilities commissions, and public interest organizations. They found that organizational perspectives on the risks of adopting nuclear technologies were consistent with an organization's cultural typology. Public utilities commissions, for example, were primarily concerned with the economic risks of adopting nuclear technology, consistent with a market-individualist typology. Public interest groups were concerned completely with public safety and the question of who might be disproportionately burdened by risk. Their interests were consistent with an egalitarian typology — a typology inherently suspicious of individualist and hierarchical systems.

Wildavsky's graduate student Karl Dake (1991) tested Cultural Theory using quantitative analysis at the scale of the individual. Dake used qualitative assessments to categorize 300 subjects in the San Francisco area into one of the four cultural typologies and then assessed their risk preferences, hypothesizing that the former would predict the latter. He found statistically significant correlations between cultural worldview and expected risk preferences as theorized by Cultural Theory. Individualists were concerned primarily with economic risk, hierarchical individuals with technological and environmental risk, and hierarchical individuals with risks related to social disorder.

When Cultural Theory of risk is applied to an issue such as geological hazards, landslide risk may be highlighted or played down depending on the prevailing goals and accompanying moral arguments of the society. For example, an individualist society, characterized by low-group and low-grid, may downplay risk in general, especially if that risk has negative implications for economic opportunity. What some communities would perceive as landslide risk, a community with a strong individualist cultural typology may perceive as a promising source of real estate venture. The goals of profit and market freedom manifests in a social code critical of regulation, and may be exercised through the reframing of risk as opportunity. As Beck (1986) argues, because some, such as the individualist in Douglas' society type, treat risk as opportunity to profit, antagonism results between those producing risk and those consuming risk. The characteristics of society types are sometimes inherently contradictory to one another. A society exhibiting strong egalitarian typology, for example, may highlight environmental risks as a symptom of distrust of industry, a philosophy that directly conflicts with that of an individualist typology (Douglas & Wildavsky, 1982).

One of the primary critiques of Cultural Theory is that it ignores individual agency in risk perception and is overly deterministic in predicting how individuals will act based on their cultural context. Gross & Rayner (1985) argue that Cultural Theory does not account for why certain individuals, based upon personality or personal experience, may prefer one typology over another. Furthermore, Rayner (1992) believes that individuals may even adhere to different typologies depending on social context and are not necessarily consistent in acting within a specific typology. Ostrander (1982) too is critical of categorizing entire societies into a single typology, arguing that Cultural Theory is more useful for identifying social contexts.

Scientists and Values

While cultural theorists stress the role of values expressed by a society in the way that individuals perceive and make decisions about risk, some argue that values may also play a significant role in the way that scientists present information to the public and to policymakers. Pielke Jr (2007) distinguishes four theoretical modes of scientific communication: Issue Advocate, Pure Scientist, Science Arbiter, and Honest Policy Broker. Issue Advocates are politically interested actors who present scientific information in such a way as to limit the scope of options to those consistent with their political leanings. Pure Scientists have no personal or political interest in decision-making outcomes, and thus provide broadly relevant information without concern for how it is used. Science Arbiters act as on-call resources for decision-makers and only provide information for which the decision-maker asks. Honest Policy Brokers aim to provide decision-makers with all possible options as well as relevant information about each option, an approach that attempts to maximize the scope of options. What Pielke Jr (2007) terms “Stealth Advocacy” (7) occurs

when Issue Advocates present themselves as Pure Scientists, attempting to conceal political interests with claims of scientific objectivity. Stealth Advocacy is the fifth mode of science communication, and results in scientists limiting the scope of policy options in a way that favors their individual political views or values, potentially damaging public perceptions of scientific integrity. Pielke Jr (2007) believes there is a legitimate place in science for all four types of scientists he originally outlines if scientists are open about what role they have chosen to play. Stealth Advocates, by definition, are dishonest, or at least not forthright about their mode of operation. For Pielke Jr, scientists can act as Issue Advocates, limiting policy options in way that furthers their agenda, so long as they do not claim to be something other than an Issue Advocate.

In extreme cases, scientists may use their credentials to further their interests or the interests of others, *in spite* of science. The most notable example of this is the decades-long denial of the link between smoking and cancer by scientists working with the tobacco industry, as illustrated by Naomi Oreskes and Erik Conway in *Merchants of Doubt*. By focusing on what existing studies did *not* explain, for example the differential rates of cancer between cities, scientists working with the tobacco industry successfully created and sustained substantial doubt about the health effects of tobacco use for decades after causal links between smoking and lung cancer, bronchitis, coronary heart disease, and other diseases had been established (Oreskes & Conway, 2011). The cases described in *Merchants of Doubt* demonstrate a case of extreme Stealth Advocacy, in which scientists are politically inclined to the extent that science is ignored and misinterpreted in order to further an ulterior agenda.

Oreskes & Conway (2011) demonstrate how even small margins of uncertainty or unexplained details can be strategically exaggerated to the extent that it muddies the public's understanding of the issue. That scientists are the ones challenging existing evidence lends legitimacy to otherwise unwarranted doubt, at least in the eyes of the public. Prior to 1985, the Federal Communications Commission (FCC) required that the media had to provide coverage to 'both sides of the debate' under the Fairness Doctrine. Established in 1949, the Fairness Doctrine was meant to ensure viewer access to diverse viewpoints in a time when channels were more limited. Though intended for broadcast media, the Fairness Doctrine was practiced in print journalism as well. While perhaps an appropriate strategy for providing contrasting political views, the Fairness Doctrine served as a basis upon which minority scientific viewpoints could be expressed publicly. As Oreskes and Conway argue, the concept of covering 'both sides' is inappropriate for scientific issues because:

[S]cience is not about opinion. It is about evidence. It is about claims that can be, and have been, tested through scientific research – experiments, experience, and observation – research that is then subject to *critical review by a jury of scientific peers*. Claims that have not gone through that process – or have gone through it and failed – are not scientific, and do not deserve equal time in a scientific debate (32).

Merchants of Doubt documents an extreme case of Stealth Advocacy, as described by Pielke Jr (2007). Cases in which scientists are deliberately obscuring well-established evidence to their own ends are a form of extremism that no doubt infuriates others within the scientific community. How politically-aligned scientists can successfully lead campaigns of misinformation, even when evidence overwhelmingly contradicts their claims, can be

explained at least partially by the perception of science as ‘objective,’ and the resulting trust in those who wield the label ‘scientist.’ If society perceive science as infallible, then those who study and ‘do’ science may be perceived as intermediaries of ‘truth.’

Public Skepticism of Science

The regulatory process in the United States depends heavily upon science and scientists to operate due to its supposed objectivity (Jasanoff, 1990). Yet, as Oreskes and Conway demonstrate, our trust in quantitative sciences as impartial can allow room for politically based claims by scientists speaking outside their areas of expertise to be given fair consideration by the public. Such trust in quantification, and those who quantify, is a relatively new reality for the Western world.

Porter (1995) argues that use of clinical, quantitative, and replicable processes within decision-making have precluded the need for face-to-face interactions with experts and decision-makers, which was the original form of trust building. The use of ‘objective’ processes and peer-review are meant to ensure that no biases influence decisions that affect our lives. Thus, quantification and its assumed companion ‘objectivity,’ are key components in decision-making processes in a society that is premised on fairness and equality. So long as science is perceived to operate on norms of objectivity, society sees science as a legitimate foundation, even a privileged foundation, for making arguments about risk, no matter what ulterior motives exist for making such an argument. Similarly, scientists and other professionals that are perceived as using ‘pure’ and ‘unbiased’ quantitative methods enjoy, for the most part, a higher level of authority and legitimacy than those making arguments based upon opinion, social connections, and emotion. This cloak of authority extends by

association to even scientists and other professionals who may be taking on advocacy positions as theorized in Pielke's Issue Advocate and Stealth Advocate roles of scientists.

Though high trust in quantitative sciences may allow scientists acting as Stealth Advocates to lend legitimacy to mass *misinformation* campaigns, as described by Oreskes & Conway (2011), trust in quantification is far from a misguided inclination. The scientific process is designed to heighten certainty through successively disproving alternative explanations, particularly through the mechanism of peer review. In itself, the scientific process is highly trustworthy when viewed over long time periods. However, a problem arises when individuals who are associated with this trustworthy process do not follow scientific protocol in a genuine manner in order to further their own interests. Even slight Issue Advocacy may paint scientists as overly interested, subjective actors (Pielke, Jr, 2007). Politically interested scientists can potentially undermine public trust in science as an empirical and generally objective mechanism of discovery and serve to de-legitimize scientific and technical expertise.

Indeed, many argue that trust in scientific institutions is waning, though diverse explanations for this exist. Jasanoff (1990) in *The Fifth Branch* demonstrates that floundering trust in science, and specifically science advisory committees in the United States, may be due to a slow revelation that scientists are not wholly objective or impartial. With the growing power of regulatory agencies in the United States from the 1970s onward, reliance upon scientific advisory committees became increasingly codified in regulatory decision-making. Jasanoff (1990) demonstrates that the public questions the role of these scientific advisory committees, as well as the way in which science is used to make regulatory decisions, as biased and value-ridden. As Jasanoff and other social constructionists of science

argue, the impartial, depoliticized scientific advisory committee cannot operate the way it is idealized to do. Scandals in the 1970s and 1980s involving scientific misconduct on the part of allegedly biased regulatory agencies such as the Food and Drug Administration (FDA) and Environmental Protection Agency (EPA) contributed to widespread distrust of how science is used to inform federal regulation (Jasanoff, 1990). The rise of the term ‘junk science’ as a figurative label, as opposed to its sanctioned definition within the science community for scientific studies that are deemed biased or overly prescriptive, may also indicate that the public and media are losing trust in scientific institutions (Herrick & Jamieson, 2001).

‘How Fair is Safe Enough?’

While straying from the scientific process in regulatory decisions may heighten public distrust of scientists at the helm of decision-making, distrust may also be rooted in the systems of power in which decisions about risk are made. Rayner & Cantor (1987) claimed that “the critical question facing societal risk managers is not ‘How safe is safe enough?’ but ‘How fair is safe enough?’”(3). Citizens, they argue, are less concerned with probabilistic models of risk and magnitude used by experts to communicate their findings on hazards. Rather, society is concerned with issues of trust, liability, and equity and is more likely to respond positively to a hazard if institutions can incorporate hazards into a society in a morally acceptable way (Rayner & Cantor, 1987; Jasanoff, 1996).

In the United States, the ideals of fairness and equality are social emphasized through mechanisms for citizen expression. Public participation and access to knowledge are cornerstones of the democratic ideal in the United States, and institutionalized through The Freedom of Information Act (FOIA), forums for public grievances, and the litigation process. Informed public participation is considered a way in which citizens can join the decision-

making process and gives scientists and decision-makers a “license to operate” (Rayner, 2003, p. 165). Theoretically, public participation operates as a system of checks and balances in which an informed and active citizenry oversees the conduct of experts and decision-makers and protests any policies that are not in the best interest of the individual or society. For example, if a local jurisdiction in Washington State passes an ordinance that restricts hillside development and a homeowner feels that the regulation unfairly burdens her, she has the right to file a lawsuit against the jurisdiction or appeal to the Growth Management Hearings Board to argue that the ordinance is not consistent with state law. Alternatively, she may argue that the geotechnical or scientific report that informs the ordinance is questionable.

Jasanoff (1996) warns that increased public participation in science and decision-making may lead to more dispute, similar to the way in which it is argued that more science leads to more controversy (Pielke Jr, 2007; Sarewitz, 2004). The political framework and information culture of the United States is premised on public participation and data availability, and governments have increasingly integrated mechanisms for public participation in policy with the help of social scientists (Rayner, 2003). Though the goal of participation in decision-making is to close information gaps and exercise the public will, Jasanoff (1996) argues that in reality, participation does not automatically unveil a clear decision. Rather, a greater volume of active stakeholders will produce “discord and confusion” (65). In her opinion, the homeowner in the previous example will put forth but one of many possible opinions of the ordinance. Other citizens may counter that the ordinance is progressive, and that they do not want their tax dollars to be spent on cleanup

efforts if the homeowner's property is destroyed by a landslide. The sheer volume of different opinions on the matter may inhibit any meaningful action at all.

Implications for Regulation of Landslide Hazard

ST&S theories suggest that the relationship between scientific information and landslide hazard policy is complex. The existence of hazard information may not necessarily lead to straightforward hazard policies that directly respond to that science. Instead, values, such as property rights, beautiful views, or economic development, may play a bigger role in formulating a community's perception of, and response to, risk and the policy that follows. When the implications of hazard information conflict with a community's values-based preferences for policy, that scientific information may be rejected as false, biased, or it may be outright avoided in favor of information, scientific or otherwise, that supports preexisting opinions about what type of policies ought to exist. The public may more readily dismiss science that conflicts with their values, because its reputation as a nonpartisan and objective process has been weakened by the perceived advocacy and bias of some scientists. The next chapter turns to landslide risk in Seattle, Washington, summarizing technical studies of this natural hazard and the regulatory process that has evolved to manage exposure to it.

Chapter 3 – Landslide Characteristics

This chapter examines the history of landslide risk and regulatory management of this risk in Seattle, Washington, a city where geographic features of lake, sea, river, hillsides, and bluffs have intersected with rapid urban development. Before examining landslide regulation and policy in Seattle and the disputes that arise from them in Chapter 4, it is necessary to understand what a landslide is, and where landslide risk exists. This chapter will review the physical characteristics of landslides, Seattle's landslide risk, and landslide triggers.

Broadly defined, a landslide is the downward displacement of earth material on a slope by the force of gravity. While the term 'landslide' categorically includes rock falls and other types of rock movement, most of the landslides I will refer to in this thesis involve the failure of unconsolidated materials such as soils and glacial deposits characteristic of Seattle (Shannon & Wilson, 2000).

Though landslides occur in every U.S. state, mountainous regions see a higher rate of incidence due to their steep topography. Washington state, home to the Cascade and Olympic mountain ranges, is one of the most landslide prone states in the country (DNR, 2016).

Scientists do not agree upon a single index to measure landslide 'magnitude,' which describes the strength or power of an event (Tobin & Montz, 1997). Media typically describe landslides to the public in terms of the variables of velocity and volume of displacement. Both give a vague sense of 'magnitude' and are widely understood concepts. In the case of the Oso landslide of 2014, a commonly reported statistic was the 'landslide area' of one square mile, a reference to the ground vicinity that had ultimately been covered in debris post-impact (Ravindran, 2014). Though not a scientific index of magnitude, 'landslide area'

provided a generalized notion of the landslide's massiveness that rudimentarily combined volume displaced with spatial extent.

The duration of a landslide varies enormously depending on the event. A landslide is, in its essential definition, the force of gravity outweighing the mechanics of the materials holding it on a slope (e.g. mechanical friction and soil cohesion) (Olshansky, 1996). Failure can be a very quick process or a very long one, such as the case of soil creep, which is detectable only to a trained eye (Wold & Jochim, 1989). Even in what appears to be a 'quick' landslide, the underlying conditions that created it may have been in formation for much longer. Duration may be considered in terms of the event itself, or its triggering conditions. According to Tobin and Montz (1997):

Landslides and debris flows represent events that usually have a very short duration of impact, but a long period of onset. . . . [W]hile the slide itself may take only minutes, the antecedent conditions may have been building for hours, days weeks, or even years.

Debris displacement in a landslide can be in the range of a few meters or a few kilometers depending on extent of slope failure and the number of failures that occurred (Crozier & Glade, 2005). Tobin and Montz (1997) describe landslides as "spatially limited in extent," but with the condition that the event is individual and isolated. Any mass triggering event such as an earthquake or widespread rainfall will affect more than one susceptible slope. Under the right conditions, an entire region may be at risk for landslides if topography is consistent and exposed to the same conditions.

Landslide speed is extremely variable. A landslide can move as slow as a couple of millimeters a year, or exceed speeds of 90 meters per second (USGS, 2014). In the case of very slow movements, landmass tends to move incrementally over time, which can complicate surveillance efforts and, in the context of early-warning systems, require improved techniques for measurement (Crozier & Glade, 2005).

It is difficult to assign frequency predictions to landslide events, as they are often the product of a combination of factors including a trigger event such as an earthquake or a high amount of rainfall. Scientists have instead turned to determining areas of risk where landslides may occur under a certain combination of events (OAS, 1991). Experts can create susceptibility maps that meet conditions of probability. Typically, these areas of risk will have experienced previous landslides and are at risk of being exposed to a triggering event, such as an earthquake, heavy rainfall, or human-induced landscape changes (Wold & Jochim, 1989). It may then be possible to determine the likelihood of a certain combination of variables converging and producing landsliding. This is often done with rainfall threshold analysis but cannot be done with other triggering events such as earthquakes, which are difficult to predict outside long-term recurrence intervals (Glade, 1998; OAS, 1991; USGS, 2013).

Landslides in Seattle

Washington state has one of the highest rate of landslides in the United States (DNR, 2016). In Seattle, landslide risk is a function of its geologic conditions, its wet winters, its earthquake susceptibility, and its dense development. Over eight percent of the city's area is classified as either known landslide, which indicates past movement, or potential landslide, which indicates probable future movement (Seattle Office of Emergency Management,

2014). The City classifies steep slopes with slopes 40 percent or higher as landslide-prone; when these slopes are considered, GIS analysis of Seattle's publicly available ECA data shows that around 13 percent of the city's area is classified as either landslide-prone, steep slope, or both. Much of the landslide risk is concentrated in Seattle's coastal areas along Puget Sound and Lake Washington, but some inland risk also exists. Figure 1 depicts landslide risk and indicates neighborhoods mentioned in this thesis.

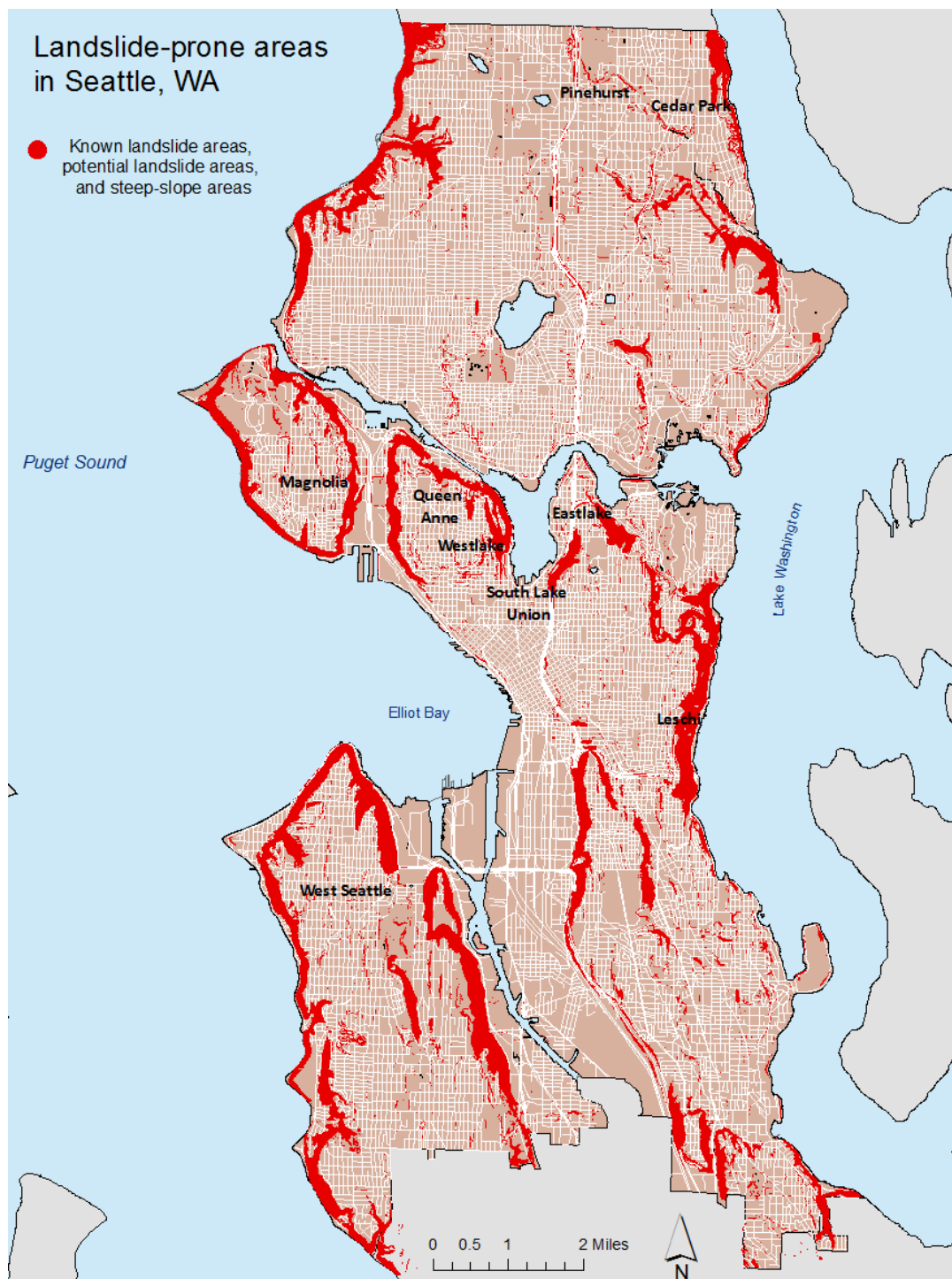


Figure 1 – Publicly available data depicts landslide-prone areas, which includes known slide areas, potential slide areas, and steep slope areas. This data was last updated in 2001 by Shannon & Wilson. The original data was used for SEPA purposes.

The geologic processes that produced Seattle's slide-prone landscape well predate human settlement in the area. Tectonic and volcanic activity, combined with the scouring and movement of material by glaciers, primarily shaped the landscape. In the past 2.4 million years, the Puget Lowland between the Cascade and Olympic ranges, has been subject to repeated glaciation, the last of which receded about 13,000 years ago (Troost & Booth, 2008). Upon glacial retreat, an array of silt, sand, clay, and gravel was deposited along Seattle's Puget coastal bluffs, creating a landslide-prone consistency of sand overlying clay. During periods of heavy or continuous rain, water penetrates the sand layer but collects upon the impermeable clay layer. As the weight of water builds, and pore pressure elevates in the sand, the sand layer may collapse in a landslide. This particularly landslide-prone combination of sand and clay is found along the coastline in Magnolia and West Seattle, where a majority of the city's landslides occur (Shipman, 2001).

The 'Seattle Landslide Study' by Shannon & Wilson (2000) identified shallow-colluvial slides and deep-seated slides as the most commonly occurring landslide types in Seattle. Shallow-colluvial slides, comprising 68 percent of landslides in Seattle, occur when large quantities of water permeate a layer of loose, sandy material and dislodge it from the slope. The saturated debris often moves rapidly, on average reaching velocities of between 13 and 22 meters per second (USGS, 2014). Shallow-colluvial landslide risk is heavily concentrated in West Seattle, Magnolia, and areas along Lake Washington (Harp et al., 2006).

Deep-seated landslides, which comprise 20 percent of landslides in Seattle, involve deeper failure points causing the movement of large blocks of material. Typically, the displacement of one block of debris will trigger further debris block displacement on the

slope. Deep-seated landslide risk is most concentrated in West Seattle and Magnolia (Shannon & Wilson, 2000). Both deep-seated and shallow landslides are often triggered by slope saturation, from either heavy precipitation, surface runoff, or rising groundwater levels.

Landslide Triggers

Landslides are caused by a multitude of factors that include both the physical characteristics of the landscape such as the type of geologic deposit, which determines material strength, vegetation cover, and slope angle, and triggering forces such as human ground disturbance, rainfall, earthquake, and toe erosion by water currents and waves, which will become a larger concern as sea levels rise. Landslides are produced by a combination of these factors.

Rainfall. In periods of high intensity and continuous rainfall, slopes are weakened and much more susceptible to sliding (Godt et al., 2008). Both deep-seated and shallow colluvial landslides can be triggered by heavy precipitation. Seattle's annual rainfall is concentrated in November through April, a period considered the local wet season. During these months, the city sees an average of 711 mm, nearly three times the average rainfall in its dry months (Chleborad et al., 2008). Most of Seattle's landslides occur in January, after concentrated precipitation in months prior (Shannon & Wilson, 2000) In the winter of 1996 to 1997, Seattle experienced high amounts of precipitation with 191 percent of average rainfall in December (USGS, 1998). The city subsequently experienced one of its worse landslide seasons in recent history with nearly 300 landslides reported (Long, 2000; Shipman, 2001).

The USGS (2011) uses two two-variable models to predict the occurrence of landslides; 3-day cumulative precipitation to 15-day cumulative precipitation preceding 3-day window and average rainfall intensity per hour to rainfall duration (Chleborad et al., 2008; Godt et al., 2008). If variables exceed thresholds in either model, landslides are more likely to occur. The USGS website dynamically updates weather conditions into each model to demonstrate current landslide risk. For example, as of March 2016, the Seattle-Tacoma airport area had exceeded the threshold based on cumulative 3-day and 15-day precipitation.

Earthquake. Earthquakes can cause widespread shaking and therefore may trigger landslides on a regional scale by shaking soil, rocks, and other earth material loose from bedrock. In some cases, resulting landslides can be just as deadly and as damaging as the earthquake itself. After China's 2008 Sichuan earthquake, landslides and rockfalls alone caused an estimated 20,000 deaths (Yin et. al, 2009). Severe ground disturbance can also create new landslide hazard zones that have the potential to cause future damage.

Earthquake risk in Seattle and the Pacific Northwest is substantial. Washington has the third highest earthquake risk in the United States after Alaska and California (USGS, 2012). The northwestern coastline of the United States is paralleled by the Cascadia Subduction Zone, an area beneath the ocean where the Juan de Fuca plate subducts underneath the North American plate (CREW, 2013). When enough strain builds between the convergent crusts, Juan de Fuca will push further underneath its counterpart, creating a massive earthquake projected to be moment magnitude (Mw) 8 or higher. While such events are rare, with current calculations of a return period of approximately 500 years for a full fault rupture, a Cascadia earthquake is expected to cause extensive landsliding in coastal areas throughout the Pacific Northwest. Planners anticipate it to block critical transportation

routes and possibly produce local tsunami events triggered by large landslides (CREW, 2005).

Seattle is also exposed to a number of shallow seismogenic faults throughout the region, including one directly below its downtown area, which is known as the Seattle Fault. The shallow faults in the Puget lowland are capable of producing earthquakes of around 6 to 7.5Mw (CREW, 2009). The Seattle Fault last produced an earthquake around 1,100 years ago, which scientists approximate had a magnitude of a 7.5Mw (ten Brink et al., 2006). Geologic evidence suggests that that earthquake sent entire hillsides and the accompanying forest into Lake Washington (CREW, 2009). Another Seattle Fault earthquake may reach the same magnitude, though lower magnitudes between 6 and 7Mw are more probable. The probability of experiencing an earthquake from the Seattle fault zone over 6.5 Mw in a 50-year period is 5 percent, while the probability of experiencing an earthquake from any shallow fault in the Puget Sound area in a 50-year period is 15 percent (Ballantyne et al., 2005).

Allstadt et al. (2013) modeled seismically induced landsliding in a 7.0 Mw Seattle Fault scenario and found that over a third of landslides likely to occur are outside of the landslide-prone areas currently demarcated by the City. The model predicts the earthquake will produce 30,000 landslides under very wet conditions, and 5,000 under dry conditions, highlighting the importance of considering the many factors that contribute to landsliding.

Human Influences. Approximately 80 percent of recorded landslides in Seattle have been caused in part by human activity (Shannon & Wilson, 2003). However, Laprade & Tubbs (2008) note that landslides that do not endanger property are less likely to be reported,

and thus the apparently high proportion of human-influenced landslides may be an overestimate.

Since officials began keeping landslide records in 1890, the frequency of landslides in Seattle has increased nearly every decade, due in part to the acceleration and extent of development (Seattle Office of Emergency Management, 2014). Development of housing, roads, and other infrastructure can be deleterious to the stability of a slope and may induce landslides under the right conditions. In general, excavating or filling a slope, poorly designing a drainage system or removing vegetation heightens the risk of landslide (Wold & Jochim, 1989; Crozier & Glade, 2005). However, many argue that in some areas, developing impervious surfaces and other structural improvements reduce existing landslide risk (Laprade & Tubbs, 2008). For example, development of seawalls or other types of barriers along the majority of Seattle's coastlines have protected the toes of slopes from wave action, and prevented landsliding (Godt et al., 2008; Laprade & Tubbs, 2008). Methods for engineering in a manner that lessens risk, and even stabilizes landslide-prone slopes, exist, yet much development in urbanized areas precedes the codification of such methods. As a result, older infrastructure may have been developed in a way that that puts strain on slopes, and heightens landslide risk.

Seattle's landslide risk is the product of its geological history and its exposure to trigger mechanisms, including heavy rainfall, earthquake, and human activity. Seattle's population has struggled to understand and mitigate its landslide risk since European settlement, with officials documenting landslide events since 1890. Despite many major landslide events in the first half of the twentieth century, it was not until the 1970s that Seattle began to develop a hazard regulatory framework.

Chapter 4 – Regulating landslide hazard areas

This chapter discusses Seattle’s gradual development of its regulatory framework for addressing landslide hazard risk. It details the period prior to the enactment of the federal and state laws that propelled the creation of more robust hazard regulations at the local level, details the development of Seattle’s Environmentally Critical Areas regulations, and provides an overview of those regulations in their current form.

Olshansky (1998) outlines four perspectives on development in landslide hazard areas that often coexist, sometimes conflictingly, in land use policy. Each perspective is held by a different actor who may advise local government. The first is the aesthetic perspective, often touted by architects and developers, which views the hillside as an opportunity for creative real estate development. This perspective rarely considers public safety. As Olshansky argues, “Hillside residences often have been designed to soar above the slope, to accentuate the sense of danger and discovery, rather than to adapt to the hillside’s constraints” (385). The second perspective considers hillside development in the context of public safety, and it is often supported by geologists and some engineers. The public safety perspective advocates diligent hazard mapping and responsive engineering solutions to mitigate the hazard. Because mitigation could call for risk elimination through mass grading, which involves the removal or fill of large amounts of ground material, this perspective is at odds with the aesthetic perspective, which frames the hillside as a canvas for architectural creativity. The third perspective, often espoused by landscape architects, combines aesthetic concerns with regard for the ecological functions of the hillside, though Olshansky argues that concern for the aesthetic and for the environmental are rarely integrated effectively. The fourth perspective, which is that of planners, attempts to reconcile many perspectives into land use

policy through the implementation of slope-density regulation. Slope-density regulation, which requires lower density development on steeper slopes serves multiple perspectives. This regulatory approach serves the aesthetic perspective by precluding invasive mitigation methods, such as mass grading that may have been necessary for higher density development. Yet it also serves the public safety perspective by minimizing development in areas considered hazardous.

Seattle's current approach to hillside development emphasizes the public safety perspective and environmental protection. Current policy and regulatory frameworks in Seattle, including the comprehensive plan and municipal code, recognize government responsibility for maintaining the health of critical areas and the safety of those living within or adjacent to them, as stated in their purposes. The government's primary tool for fulfilling this responsibility is through review and regulation of land use on steep slopes that goes beyond regulation of development elsewhere. However, as will be discussed, the government throughout much of the twentieth century lacked the regulatory power it has today to prohibit or limit hillside development. During much of Seattle's development, the responsibility of ensuring sound construction was borne by developers, who Seattle land-use attorney Richard Settle argues were incautious of landslide hazards:

[D]evelopers have paid little heed to topography and subsurface geology, soil permeability and steepness of slopes, flood plains, surface drainage and groundwater. . . . By the time houses slid down slopes or were swept away by floodwaters, septic tanks ceased functioning or wells became polluted, the subdivider had sold out and moved on (Settle, 1983).

Lack of a robust regulatory framework for guiding development in hazard areas resulted in building stock susceptible to landslide hazard, which set the stage for several major landslide events throughout the twentieth century.

Seattle has landslide records dating back to 1890. Black and white photographs depicting tilted houses and collapsed hillsides at the turn of the century can be found in its municipal archives. An 1897 letter from a city engineer to the city attorney indicates early attempts to mitigate landslide risk along shorelines by building retaining walls and covering slopes with impervious surfaces (Laprade & Tubbs, 2008). While early residents of the city maintained a cultural understanding of landslide risk through experience, comprehensive scientific data that could delineate where risk was high, and where it was low, was not yet available.

When hillsides failed, the public typically considered the government liable, charging it with neglecting drainage systems or improperly building public infrastructure. After heavy rains triggered citywide landsliding in the winter of 1933-34, the City was sued for a total of over \$600,000 (nearly \$11 million in 2016 dollars) by homeowners alleging the City had failed to maintain its drainage systems (Maier, 1997a). As lawsuits were pending, the City successfully petitioned the Federal Civil Works Administration and state's emergency relief agency for aid, which funded over thirty landslide mitigation projects in the city over the next two years (Laprade & Tubbs, 2008). Mitigation projects focused heavily on developing drainage infrastructure, particularly on Perkins Lane in Magnolia, which sits on a bluff overlooking the Puget Sound. In total, the City spent around \$1.5 million in landslide prevention efforts on Perkins Lane after the 1933-34 landslides, while development continued on the bluff unabated (Maier, 1997b). A historical photograph, shown in Figure 2,

depicts a real estate sign in 1938 that reads ‘Best Buy. Best View on Perkins Lane. NO SLIDES. Civil engineer says...Good condition to build on.’ The sign’s emphasis on ‘no slides’ attests to the notoriety of the landslide hazard on Perkins Lane, as well as the reliance upon technical specialists, rather than regulatory restrictions, when evaluating landslide risk.



Figure 2 *This 1938 real estate sign was photographed on Perkins Lane in Magnolia, a street considered Seattle’s ‘poster child’ for landslide risk. Homes on the street would undergo repeated damage from landslides, the most famous of them a slow moving slide between 1996 and 1997, which sent six homes down the bluff. Courtesy of Seattle Municipal Archives, Item 12194*

In the winter of 1942, Perkins Lane slid again. That same winter, a landslide on East Boston Terrace in Capitol Hill pushed a home 750 feet down a ravine, killing Ruth Grapp, and seriously injuring her husband. The Capitol Hill landslide had not come without warning; city officials had come to warn the couple of slope instability under their home just days before the slope failed. One year prior, another landslide had destroyed the house of another East Boston Terrace resident (Maier, 1997b).

In response to the landslide under the Grapp property, as well as to landsliding under Perkins Lane, the City Council proposed prohibiting construction on slopes known to be hazardous. This proposal was almost immediately retracted after city lawyers advised the Council that such a regulation would result in lawsuits from property rights proponents, in addition to the existing lawsuits alleging city liability for landslide damages. Government regulation of hillside development directly contradicted a conventional conception of individual property rights that supposed a homeowner should be able to build on the land he owned, regardless of risk. As City Attorney A.C. Van Soelen remarked in response to the failed Seattle proposal:

You would, in effect, be telling a property owner who presumably had investigated and satisfied himself, perhaps with engineering advice, he could build safely, that you dispute his judgment and won't permit him to do what he wants with his own property (Maier, 1997b).

While failing to pass development restrictions on steep slopes, the City Council did require that residents on Perkins Lane sign a covenant acknowledging the slide-risk on their properties (Nelson & Ostrom, 1997).

Transition into Regulation

The State Environmental Policy Act (SEPA) provided Seattle with its first tool for monitoring development in hazard-prone areas. The passages of the National Environmental Policy Act in 1969 at the federal level and SEPA in Washington state in 1971 reflected a growing regional and national concern for the environment, as well as a recognition that jurisdictions lacked the legal tools to address these concerns. The SEPA review process,

which is still in effect, required that a project applicant complete an environmental checklist evaluating potential impacts of his or her proposal and detailing strategies to mitigate for those impacts. Based on the applicant's checklist, the lead agency either required an Environmental Impact Statement or issued a Determination of Nonsignificance. The results of the SEPA process served to inform permit decisions, but had no regulatory weight per se. In effect, reliance on SEPA to regulate development in critical areas vested substantial trust in the developer. Developers could build in a steep slope or landslide-prone area so long as they assured the city they would use sound construction techniques and that they acknowledged the risk of building on the site (Associated Press, 1986; Ho, 1996).

In 1984, Director's Rule 7-84 laid out the city's first set of regulations for developing in landslide-prone areas. The rule required that applicant's submit topographic surveys and hire geotechnical consultants to do site and stability evaluations for landslide-prone areas before a permit was granted. The City also hired its first geotechnical engineer to review these evaluations and conduct site visits, if necessary. At the time, these standards were considered stringent in comparison to those enforced in other jurisdictions in King County, many of which experienced similar landslide risk (Balter, 1986).

In 1990, the State legislature passed the Growth Management Act (GMA), which directs jurisdictions to develop comprehensive plan policies and codes that address the protection of critical areas, which are areas considered environmentally valuable or hazardous to human safety. Though the GMA did not require jurisdictions to amend their policies until the following year, the City Council passed an emergency ordinance to adopt interim environmentally critical areas (ECA) regulations, which regulate development in hazardous and other environmentally sensitive areas, as a placeholder until permanent ones

could be developed. The interim ECA regulations, which required that a certain percentage of a lot in a wetland or on a steep slope remain undeveloped, were met with protest from many developers, who worried the regulations would render many properties less developable. However, the regulations were widely supported by many residents of slide-prone neighborhoods who often bore the cost of stabilizing slopes themselves (Nelson, 1990). The interim regulations were replaced with permanent ECA regulations in 1992, which clarified and strengthened the interim regulations.

Shifts in Policy

In 1995, a developer sued the City after the Department of Construction and Inspections (DCI) denied him an ECA exception, which would have allowed him to bypass the requirement that 30 percent of the steep slope area on his property be left undeveloped. A Superior Court judge ruled in the applicant's favor, reasoning that development on more than the allowed portion of the slope would serve to stabilize it, and that enforcement of the 30 percent rule would heighten risk. Though the judge's ruling only applied to the applicant's property, city officials feared that the precedence set by the case would invite future lawsuits based in the same argument. In response, ECA regulations for steep slope and landslide-prone areas were amended so that DCI could exempt projects from regulations that, if applied, would inhibit stabilization of a slope. A geotechnical engineer for DCI remarked to the *Seattle Times* the following year that, despite reviewing more development proposals in landslide-prone areas, "We basically have to see a fatal flaw that we're willing to go to the mat for if we're not going to grant a permit" (Paulson, 1997). Effectively, the outcome of the lawsuit budged the City into allowing almost any development proposal on a steep slope that was backed by geotechnical expertise.

In the winter of 1996-97, Western Washington experienced heavy rainfall that resulted in nearly 300 landslides throughout Seattle; these landslides damaged nearly 100 properties. On nearby Bainbridge Island, a family of four was killed when their home fell down a slope and into the Puget Sound in the middle of the night. That fatal and highly publicized landslide, along with landslide damages to public and private property in Seattle totaling over \$100 million, prompted the City Council to enact a 90-day moratorium on development in hillside areas while they investigated damages and considered whether current regulations were sufficient (Conklin, 1999). Though most damage to private property was found to be on lots developed prior to the passage of ECA regulations in 1990, the extent of the damage propelled the City to consider a new approach to its landslide policy that focused on public outreach and a better scientific and spatial understanding of landslide hazard.

The City worked with the United States Geological Survey (USGS), Seattle geotechnical firm Shannon & Wilson, and University of Washington geologists to produce new landslide hazard maps for the city that could inform future policy. The Shannon & Wilson 'Seattle Landslide Study,' which was published in 2000 and updated in 2003 (Shannon & Wilson, 2000; Shannon & Wilson, 2003), detailed landslide risk based on analysis of Seattle's historical landslide records, consulting records, and field tests. The study provided recommendations for remedial action. In 2006, the USGS published a series of landslide risk maps and models that depicted susceptibility to different types of landslides under variable weather conditions, including an overall landslide recurrence interval and probability map that was made public. The use of historical landslide analysis and LiDAR, a remote laser-based surveying technology, produced more precise risk maps that depicted four

times the amount of landslide than had been depicted in previous maps (Schultz, 2005). In response to the publication of both the Shannon & Wilson and USGS studies, Seattle in 2006 updated its ECA regulations to codify the new hazard maps into decision-making, changing the definition of a landslide-prone area in the Seattle Municipal Code to include those areas mapped by the Shannon & Wilson study. DCI also made amendments to conditions for building in ECA areas. It began enforcing Director's Rule 32-2006, which requires additional Letters of Certification from geotechnical engineers that ensure no conditions have changed on landslide-prone sites between the issuance of a permit and commencement of construction. It also placed more restrictions on altering vegetation or trees in landslide-prone areas.

2014 Oso Landslide. The 2014 Oso landslide in Snohomish County re-sparked the regional conversation about landslide risk and appropriate policies for addressing that risk. Though the focus of the debate was on the regulatory framework for hazard mitigation in unincorporated Snohomish County, policymakers at the state level were also pressured to reconsider their role in creating risk-averse policy through data provision. The Department of Natural Resources provides geographically limited statewide landslide data to the public, which is often used by jurisdictions, sometimes in conjunction with local data, to inform hazard policies.

After the Oso slide, Governor Jay Inslee signed Senate Bill 5088, which allotted \$4.6 million to statewide landslide hazard mapping using LiDAR. Supporters of the Bill hoped that with access to precise landslide hazard data throughout the state, jurisdictions would be better equipped to prevent 'another Oso.' Seattle, for its part, published LiDAR based landslide-hazard maps of the city in 2006, a product of the effort to better understand

landslide risk after the 1996-97 landslide season. Though Seattle officials made minor amendments to its ECA regulations in 2014, no fundamental changes were made directly due to the Oso event. A government planner said, “[T]he changes that we’re making are not because of Oso, because we feel like we do a good job already.” The city’s planners considered its approach to hillside development sufficient under its current regulatory framework, a framework summarized below.

Current Regulatory Framework

Seattle Municipal Code (the Code) Section 25.09 Regulations guide development in areas considered at risk for landslide as part of designated Environmentally Critical Areas (ECAs). ECA regulations control development in areas prone to natural hazards or with important ecological function. Areas categorized as ECA in Seattle’s Code include those prone to landslide, flood, liquefaction, seismic and volcanic activity, as well as wetlands and wildlife conservation areas. In Seattle, landslide-prone areas compose 8.4 percent of the city’s area (Seattle Office of Emergency Management, 2014).

Landslide-prone areas include ‘known landslide areas,’ which demonstrate past movement either through documented record or geological evidence, ‘potential landslide areas,’ which are those areas mapped by Shannon & Wilson (2000) in its ‘Seattle Landslide Study,’ areas with past landslide activity, landslide runout zones, areas within a certain distance of the top of a steep slope, and areas on a steep slope. Steep-slopes are defined as areas with a vertical incline of ten feet or more over a horizontal area of 25 feet or less, or forty percent incline.

In general, an applicant who wishes to develop in a landslide-prone ECA must apply for a land use permit from the Department of Construction and Inspections (DCI). The

application must include a topographic survey detailing the physical landscape of the site and prepared by a licensed surveyor, a map detailing critical areas and buffers prepared by “qualified professionals,” and technical reports that detail the geology, hydrology, and soils on site, as well as engineering conditions that must be met to make a project feasible.

A permit, if granted, is conditioned approval of a land use project. However, a building permit is also required to commence demolition or construction. The applicant must meet all requirements from the both the general development standards and standards for landslide-prone critical areas, at minimum, in order to receive a permit approval from the Director of DCI (Director). Provided below is only a selection of the requirements from these regulations:

General development standards (25.09.060)

- Avoid negative impacts to ECAs
- Fencing during construction
- Minimize removal of vegetation
- Review of construction schedule and mitigation plan
- Grading generally complete before the wet season

Landslide-prone critical areas (25.09.080)

- Stabilize all areas of a site disturbed by construction
- Minimize environmental harm and ensure stability and safety
- May be subject to third-party geotechnical review
- Do not remove of trees or vegetation unless pruning or routine maintenance

If applicable, the development standards for steep slope areas (25.09.180)

- May not develop on steep slopes of over 40 percent incline unless
 - The site is located where other development is already located
 - The steep slope in question was created through previous, legal, grading activity
 - The slope is less than 20 feet in vertical rise and more than 30 feet from another slope
 - Development promotes stability of the slope
 - A steep slope variance is granted; in which case only 30 percent may be disturbed
- Must buffer 15 feet between development and the toe and the top of the slope
- Authorized vegetation removal must be kept to a minimum and must followed a plan approved by DCI

If the proposed development also falls within a Shoreline District, it is subject to additional development standards as described in 23.60A.156 Standards for Environmentally Critical Areas in the Shoreline District. These shoreline regulations impose additional requirements for development in Shoreline Districts due to concerns about their impact on water quality and marine habitat.

Regulatory Relief. In some cases, an applicant may be eligible for regulatory relief, indicating that the applicant does not have to meet some or all of the requirements described

above. Applicants have four primary avenues for regulatory relief in areas considered landslide-prone:

- ECA exemptions,
- small project waivers,
- steep slope variances, and
- ECA exceptions.

Applicants will typically pursue exemptions first if they believe they qualify for one. If an applicant does not qualify for an exemption, the applicant may apply for a small project waiver or a steep slope variance, depending on the characteristics of the project. ECA exceptions, the last option, can be pursued only after the applicant demonstrates that the project qualified for no other type of regulatory relief. Each form of relief is described in more detail below.

An exemption is the broadest form of relief possible and, if granted, the project in question is exempt from all provisions of the Code's Regulations for ECAs, though it must still follow all other applicable regulations in the general land use code. An applicant only qualifies for exemption relief if the project meets one or more of the following criteria:

- 1) not within an ECA,
- 2) involves ending a public health or safety risk and requires immediate remediation,
- 3) alters an existing structure that does not negatively impact the ECA,
- 4) rebuilds a structure "destroyed by an act of nature" and construction does not further impact the ECA,
- 5) only involves relocation of utilities infrastructure under certain conditions,

- 6) is a public project,
- 7) is routine repair to public facilities,
- 8) is routine vegetation or tree maintenance.

If an exemption is granted, the project is no longer guided by the standards within the ECA Regulations chapter, save for any conditions laid out by the Director. If an applicant does not qualify for exemption, the applicant may seek other types of relief, depending on the characteristics of the project proposal. There is no administrative appeal process for exemptions.

If an applicant does not qualify for exemption, the applicant may seek a small project waiver. DCI may grant an applicant a small project waiver within a landslide-prone area if the proposal is to build a new accessory structure or addition to an existing structure that is:

- 1) limited to 300 square feet within a steep-slope area or 750 square feet within a landslide-prone area,
- 2) the lot existed prior to October 31, 1992 when the city's permanent ECA regulations were adopted, and
- 3) it is not possible to develop outside of the ECA or buffer.

A waiver permits a project, by virtue of its small-scale, where it may otherwise be denied in a regular review process. Small project waivers are exempt from application submittal requirements (25.09.330), which require a detailed plan of how an applicant will comply with general development standards. However, projects granted small project waivers are still subject to all other ECA regulations.

If developing on a steep-slope area, an applicant may apply for a steep slope variance, which reduces the required 15-foot buffer from the top and toe of the slope. An applicant may pursue this type of relief if the project does not qualify for, or does not need, the high level of relief provided by exemptions. Variances provide relief from specific code requirements. A steep slope variance reduces buffers to slope only to the minimum necessary “to afford relief from hardship.” Steep slope variances are only granted if the lot in question existed before the adoption of ECA regulations in 1992.

An ECA exception is the last course of action in seeking regulatory relief; DCI will not consider granting an exception until “all other administrative remedies in the ECA Regulations and Code Title 23 have been exhausted” (SDCI, 2015, p.1). ECA exceptions allow applicants to use and improve the value of their land, despite ECA status. An exception modifies regulations to allow “reasonable use of the property” with modification limited to the “minimum necessary” to grant reasonable use. For example, if an applicant can demonstrate that the standard setback precludes reasonable use of the property, an applicant could request an exception to alter a setback to a distance less than the minimum stipulated in the ECA regulations. If such an exception is granted, all other regulations within the chapter still apply.

SEPA. The State Environmental Policy Act (SEPA) requires DCI to consider potential environmental impacts of development proposals before making decisions. Depending on scale, location, and ECA status, a project may be considered categorically exempt from SEPA review. Smaller projects, those in high-density areas, and those outside of ECA areas are more likely to fall into the exempt category.

Two types of activities within ECAs automatically require SEPA review due to their high environmental impacts: grading activity within a landslide-prone area and short platting within any ECA. Grading involves altering ground level by excavating, adding, or moving soils, which in landslide-prone areas has the potential to destabilize the slope and thus requires SEPA review. Short platting divides a property into multiple lots for multiple structures. The higher intensity development suggested by a short platting project increases the load on a slope and, thus, the potential the slope will fail. As such, short platting subjects the project to SEPA review. In addition, any development proposal for a single-family dwelling within a landslide-prone area is subject to SEPA review if the lot is over 9,000 square feet (836 square meters).

Applicants subject to SEPA review must submit an Environmental Checklist that acknowledges potential adverse environmental impacts their project may have and what mitigative measures the applicant will take. An applicant must erect a sign of public notice indicating that the proposed project is under environmental review. Following the erection of the sign, the proposal is subject to a public comment period of 14 days in which members of the public as well as the applicant can submit letters to DCI to express their support for, or concerns about, the proposed project. At the end of the comment period, DCI will make an environmental threshold decision, a decision that determines whether further review is required. If DCI determines that a project is likely to have substantial adverse environmental impact, DCI will issue a Declaration of Significance. With such a declaration, the applicant must submit an Environmental Impact Statement, which DCI uses to decide whether to approve or deny a permit, as well as any conditions upon which an approval is granted.

Appeal Process. All decisions made by DCI are appealable to Seattle’s Hearing Examiner, with the exception of Type I decisions, which include exemptions. Any party may appeal a decision, including applicants, neighbors, and concerned citizens. Applicants may appeal the denial of a permit or regulatory relief or the conditions placed upon their projects. Neighbors or concerned citizens may appeal the granting of a permit, regulatory relief, or conditions placed upon a project. The Hearing Examiner’s task is only to evaluate whether the Director of DCI made a decision consistent with the Code, with the burden of proof that a decision was inconsistent resting on the party appealing. For this reason, the Code directs the Hearing Examiner to give “substantial weight” to the Director’s decision. If an appellant loses his or her case at the Hearing Examiner level, the appellant still has recourse to appeal to the Superior Court of Washington and then up through the appeals courts to the State Supreme Court.

Actors

The main actors in a permitting appeal process are the applicant, the appellant, and the mediating government agency. However, outside experts may also play a role in the dispute process. Below are brief definitions of the roles and responsibilities of actors, as well as their relationships with other actors.

Applicant. An applicant is a property owner or developer who is applying for a permit to build upon his or her property. When a property is in an ECA area, the applicant must hire a geotechnical engineer, and potentially other types of technical experts, to assess the feasibility of development on a parcel. The applicant then submits a geotechnical report with a land use application to DCI. If a land use application is approved, the applicant may

move to obtain a building permit. If an application is denied, the applicant may reapply with an altered proposal or appeal DCI's decision to the Hearing Examiner.

Department of Construction and Inspections (DCI). DCI is a city agency that regulates land use and construction practices; it is responsible for enforcing Seattle's ECA regulations. DCI reviews land use and building applications and issues permits based on whether a proposal is consistent with municipal code. Most land use decisions made by DCI are appealable to the Hearing Examiner. DCI was formally known as the Department of Planning and Development (DPD) and as the Department of Construction and Land Use (DCLU). For clarity's sake, the agency is referred to only as DCI throughout this thesis.

Hearing Examiner. The Hearing Examiner is responsible for reviewing decisions of city agencies when they are challenged as inconsistent with applicable regulations. When applicants or appellants challenge decisions made by DCI, they are heard by the Hearing Examiner, who determines whether DCI's decision was consistent with code. The Hearing Examiner is the final administrative authority on decisions. Appellants must file a lawsuit for further appeal.

Appellant. An appellant is an individual or group that formally challenges a decision made by DCI, whether that decision is the approval of, denial of, or conditions attached to, development. An appellant may be the applicant or a third party opposed to DCI's decision.

Geotechnical engineer. A geotechnical engineer assesses the feasibility of development on a site through evaluation of ground characteristics. Applicants hire geotechnical consultants, often through consulting firms, to produce reports for a land use application. The geotechnical engineer produces a report that details strength parameters of

ground material and makes recommendations for how development can safely occur based on the site's limitations, but stops short of making structural recommendations.

Conclusion

Seattle's history of landslide disaster prompted the City in the 1980s and 1990s to adopt more stringent development rules for hazardous areas. Property owners or developers who wish to develop in landslide-prone areas must now follow several sets of standards laid out in Chapter 25.09 of the Seattle Municipal Code. A proposal must meet all applicable ECA standards for the DCI to approve the application, or it may be subject to conditions, or denied. If an applicant or third party opposes DCI's decision, they may appeal to the Hearing Examiner. These appeals are a major focus of my methodology.

In the next chapter, I explain the methodology I used to sample and analyze contentious land use regulation of steep slopes in Seattle. Most of the disputes that I analyze take place at the Hearing Examiner level. However, some disputes went through the Hearing Examiner and then on to various levels of appeals in the court systems, and one originates in the court system.

Chapter 5 – Methodology

To better understand the role of geological information in supporting risk-adverse land-use planning in development in Seattle, this thesis aims to identify a) what common arguments about landslide risk and regulation are used by actors in regulatory disputes in Seattle and b) how these actors use science and technical information to support their arguments. For the purpose of this thesis, disputes are defined broadly as legal challenges that revolve around landslide-related regulations, policy-decisions, or hazard outcomes, and is concerned with the time period from 1990-2015.

To identify how actors use science and technical information to support their arguments, I analyzed arguments in twelve temporally and geographically diverse disputes by manually organizing selected disputes by their outcomes, actors, and arguments. I noted which actors most commonly used scientific and technical information, and how that information supported their interests, and which actors relied on non-scientific information or lacked evidence in their arguments. To illicit broader actor arguments and interests about landslide risk regulation, I analyzed dispute material, news articles documenting landslide regulation debates, and interviews with scientists and planners with experience in landslide hazard risk. I describe my selection of disputes and analysis methodology below. In the later part of the chapter, I provide narrative summaries of the 12 disputes selected.

Identifying and Sampling Disputes

I collected and cataloged disputes relating to Seattle's ECA regulations between 1990 and 2015 through a search of court records, GMA hearing board records, newspaper archives, neighborhood blogs, hearing examiner records and basic google searches.

Keywords “steep slope” and “landslide” were used in combination with the words “appeal,” “regulations,” “lawsuit,” and “Seattle” depending on the search engine. These searches produced close to 200 disputes, which were manually filtered to ensure relevance to the thesis topic. I eliminated 110 disputes that either did not fit my temporal or geographic criteria, were duplicates, or were not focused on landslide regulation. From the remaining 90 disputes, I selected only those disputes in which landslide-related regulations were a significant part of contention, and only those in which action was taken by a party to change an interpretation of these regulations or the regulations themselves. I opted out of selecting regulation-related disagreements that amounted only to online banter common to neighborhood blogs, not because these disputes are not valuable to understanding the politics of hazard regulation, but because these disputes lacked the depth needed for analysis. These more informal and social-media based disputes were cataloged and used as content for narrative analysis in a separate dimension of the project, as described in the section *Actor Narratives and Fundamental Perspectives on Landslide Hazards* below.

After manual filtering, there remained 90 disputes, 81 of which were Hearing Examiner case files. Eight were court cases including Superior, Appeal, and Supreme cases. One was a Growth Management Hearing Board Case against the City of Seattle. From this list of 90 disputes, 40 were randomly selected by assigning each dispute a number and generating a random set of numbers. For each of the 40 disputes selected, I created a file that included a dispute summary, noted the date, address and neighborhood, appellant information and resolution. I logged dispute files in a single spreadsheet where they could be organized and compared easily. My goal was to find a means of sorting these disputes into categories by which I could systematically select a subset of 12 disputes for my final sample.

I decided to divide cases into clear-cut categories of appellant type, time period, and geographic location. I had originally planned to categorize my disputes by primary grounds for launching dispute, but found that in a majority of cases appellants and plaintiffs use multiple and diverse arguments to maximize their odds of prevailing in the case. For instance, neighbors appealing a development project based on its impacts on traffic and parking may find it useful to cite issues with the land's geological stability, the adequacy of its mitigation measures against slope failures, or even the proposed building's aesthetic design. The tendency for cases to hold mixed arguments on both sides complicates identifying a singular grievance by which cases could be categorized, though categorizing by appellant type, period, and location proved a viable categorization scheme.

I found three distinct categories for appellant type: neighbors challenging greenlighted projects or specific conditions by which a project had been approved ('neighbor'); applicants challenging a project denial or project condition ('applicant'); and residents or citizens challenging regulations or regulation enforcement alleged to have resulted in adverse events post-development, typically with claims of negligence ('plaintiff').

From the 40 cases cataloged, 25 were 'neighbor' appellant type, 13 were 'applicant,' and two were 'plaintiff.' I used proportional sampling of my appellant types to select my final case sample. Because my goal was to have twelve cases for in-depth analysis, I aimed to have seven 'neighbor' cases, four 'applicant' cases and one 'plaintiff' case. To select these cases in a way that produced temporal and geographic diversity, I divided my time range into three roughly equal intervals: 1990-1997, 1998-2006, and 2007-2015. I then allocated a roughly equal number of cases within each appellant type to each time period. For example, of the seven 'neighbor' cases, three were selected from 1990-1997, two from 1998-2006 and

two from 2007-2015. The time period 1990-1997 was allotted the higher number of cases where the total did not divide evenly by three because the greatest number of cases lay in that range. With the predetermined selection criteria in mind, shown as the italic numbers in Table 1 below, I went through my 40 case spreadsheet to do the final selection.

Table 1. *Ideal and actual dispute selection by year and appellant type*

Time period	Citizen	Applicant	Plaintiff
	<i>Ideal (Actual)</i>	<i>Ideal (Actual)</i>	<i>Ideal (Actual)</i>
1990-1997	3 (3)	2 (2)	
1998-2006	2 (2)	1 (2)	1 (1)
2007-2015	2 (2)	1 (0)	
Total	7	4	1

The selection of actual cases, shown in parentheses in Table 1 above, deviated slightly from my ideal selection. There was no case that fulfilled the ‘applicant’ appellant type within the time range 2007-2015, so I selected one from the closest year in the 1998-2006 category. Where multiple cases fulfilled my criteria and I could make a choice, I chose based on geographic diversity, noting the neighborhood associated with the case. I ensured I had good representation of the West Seattle and Magnolia neighborhoods, where a majority of disputes come from, but also that I had representation from Lake City, South Lake Union, and Leschi. Out of the two options I had to select for my ‘plaintiff’ category, I chose the one

that I knew had better documentation. For each dispute, I gathered all available news articles and legal files, creating case files for each.

Gathering Data

For disputes that took place at the Hearing Examiner level, I accessed the Hearing Examiner file on the city website. For disputes that reached Superior Court, I accessed court records at the City Clerk's office in downtown Seattle and printed select documents. One dispute was a State Supreme Court case, which, upon arrival at the courthouse in Olympia, I discovered had been destroyed. However, that dispute had been so highly publicized in the late-1990s that I decided to move forth with it, relying solely on news articles and limited court records from third party online legal databases.

For all disputes, I searched for additional data through name searches on the Google search engine and within Seattle Times and Seattle Post-Intelligencer archives.

Analyzing Science and Technical Arguments

To identify how science and technical information are used in landslide hazard disputes, I studied the arguments and information used in the sample cases. I wrote case summaries for each dispute, highlighting where technical information-based arguments were made. I then created a spreadsheet that noted the case's actors, the actors' preferred outcomes or desires, the main arguments put forth, and what type of evidence supported those arguments. Also noted for each case was which actor prevailed in the dispute. Prevailing actors were compared against the types of arguments those actors tended to make, and what kind of information those actors tended to use.

Interviews

In addition to collecting and analyzing dispute files, I conducted semi-structured interviews with six planners and seven science or technical experts through personal referral and through participant referral. Science and technical experts were composed of one geotechnical consultant and six university or government geologists. Planners worked in the areas of hazard mitigation, disaster response, permitting, or policymaking and were from various regional jurisdictions.

I asked planners a different set of questions than scientists and technical experts, but both groups discussed the general themes of science-policy communication, their role in science-policy communication, and obstacles to better landslide hazard regulation. Interviews were semi-structured, and involved a limited number of set questions, but I encouraged participant elaboration and extended discussion. I transcribed all interviews and used the transcriptions as sources for qualitative analysis and as quotes within the body of this thesis. Because my project involved interviews, I completed a human subjects review and developed an informed consent form that was provided to informants before their participation in my project. Informants were made aware that their identities would be left anonymous. A list of predetermined questions and a copy of the informed consent form are located in the appendix.

Using NVivo for Organization and Analysis

To identify the origins of actor narratives and arguments, I analyzed dispute documents, news articles, and interviews with scientists and planners using narrative analysis in NVivo. NVivo 11 is a standard qualitative data analysis software that organizes, codes,

and visualizes patterns in data. It stores and analyzes data across ‘cases’— in this thesis dispute cases — and ‘nodes,’ which are used to identify themes. The user can code sections of text by different nodes and later compare the prevalence of nodes, relationships between text sources and nodes, or relationships between types of cases and nodes. NVivo served primarily as an organizational tool and as a coding tool for this project.

I used NVivo 11 to store 130 news articles, over a dozen legal documents, and nine interview transcripts. Within NVivo, I then coded all text iteratively over the course of six months as new sources were added to the database. I coded sections of text at a node that reflected a specific argument, concern, or desire of an actor, or for broad concepts. For example, I coded ‘negligence’ because it is an argument, ‘parking’ because it is an actor concern, ‘views’ because it is an actor desire, and ‘acceptable risk’ because it is a broad concept that relates to multiple actors and their arguments, concerns, and desires. I coded iteratively, deleted nodes, renamed them, or merged them with other nodes as found to be fit to the data. Figure 3 is a screenshot depicting a partial list of nodes in order of reference frequency. After all text had been coded, I discussed the nodes that had the most text references as they relate to actor narratives in disputes. The purpose of narrative analysis was to identify worldviews, perceptions, or stories of individuals or groups through data and artifact analysis.

The screenshot shows the NVivo Pro interface with a list of nodes. The nodes are sorted by the number of references, with 'Liability' having the highest count at 29. The table below represents the data shown in the screenshot.

Name	Sources	References	Created On	Created By	Modified On	Modified By
Liability		29	12/21/2015 4:22 PM	AMC	4/3/2016 8:06 PM	AMC
Safe with proper engineering		20	1/13/2016 2:29 PM	AMC	4/8/2016 9:08 AM	AMC
Acceptable Risk		16	12/21/2015 3:01 PM	AMC	4/3/2016 8:09 PM	AMC
Tension or contradiction		16	1/7/2016 5:21 PM	AMC	4/8/2016 10:04 AM	AMC
Opposition to development		7	12/15/2015 3:51 PM	AMC	2/23/2016 9:46 AM	AMC
Pro-development		13	12/16/2015 8:09 PM	AMC	4/3/2016 8:09 PM	AMC
Views		9	1/8/2016 11:56 AM	AMC	3/16/2016 5:11 PM	AMC
CONTEXTUAL		15	3/16/2016 4:12 PM	AMC	3/31/2016 11:48 AM	AMC
Risk communication		11	1/8/2016 12:17 PM	AMC	4/3/2016 8:34 PM	AMC
Public bears private costs		11	2/23/2016 10:26 AM	AMC	3/25/2016 12:24 PM	AMC
Mitigation		9	12/22/2015 10:18 AM	AMC	4/3/2016 8:11 PM	AMC
Pressure to allow development		8	2/23/2016 9:43 AM	AMC	4/3/2016 8:10 PM	AMC
Need more information		10	12/22/2015 9:12 AM	AMC	4/2/2016 2:30 PM	AMC
Homeowner responsibility		12	1/7/2016 6:11 PM	AMC	4/3/2016 8:10 PM	AMC
Costs		11	12/21/2015 5:23 PM	AMC	4/1/2016 4:21 PM	AMC
Drainage		10	12/22/2015 9:46 AM	AMC	3/16/2016 4:38 PM	AMC
Geotechnical Assessment		8	1/8/2016 12:53 PM	AMC	3/8/2016 9:39 AM	AMC
Scientists and values		5	1/27/2016 6:43 PM	AMC	4/2/2016 5:00 PM	AMC
Claims with incomplete evidence		3	1/27/2016 2:46 PM	AMC	1/27/2016 3:44 PM	AMC

Figure 3 A screenshot of NVivo depicts 'nodes,' or themes, in the order of reference frequency.

In the next chapter, I summarize the 12 selected disputes, providing details about the basis for dispute, actors involved, types of arguments used, and resolution. The following chapters then detail my analysis of these disputes and the news articles and interviews I gathered as part of this thesis work.

Chapter 6 – Dispute Summaries

This chapter summarizes the 12 disputes I selected to analyze the use of science and technical information in the regulation of development on landslide-prone slopes. The disputes are summarized below and organized chronologically. Dispute summaries note the character of the development disputed, applicable regulations, and demonstrate how actor interests conflict. Though all disputes below are public information, I do not find it useful to publish the names of the individuals involved, and thus actors are referred to as ‘appellant,’ ‘applicant,’ or ‘plaintiff.’ Cases are identified by a number assigned by me, and by the street and neighborhood of the disputed development. All neighborhoods described are labeled in Figure 1, the map provide in Chapter 3 showing Seattle’s landslide areas.

Dispute 1 – 1990-1995 – Aurora Ave N, Queen Anne

In 1990, a developer purchased a property on a steep slope on Aurora Avenue from the Seattle for \$141,000 on the same day that the interim ECA regulations were signed into law. The developer was unaware of the interim regulations at the time of purchase. In 1992, the developer (applicant) applied for a steep slope exception to develop more than 40 percent of the property because he could not ‘reasonably’ use his property conforming to that limit.

To qualify for an exception, an applicant must demonstrate that application of a rule is unreasonable, and that the proposal will not cause any significant adverse environmental impacts. It had been established that the slope in question was steep, but stable. The applicant produced expert testimony that erosion currently occurred on the slope at a rate of 2 cubic feet (.05 cubic meters) annually. With complete development of the slope, erosion would be reduced to zero.

The question at hand was whether application of the 40 percent rule was unreasonable in the applicant's case. If the standard was found to be unreasonable, the applicant would be entitled only to the minimum relief necessary to achieve 'reasonable use.'

The applicant submitted with his application for exception four development plans, three of which conformed to the 40 percent rule, the last of which did not. The last plan was preferred, and proposed to disturb 97 percent of the steep slope. The applicant intended to demonstrate that the three plans that conformed to the 40 percent limit were not economically viable because they produced fewer square feet of leasable space. DCI found that one of these three conforming plans was viable, and denied the exception. The applicant appealed DCI's denial of the exception to the Hearing Examiner.

The Hearing Examiner was tasked with the question of whether application of the 40 percent rule was unreasonable for the applicant's proposal, and whether DCI had erred in its judgment.

The applicant argued that more coverage of the steep slope would prevent erosion and landslide risk more so than a 40 percent development coverage would. Thus, his preferred alternative was aligned with the purpose of the ECA regulations. The applicant produced testimony from four highly regarded geotechnical engineers, all of whom concluded that the preferred project would reduce the current level of erosion on the slope and that application of the 40 percent rule would inhibit erosion control. Three of the four geotechnical engineers at the hearing were unpaid, and explicitly noted that they agreed to provide testimony because they felt that the relevant portion of the ECA regulations were poorly designed, and in many cases resulted in higher risk of erosion and slope instability. One stated, "[m]y previous review of this case and other related cases has convinced me that the City's

regulation is unreasonable and inconsistent with its stated goal” (Pang vs. Hearing Examiner for the City of Seattle and City of Seattle, 1994). Another stated that he was concerned that parts of the ECA regulations are "unsupportable on a scientific basis and not credible to achieve the objectives that were stipulated in the Critical Areas Ordinance” (Pang vs. Hearing Examiner for the City of Seattle and City of Seattle, 1994).

The Hearing Examiner noted that though the application of the 40 percent rule was unreasonable in this case, the applicant’s preferred plan did not demonstrate minimum relief necessary, and that the applicant had not explored any intermediate options that disturbed more than the 40 percent limit but less than the 90 percent proposed. The Hearing Examiner agreed with the applicant that additional coverage would prevent more erosion, but that the ECA regulations stipulated that erosion control be addressed in a less intrusive way. The Hearing Examiner also noted that the lack of economic viability of the plans, as testified by the real estate brokers, demonstrated a dip in the real estate market and was not evidence of misapplication of ECA regulations. The Hearing Examiner confirmed DCI’s decision to deny the exception.

The applicant appealed this decision to the Superior Court. The applicant again argued that denying an exception to develop his preferred proposal was unreasonable because compliance with regulations would result in projects not economically viable. By denying the ability to develop and profit from his land, he argued, the City was guilty of a taking. The applicant claimed that through application of the regulations, the City forced him to bear the public burden of preserving greenspace. The applicant reiterated the argument that his preferred proposal would be more effective at preventing erosion than a plan that conformed to the 40 percent rule. The applicant requested reversal of the decisions to deny regulatory

relief, and compensation for the “violation of their federal rights,” government taking, and legal fees. The Court found that:

Under these circumstances, there is no legitimate regulatory purpose for the City to enforce the steep slopes building restrictions against the applicants. Accordingly, the City’s enforcement of the restrictions against the applicants was an improper exercise of governmental authority since enforcement failed to be rationally related to advancing the purposes for which the restrictions were passed (Pang vs. Hearing Examiner for the City of Seattle and City of Seattle, 1994).

The Court directed the City to allow the exception for the applicant’s preferred project. The City paid the applicants a settlement amount of over \$60,000.

Dispute 2 – 1991 – West Plymouth St., Magnolia

An application to develop a three-story single family home in a steep slope ECA and designated greenbelt area was received by DCI. The proposal was subject to L2 zoning, which requires 30 percent of the lot to be preserved as open space. The applicant applied for height and open space variances, which would allow her to exceed the zone limits of 25 feet for height and to fulfill part of the open space requirement through the construction of a rooftop deck. The applicant submitted an environmental checklist as required by SEPA, as well as a soils report, which recommended construction techniques to best mitigate for erosion and landslide risk. DCI reviewed these recommendations and agreed that they would be sufficient to mitigate landslide risk. The DCI Director subsequently issued the project a Determination of Nonsignificance (DNS).

Several neighbors appealed the DNS, stating they were primarily concerned about the impact that the development may have on wildlife and on slope stability. Appellants used testimony from a neighbor that cracks in the concrete on his property indicated slope movement. No expert testimony was provided to substantiate the claim that the slope was unstable, to contradict the soils report submitted by the applicant's geotechnical engineer, or to demonstrate adverse impact to wildlife.

One of the appellants and her husband owned an apartment complex across the street from which views of Elliot Bay would be blocked with the proposed development. The appellants suggested, based on the advice of a real estate broker, that the value of their apartment complex would be reduced by \$165,000 if those views were lost. For this reason, appellants argued that the height variance requested by the applicant should be denied. Other appellants had similar concerns about the development blocking views of Elliot Bay from the vantage point of the street.

Because the appellants had no produced expert testimony to demonstrate slope instability, the Hearing Examiner dismissed this claim. The Hearing Examiner noted that regardless of whether a variance was issued for the proposal, views would be diminished by any development on the subject parcel. Because no established public views were at risk, the granting of the variance would not contradict SEPA policies. The Hearing Examiner affirmed the DCI decision to issue a DNS for the proposal.

Dispute 3 – 1993 – Lakeside Ave., Leschi

DCI denied an ECA exception to an applicant proposing to build a three-story single-family home on a steep slope in the Leschi neighborhood. The site on which the applicant proposed to build was almost entirely steep slope with an average incline of 70 percent. ECA

regulations stipulate that not more than 40 percent of a steep slope area can be covered by impervious surfaces, and the applicant's proposal was to develop almost 54 of the slope. To bypass the 40 percent rule, the applicant applied for an ECA exception. ECA exceptions modify ECA regulations on a case basis to allow for 'reasonable use' of a property. The applicant's argument was that, if the 40 percent rule were applied to him, the City would be denying him reasonable use.

Applications for ECA exceptions must be accompanied by an alternative proposal that conforms to the requirement from which the applicant is requesting relief. The alternative proposal theoretically demonstrates the hardship an applicant would endure by following standard regulations. The applicant's alternative proposal reduced overall impervious surface to 39 percent by reducing the sizes of walkways, decks, and landings, and removing plans for two patios. The original plans for the structure itself were otherwise identical to the none-conforming proposal. The Director of DCI denied him the ECA exception on the basis that his alternative proposal, which conformed to ECA regulations, qualified as reasonable use that did not present the applicant hardship. The applicant subsequently appealed to the Hearing Examiner.

The applicant argued that he had expected to be able to develop his property to the extent of his original proposal because other homes, which had been built prior to the passage of ECA regulations, were of similar size and had the additional components of patios, driveways and other impermeable areas on site. Denying him the right to develop further than the allowed 40 percent would be unreasonable, the applicant argued, because his property would not par up to neighboring properties in terms of proportion of developed area.

The applicant hired several geotechnical experts who argued that developing a greater proportion of the property with the proposed decks, patios, and other impermeable structures, would better mitigate landslide and erosion risks. The geotechnical experts testified that slopes that are exposed to precipitation and runoff have a greater risk of failure and that the best way to mitigate for landslide and erosion susceptibility is to cover the slope with impermeable surfaces. The geotechnical experts were in favor of the applicant original proposal, which covered 54 percent of the slope.

As the Hearing Examiner noted, the views of the applicant and his geotechnical experts regarding slope coverage directly contradicted the view represented in ECA regulations, which was that less development in ECA areas was better for controlling erosion and mitigating landslide risk.

The Hearing Examiner concluded that, because the applicant had demonstrated in his alternative proposal that an identical structure that conformed to regulations was possible, adherence to the 40 percent rule did not represent unreasonable use. The Hearing Examiner rejected the applicant second argument that increasing the proportion of impermeable surface better controlled erosion and mitigated landslide risk on the basis that the argument challenged the regulation itself, a dispute outside of the Hearing Examiner's purview. The Hearing Examiner confirmed the Director's decision that the exception should be denied.

Dispute 4 – 1994 – 54th Place SW., West Seattle

DCI issued a SEPA Determination of Nonsignificance (DNS) for a proposal to demolish a single-family home and construct 15 units with underground parking on a steep slope ECA in the coastal Alki neighborhood of West Seattle (Figure 1). The area of proposed development was highly vegetated and close to the Duwamish Head Greenbelt. The proposal

would disturb 9 percent of the steep slope, substantially under the 30 percent limit, and the applicant's geotechnical engineer submitted to DCI a minimal risk statement. DCI issued a DNS, indicating its belief that the proposal posed no threat to the environment, but with the condition that the applicant plant 15 trees on the slope. A SEPA determination does not constitute a permit decision, but may affect a future permit decision.

Several citizens appealed the issuance of the DNS. They argued that the development of the proposed structure would pose a threat to wildlife and vegetation on and adjacent to the property, to the stability of the slope, and to drainage. They requested that a prior landslide in the area be investigated. Appellants were also concerned with the negative impact the new development would have on the aesthetics of the landscape, parking, traffic, noise, and light.

The appellants' aesthetic concerns about the development were dismissed because SEPA policies concern only public views, which were not at risk. The Hearing Examiner also dismissed concerns about light pollution because the appellants had provided no evidence to substantiate this claim.

The Hearing Examiner, citing the City's SEPA policy, clarified that because the site was not mapped as 'priority habitat' by the Department of Fish and Wildlife, it could not be considered the rare or unique habitat that would merit protection under SEPA. The Hearing Examiner argued that the conditioned planting of 15 trees on site would sufficiently mitigate any detriment to the environment posed by the new development.

In response to the appellants' concerns about soils and slope stability, the Hearing Examiner pointed out that the project was subject to several ECA regulations that would require site-specific construction techniques and mitigation for landslide hazard.

In regards to parking and traffic, the Hearing Examiner decided that the underground parking proposed by the applicant would mitigate for any increase in vehicles, and that traffic on the street of proposed development would not be substantially disrupted to the extent that mitigation is required. The Hearing Examiner affirmed the Director's decision to issue a DNS.

Dispute 5 – 1997 – 49th Ave SW., West Seattle

DCI approved an application to subdivide a single parcel with a home built upon it into two parcels. Presumably, the new parcel would be subject to future development of a single-family home as zoning allowed. The West Seattle (Figure 1) property lay about 200 feet from the coastline with the westernmost part of the property sloping steeply downward into a forested area toward the coast. The City had mapped the property, and surrounding area, as “Potential Slide Areas” in previous reports because of an ancient landslide underlying the area. DCI approved the application and issued a Determination of Non-Significance, indicating its view that no negative environmental impact would occur from the proposal, despite the hazard presence, because the application was for subplatting only and no development was involved. Any future proposal for construction upon the property would be met with a more thorough review of the hazards present in the area.

The approval of the subplatting application was quickly appealed to the Hearing Examiner by a neighbor of the property on several grounds. Her main grievance was that a stability analysis should have been completed before approving the sub plat of the property. As a homeowner adjacent to the subject site, she worried that any future development on the subject site, which she believed was landslide-prone, could destabilize her own property.

Prior to the DCI decision, several geotechnical studies had been done on or near to the subject property. In 1970, the City did a soil boring approximately 75 feet away from the property and found a clay layer 35 feet deep. Clay overlaid by sand is common to Puget Sound coastal stratigraphy; it is also indicative of potential landslide risk. The 1970 record was utilized by the appellant as evidence of widespread landslide-prone stratigraphy in the immediate area, including on the subject property. A soil boring had been performed by the applicant's engineer earlier in the summer of 1997, but had only reached a depth of 10 feet. If the clay-sand combination did indeed underlay the subject property, the applicant's boring had not reached a sufficient depth to identify it. The appellant's geotechnical engineer indicated that, given the prevalence of clay in the area's coastal stratigraphy, without doing a boring that extended to at least the toe of the slope, it could not be assumed that there was no clay layer. Another boring was not apparently done. However, a second geotechnical assessment was arranged, which included geotechnical engineers hired by both the applicant and the appellant, and a representative from DCI. The report, as summarized by the Hearing Examiner, concluded, "absent a major earthquake, it is unlikely that the ancient landslide would undergo significant movement in the foreseeable future."

The appellant submitted two more points of appeal on top of her principal argument that the subject property was unstable and landslide-prone. She argued that the drainage from the property would overflow its designated public storm drain, which was dismissed by the civil engineer who did a drainage review for the City. The appellant further argued that the future structure to be built upon the subject property would be incompatible with the existing neighborhood because its maximum buildable lot was smaller than that of other properties in the neighborhood. No evidence was provided for this claim.

The Hearing Examiner ultimately confirmed the Director's decision to approve the sub plat application, for the primary reason that dividing the property for future development should not be subject to the same standards as development. However, the Hearing Examiner conditioned that prior to the submission of any construction plans, a boring must be done by a geotechnical engineer to a depth of 36 feet, one foot deeper than was done in the 1970 boring that identified clay. The results of the boring would be used by the engineer responsible for submitting an evaluation to DCI that ensures minimal harm to adjacent properties.

Dispute 6 – 1997-2003 – Lakeside Blvd., Eastlake

In 1989, before ECA regulations had been passed in Seattle, the City granted a permit to build three townhomes upon a landslide-prone area of Eastlake (Figure 1) after reviewing a geotechnical report of the slope, which indicated a risk of slope movement. The City conditioned the permit upon three conditions; buyers would have to be notified of the potential for soil movement, landslide insurance was required, and developers were to sign a covenant releasing the City of all liability or damages caused by slope movement, unless the damage had been caused by City negligence. That covenant applied to all successive owners of the property.

The developers built and sold all three townhomes for around \$300,000 each, assuring all buyers that the structures were stable and engineered in a way to withstand soil movement. In early January of 1997, after heavy regional precipitation, all three properties began sliding. They were condemned by the City.

The homeowners sued nearly every actor involved with the development of the townhomes, including the developers, the builders, the architects, and engineers. Though the

homeowners received a settlement of \$190,000 from the developers, claims against the other actors were dismissed due to a statute of limitations of six years. The homeowners subsequently sued the City for \$1 million, maintaining that the City had negligently granted a building permit and failed to maintain public drainage systems near the subject properties. Residents presented evidence at court demonstrating that the drainage system onsite had funneled water toward the foundation of the properties rather than offsite, and that the City had failed to inspect this system before it was buried after construction.

The City moved for summary judgement in Superior Court based on its no liability, and the Court sided with the City. The homeowners appealed this decision to the Court of Appeals, which found that the City, in neglecting to maintain the storm drains that contributed to soil instability on the properties, could be found liable for damages.

The City, fearing a precedent that would leave it vulnerable to future liability suits, appealed this decision to the Supreme Court, which found that, while the City could not be held liable for permitting the construction of the townhomes, it could be found liable for damages resultant of negligence of public drainage systems. In 2003, the City settled with the homeowners for a total of \$125,000.

Dispute 7 – 1998 – 124th St., Pinehurst

The Director of DCI approved a short plat application to subdivide a property in the Pinehurst neighborhood of North Seattle (Figure 1) into three parcels. The property was designated a steep slope and landslide prone area. An existing structure on one of the new parcels would remain, and new properties would presumably be built on the other two parcels. The short plat application was issued a DNS with conditions. The applicant also applied for, and was granted, a limited ECA exemption after it was found that on the steep

slopes the vertical incline was less than 20 feet, a condition upon which ECA regulations allow development. As part of the application for the ECA exemption, the applicant hired a consultant to do a soils report and a topographic survey. The applicant later submitted a geotechnical report by a separate consulting firm as part of the Director's requirement for the exemption. That geotechnical report showed groundwater seepage under the site, but the consultant concluded that the site could be developed with regard for their construction recommendations.

The DCI received 17 comment letters opposing the short plat proposal during the comment period prior to its decision. Those letters expressed concern for the negative impact the short platting and subsequent development would have on density, traffic, parking, drainage, the stability of the slope, and potential for landslides. Neighbors appealed both the DNS and the approval of the short plat application. Appellants pointed to the geotechnical report used by the applicant in support for the development to demonstrate drainage problems on site. Appellants also noted that a church downhill from the site regularly experienced basement flooding because of improper uphill drainage.

Appellants were concerned with the impact any new development would have on street parking. However, they presented no evidence that additional vehicles in the vicinity during construction would present a significant adverse impact to the neighborhood.

Appellants also complained that future development on the new parcels would be too small to be compatible with other homes in the neighborhood, but presented no evidence that future construction would necessarily be out of character with other homes in the neighborhood.

Concerning the appellants' drainage concerns, the Hearing Examiner noted that appellants had failed to provide evidence suggesting the DNS had been erroneously issued. The appellants had no evidence to contradict the conclusion of the applicant's geotechnical consultant that development on the new parcels was feasible. The Hearing Examiner dismissed concerns about parking and neighborhood compatibility because the appellants had presented no evidence to support their arguments. The Hearing Examiner affirmed the Director's decision to approve the short plat application and DNS.

Dispute 8 – 2000 – 31st Ave W., Magnolia

The Director of DCI approved applications for two short plats and issued a DNS for the construction of two two-unit townhomes and one single-family house in a steep slope area in Magnolia (Figure 1). The applicant was also granted a limited steep slope exemption. The applicant's proposal was to build the townhomes and the single-family house on the east side of the property, which faced an alleyway. The west side of the subject property was already developed with three duplexes. The short plats would divide the property in a way so that the house, and each townhome and duplex unit, sat on its own parcel. The new construction would require grading and removal of 10 trees on the property. The applicant's geotechnical engineer concluded that the applicant's proposal could be done with "minimum risk."

The applicant applied for, and was granted, a limited steep slope exemption because the subject site has previously been developed, which is a condition on which an exemption will be granted. This meant that the proposal was not subject to steep slope development standards, but still subject to all other ECA standards. DCI conditioned its DNS on the

applicant adhering to a construction plan that did not disrupt local access to the alley and that did not generate noise outside of certain hours of the day.

The applicant also hired an expert to conduct a parking study, which concluded that with the additional parking spaces provided on site of the new dwellings, there would be an overflow of at most five vehicles. The parking study suggested the street could handle this level of overflow.

Several neighbors appealed the issuance of the DNS and the approval of the short plat. Their primary concerns pertained to slope stability, drainage, tree retention, parking, structure height and scale, noise, and crowding of the alley. The appellants argued that these issues had not been sufficiently addressed in the DCI's decision to approve the short plat and grant the development a DNS. Particular emphasis was put on parking shortages that would arise from residents of the new structures. Appellants did not support their concerns with technical studies or evidence that any regulations were being violated. The Hearing Examiner noted that the appellants were "straightforward in its desire to block the entire project," fearing that it would set a precedence to develop dense housing throughout the neighborhood.

In regards to appellant concerns about drainage and slope stability, the Hearing Examiner noted that the project had been granted a statement of "minimal risk" by the applicant's geotechnical engineer. Appellants did not provided evidence to contradict the findings of that geotechnical engineer. Appellants similarly failed to produce evidence that would contradict the findings of the parking study, which suggested minimal parking space loss in the area.

Despite appellant claims about height and scale, the sizes of the proposed structures were well within the limits defined by the zoning. The Hearing Examiner noted that DCI had

conditioned its approval of the project upon design of a construction plan that would maintain local access to the alley, and that this condition should alleviate appellant concerns about crowding of the alley.

The Hearing Examiner affirmed the Director's decision to approve the short plats and to grant a DNS for the proposed development.

Dispute 9 – 2002 – 5th Ave N., Westlake

The Director of DCI denied a variance to a homeowner to allow an existing deck to extend into his property's side yards. The subject property was located on a steep slope and designated a landslide area. After a landslide in 1996, the homeowner had fortified two damaged retaining walls below his property and built the deck as a way to add weight to those walls. He constructed the deck without a building permit or required variance to extend the deck into his side yards. That deck was reported as a violation of code to DCI, and the homeowner had subsequently applied for both the permit and variance. The homeowner hired the consulting firm Shannon & Wilson to perform a geotechnical analysis of the deck and property. Shannon & Wilson reported that while the deck was stable in normal conditions, it was unstable under earthquake loading. It noted that the deck diverts water away from the slope, yet DCI later suggested that diversion of surface water from the deck to further down the slope increased landslide risk offsite. The Shannon & Wilson report recommended remedial action to fortify the deck to withstand seismic stress, which was not performed prior to application for the variance. It did not make any recommendations regarding the deck's extension into the side yards.

After reviewing the variance application, the Director of DCI denied the homeowner the variance, based on the belief that the extension of the deck into the side yards was not

necessary to ensure slope and deck stability, and therefore a variance was not warranted. The denial of the variance indicated that the homeowner would have to remove the deck in its current form.

The homeowner appealed this decision to the Hearing Examiner, arguing that the extent of the current deck is necessary to prevent water from infiltrating the slope. While the Shannon & Wilson report recommended that surface runoff be diverted away from the slope, it did not recommend the extension of the deck's surface area to accomplish this. The Hearing Examiner reiterated DCI's concern that the deck's diversion of water downslope from the property increased landslide risk on adjacent property. The Hearing Examiner affirmed the Director's decision and denied the variance, indicating that the homeowner would have to consult with DCI to determine how to conform to code. Aerial imagery from 2016 shows that the deck has since been completely removed.

Dispute 10 – 2006 – Perkins Lane W., Magnolia

DCI denied a request for an ECA exemption to build a single-family home in a steep slope area on Perkins Lane West in Magnolia (Figure 1). The property on which development of the house was proposed was almost entirely steep slope. A house formerly located on the same property had been destroyed by a landslide in 1955. The applicant sought an exemption based on the subject slope being created by "legal grading activities," those "activities" being the creation of Perkins Lane. The exemption was denied because the steep slope had existed prior to the creation of Perkins Lane, and the creation of the road constituted minimal changes to the character of the steep slope. The applicants did not appeal this decision. The applicant instead applied for an ECA exception. DCI requested additional information from the applicants about wetlands on the property before making a decision.

The applicant did not respond to the request for additional information, and instead submitted a second application for exemption. The second exemption was based upon the claim that application of ECA regulations, in this case prohibition of building on the property, would “prevent necessary stabilization of a landslide-prone area.” This claim was supported by the applicant’s geotechnical engineers, who had prepared a plan to increase the stability of the subject property and surrounding area by constructing retaining walls and drainage systems. DCI denied the applicant’s second exemption request, disagreeing that application of regulations prevented stabilization of the undeveloped slope, and indicating that an ECA exception was necessary for the project. The applicant appealed to the Superior Court for judicial review of DCI’s decision.

The applicant requested judicial review of the exemption denial, arguing that geotechnical experts confirmed that their proposal would better stabilize the slope in question, which would qualify them for an exemption. DCI argued that the Superior Court had no jurisdiction over the case because the applicant had failed to exhaust administrative remedies, specifically a Director’s Interpretation, which clarifies the application of regulations to a specific property. DCI also claimed that the denial of the exemption was not a final decision on the land use application, merely a clarification of the standards by which the project was subjected to. The Superior Court dismissed the applicant’s claims.

Dispute 11 – 2008 – 42nd Ave NE., Cedar Park

DCI approved an application to sub plat a property into four parcels in the Cedar Park neighborhood of North Seattle (Figure 1). DCI also issued a Determination of Nonsignificance as required by SEPA guidelines, indicating its view that that proposal posed no detrimental impact to the environment. The applicant’s plan was to demolish the existing

structure atop the property and to develop a single-family home in each of the four parcels, which would be subject to a separate application process. Though much of the property was flat, its eastern end sloped downhill toward the Burke Gilman trail, which is adjacent to Lake Washington. Presence of the steep slope meant that part of the property was considered to be in an ECA. The bottom half of the slope below the property had been subject to landslides in the past. At the time, the street's drainage control relied on a ditch and culvert system, which overflowed during heavy rain. When this occurred, water flowed over the edge of the slope.

The applicant's geotechnical engineer asserted that the sub plat proposal posed no risk to the slope because it did not yet involve any construction. However, he suggested that development on the property was feasible with proper engineering, writing in the geotechnical report that the property was "suitable for the proposed development using appropriate conventional design and construction procedures."

DCI based its approval of the sub plat on the evaluation of several factors. First, it relied on its own drainage review, which found that the current system of storm water control was lacking; it conditioned its approval on the development of a new drainage control plan to divert water to a drainage collection line in the main street. Second, DCI's geotechnical engineer evaluated the geotechnical report prepared by the applicant's geotechnical engineer, which affirmed the feasibility of future development on the site. DCI's geotechnical engineer agreed with this report. Third, DCI determined that the current property could be subdivided into four parcels and still meet minimum lot size. Finally, DCI determined that, as required by Land Use Code, the short plat meets "the public use and interests," because it provides additional housing stock.

Friends of Cedar Park Neighborhood, a community group, appealed the approval of the short plat application, arguing that the DCI's evaluation of drainage adequacy, lot size, and 'public use and interests,' was erroneous. The appellants argued that both the current drainage system and the drainage condition imposed by DCI were inadequate. Appellants provided the Hearing Examiner with their firsthand observations supporting the assertion that the subject property experiences drainage issues too extensive to rectify with the drainage condition imposed by DCI. However, drainage studies performed by both the applicant's and the City's geotechnical engineers indicated that drainage from future development on the property would flow away from the slope and sufficiently control storm water. The appellants also claimed that only three lots, not four, could reasonably fit on the property, hypothesizing that garage structures for each house would be large, thus reducing space for required setbacks. Finally, the appellants argued that the short plat did not meet the 'public use and interests' because increasing density diminishes the property's compatibility with the rest of the neighborhood.

The Hearing Examiner dismissed the claim that only three lots could fit on the property because it was based on speculation, and did not consider all possible design scenarios. Concerning the claim that construction of four structures would increase density, the Hearing Examiner concluded that each parcel met minimum lot requirements for its single-family residential zone, and thus the four parcels would not be any denser than other adjacent properties. The appellants' drainage concerns were similarly dismissed for lack of evidence to contradict the studies performed by licensed geotechnical engineers. The Hearing Examiner affirmed the Director's decision to approve the sub plat, but reiterated the requirement that the applicant submit a new drainage control plan to DCI.

Dispute 12 – 2009 – Westlake Ave N., South Lake Union

DCI issued a DNS for a proposal to demolish two buildings and construct a six-story office building on a large parcel in South Lake Union (Figure 1). Parts of the site of proposed development were mapped as steep slope, potential earthquake, and potential liquefaction. The applicant's application for an exemption from steep slope regulations was granted because the steep slopes on site had been created by previous, legal grading. The applicant had cited several geotechnical studies that supported the claim that the slopes had been created by grading.

The property management company that managed buildings adjacent to the proposal site appealed DCI's issuance of the DNS. The appellants' primary grievance was the loss of views of Lake Union that would result with the development of the six-story structure. The appellants prepared a three-dimensional view impact report, which included vantage points from Dexter Avenue looking toward Lake Union with and without the proposed development. The appellant argued that the blockage of views of Lake Union would be inconsistent with SEPA, which protects public views of certain natural features, including Lake Union. The appellants argued that the size of the proposed development was out of character with existing development in the area, but presented no evidence to demonstrate this.

The appellants suggested that the proposal should have been required to undergo an Environmental Impact Statement based on the presence of ECAs on site, arguing that the potential impacts of these areas required further review and mitigation measures. However, no evidence was produced to support the claim that significant adverse impacts to the environment would occur because of the development.

In regards to the appellants' concerns about view impacts, the Hearing Examiner noted that not all views of the lake from Dexter Avenue would be lost, citing a setback at the north side of the proposed development that would preserve views from Dexter Avenue. The Hearing Examiner acknowledged that views of the lake would be lost, but that no "reasonable mitigation" existed to alleviate the view loss. The Hearing Examiner affirmed the Director's decision to issue the DNS.

Patterns Identified in Disputes

Taken together, the twelve disputes that I selected for in-depth analysis provide a nuanced view into the actions of applicants, appellants, and regulatory agency and the outcomes of typical disputes in Seattle over the regulation of development on landslide-prone slopes. Out of twelve disputes, seven are characterized by neighbors appealing the approval of development in either its entirety or its extent, four are characterized by applicants appealing denials or conditions of development, and one is characterized by homeowners suing the City for allowing development to occur. Eleven disputes concern pre-development decisions about whether to allow development in the ECA, and under what conditions. Table 3 summarizes all twelve disputes, appellant concern, and legal outcome.

Table 2. *Dispute Summaries*

DISPUTE #	YEAR	APPELLANT TYPE	CONCERNS	OUTCOME
1	1990-1995	Applicant	Property rights, slope stability, profitability	Court ruled in favor of applicant; development allowed
2	1991	Neighbor	Views, wildlife, slope stability	DCI decision affirmed; development allowed
3	1993	Applicant	Property rights, slope stability	DCI decision affirmed; development allowed without regulatory relief

4	1994	Neighbor	Views, wildlife and vegetation, parking, noise, slope stability	DCI decision affirmed; development allowed
5	1997	Neighbor	Slope stability	DCI decision affirmed; development allowed with conditions
6	1997-2003	Plaintiff	Costs of landslide damages	Parties settled out of court
7	1998	Neighbor	Density, traffic, parking, drainage, slope stability	DCI decision affirmed; development allowed
8	2000	Neighbor	Slope stability, drainage, vegetation, parking, structure size, alley crowding	DCI decision affirmed; development allowed
9	2002	Applicant	Slope stability	DCI decision affirmed; development condemned
10	2006	Applicant	Property rights, slope stability	Court dismissed applicant's claims
11	2008	Neighbor	Drainage, lot size	DCI decision affirmed; development allowed
12	2009	Neighbor	Views, hazard areas	DCI decision affirmed; development allowed

Two major patterns are evident from analysis of these disputes. The first is that a Hearing Examiner is likely to affirm any decision made by DCI, regardless of whether that decision allows, denies, or restricts development. In fact, there were no cases examined in which a Hearing Examiner reversed a decision made by DCI and sided with an appellant. The second pattern is that neighbor appellants rarely if ever succeed in blocking or restricting development by appealing a DCI decision, though neighbors protesting development characterized a majority of disputes analyzed.

The two patterns are interrelated and can be explained by the nature of the appeal system. An appeal implies that a decision has already been made by DCI. Thus, in an appeal, appellants question the validity of a government agency's decision. Appellants must prove that an error was made in the decision-making process by providing evidence that the decision was inconsistent with relevant policies and regulations, or that the information upon which that decision was based was flawed. Providing evidence that creates ambiguity around

the validity of a decision is insufficient; according to the Seattle Municipal Code, the Hearing Examiner must give “substantial weight” to the Director’s decision, therefore, appellants must provide evidence that overwhelmingly demonstrates DCI erred. In other words, the appellants must provide information supporting their desired outcome that is more compelling than the information upon which DCI based its decision. Hearing Examiners are unlikely to favor appellants unless strong evidence suggests DCI erred, and neighbors are unlikely to provide that strong evidence. On the other hand, applicants are required to provide extensive information to DCI when applying for a permit. Because DCI’s decision is implicitly based on extensive information provided by applicants, the appeal process systemically gives preference to its decision.

Chapter 7 – Analysis: Trends in Dispute outcomes

An analysis of the arguments made in the disputes described in the previous chapter, along with the information that actors tend to use in their arguments, helps to illustrate the complex relationship between science and policy, as influenced by diverse actor interests. In this chapter, I will give a short description of the patterns identified in the twelve disputes, and explain these patterns as functions of actor interests and preferred outcomes and the types of information that different types of actors tend to use. I will then address the themes identified in the broader narrative analysis, which are ‘liability,’ ‘engineering safety,’ ‘acceptable risk,’ and ‘contradiction. These themes are discussed in their relation to defining actor interests and arguments. The final chapter will situate these themes within the ST&S literature on the role of science in policy decisions, and how it plays out in these cases where private property intersects with public safety.

Actors and their Interests

In the twelve disputes analyzed, four primary actors can be identified; applicants for development projects, neighbors who have concerns about development projects, government agencies, and consulted technical experts. These four actors participate in the dispute process playing the roles of applicant, appellant, government, and expert. In court cases, the role of plaintiff, which is analogous to the role of appellant, and the role of defendant are relevant. An actor may, in fact, play more than one role — an applicant may also be the appellant (Disputes 1, 3, 9, and 10), or different government agencies may play the roles of both mediator and defendant (1, 3, 6, 9, and 10).

Across the twelve disputes, immediate interests of actors are generally consistent. Applicants have an interest in developing property that happens to be in an ECA. With the

exception of dispute 6, which concerns past development, all cases are concerned with prospective development in areas considered landslide-prone, either because they have been mapped as such or because they have steep slopes. Despite a property's ECA status, applicants look to develop property as an investment, and a quality of neighborhood and views increase the value of that investment. In eight disputes, the subject property overlooked a body of water, and many were located within popular residential neighborhoods.

While an applicant's interest is in development of a specific property, neighbors have an interest in maintaining their quality of living and are concerned with the impact development will have on their views of the landscape, parking availability, current neighborhood density, environmental health, and slope stability. In three disputes (4, 7, and 8) appellants specifically expressed concerns about the negative impact development would have on parking and traffic in their neighborhood. In three disputes (2, 4 and 12) appellants were concerned that new development would block view of the landscape from their properties. In six disputes (2, 4, 5, 7, 8, and 11) appellants had environmental concerns regarding either the stability of the slope or the retention of trees and wildlife. The common theme evident among neighbor concerns is the maintenance of the neighborhood's current quality — environmentally, aesthetically, and in ease of access.

Olshansky (1996) emphasizes aesthetics as a value upon which neighbors commonly object to landslide-prone slope development. Nearby neighbors often have an interest in maintaining their views, levels of natural light, and privacy, and distant neighbors may share similar concerns. Olshansky (1996) suggests that hillsides contribute to a community's sense

of place and identity, and thus even distant neighbors may dislike, and object to, new hillside development, perceiving that new development visually disrupts the landscape.

The government has an interest in regulating development in ECAs in consistence with local and state policies and regulations. DCI is bounded by Seattle's ECA regulations in its decision-making about ECA areas. The enforcement of ECA regulations reduces the City's risk of being held liable for future landslide damages if it has held the subject development to all applicable standards. One government geologist involved with permitting said:

We're in a position where we can't really prevent people from using their property, that's a taking. And so that's why the code says we have to meet these certain standards. . . . [I]f you can't provide a clean source of drinking water, you can't build a house. If you can't design a septic system for these soils, you can't build a house. If you can't mitigate the landslide, then we would say you can't build the house, and then they might go to the Hearing Examiner. . . . [I]n any case, we've done our part in meeting that code (Anonymous, personal communication, February 19, 2016).

In theory, a geotechnical expert, or other consulted expert is to evaluate the physical characteristics of a site and make recommendations as to whether or not a site can safely be developed. However, some planners and geologists interviewed suggested that some expert consultants provide reports that are consistent with client needs because that client pays the consultant's salary. In those cases, a consultant can be seen as having the same interests as the client. While a geotechnical consultant interviewed agreed that in cases of permitting,

clients expect recommendations from their consultants, he believed that the interests of geotechnical consultants were more consistent than those of government agencies:

You would assume that geotechs would have the same character decade after decade, either in support or not for development. You would think engineering practice would have a much more consistent practice in the way that they interpret information. A permitting agency would be much more constricted by conflict, their need to promote or restrict growth, who the mayor is. [Depending on those factors], suddenly you see more slopes built on (Anonymous, personal communication, April 14, 2016).

Applicants, neighbor appellants, government, and sometimes vocal expert consultants, advocate for outcomes that are consistent with their interests. In permitting disputes, applicants advocate for the allowance of development with minimal conditioning, and neighbor appellants advocate for the denial or restriction of development. The government's interest in regulating development does not result in necessary advocacy for either the allowance or denial of development; in theory, it advocates for whatever outcome it perceives as being consistent with its regulations. For example, the Hearing Examiner upheld the restriction or denial of development in four disputes (1, 3, 9, and 10), and upheld approval of development in seven cases (2, 4, 5, 7, 8, 11, and 12).

Each actor's preferred outcome can be placed on a spectrum that ranges from low risk acceptability to higher risk acceptability, as illustrated in Figure 3. Low risk acceptability is characterized by risk-adversity and an avoidance-based risk regulation, and higher risk acceptability is characterized by more flexible risk regulation, and the notion that proper engineering will mitigate for risk. Proponents of engineering mitigation may not associate

themselves with 'higher risk acceptability' because engineering reduces risk. Yet because development within an ECA inherently involves more exposure to hazards than avoidance of ECAs, I have characterized it as comparatively 'higher' risk. The difference between points on the spectrum may be understood as the margin of acceptable risk between actors.

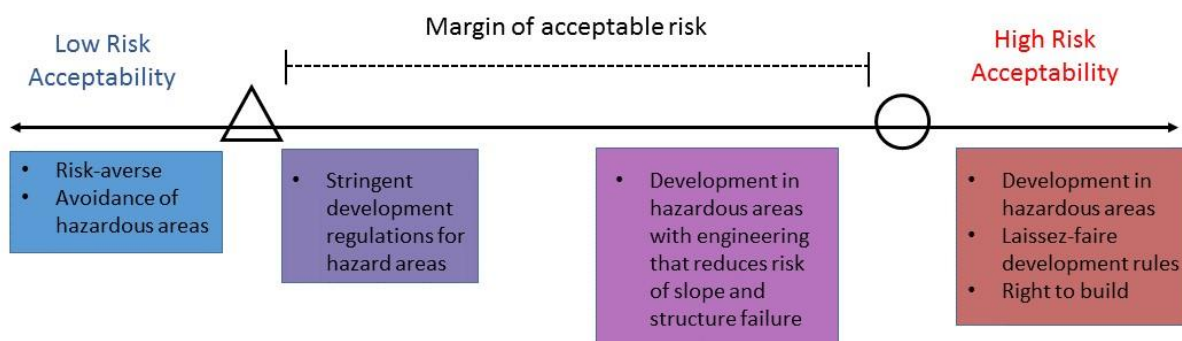


Figure 4 – Actor perspectives and preferred outcomes can be placed on a spectrum of acceptable risk, with low risk acceptability characterized by risk-adversity and hazard avoidance, and higher risk acceptability characterized by property rights and engineering stability.

The outcomes advocated for by neighbor appellants fall on the low risk acceptability side of the spectrum; these actors typically want to block or restrict development in ECAs because they perceive development as a threat to their quality of life. The outcomes advocated for by applicants fall on the higher risk acceptability side of the spectrum; these actors want to develop in ECAs and hire engineers to help them minimize risk in developing their property. The outcomes advocated for by DCI or the Hearing Examiner, while not consistently pro- or anti-development, fall somewhere in the middle of the spectrum. The GMA, Comprehensive Plan, and ECA regulations call for maximum avoidance of ECAs, and Seattle is considered to have one of the most progressive regulatory frameworks for hazard risk, which is consistent with low risk acceptability. However, the City simultaneously allows private development to occur in ECAs where adequate mitigation can be demonstrated, which is consistent with higher risk acceptability.

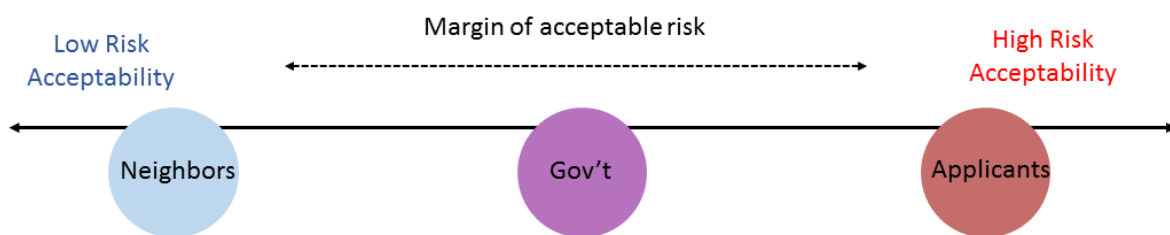


Figure 5. *The preferred outcomes of neighbor appellants are generally characterized by low risk acceptability, while the preferred outcomes of applicants are characterized by high risk acceptability. Positions of actors may shift on the spectrum under different circumstances.*

Across time, individuals may play the roles of different actors, and may advocate for outcomes that are on different points of the spectrum. Outcomes actors advocate for in a single case do not necessarily represent their general political views about property rights, hazard regulation, or government oversight. For example, while the preferred outcome of neighbor appellants to block or restrict development aligns with an avoidance approach to hazard risk, many of their grievances about development are commonly non-hazard related, and concern views of the landscape, aesthetic character, parking, and traffic. This suggests that, in another context, a neighbor appellant may advocate for an outcome that is consistent with higher risk acceptability, because the individual does not operate on a low risk acceptability platform per se.

The Typical Nature of Appellant Arguments

In the twelve case studies, neighbor appellants typically expressed their concerns about development in frames of fairness and decency. For example, neighbors commonly suggested that the proposed development would diminish their quality of life in its negative

impact on views, parking and traffic, and neighborhood character. In some cases, neighbor appellants pointed to specific policies that discouraged these impacts, such as SEPA's protection of public views, or the Comprehensive Plan's policy that new development be 'compatible' with the surrounding neighborhood, yet neighbor appellants provided little concrete evidence, legal or technical, that suggested a policy or code was being violated.

Neighbor appellants tended to rely on eyewitness observation in arguing for their interests on environmental issues that typically warrant scientific or technical studies. In dispute 2, appellants pointed to cracks in a neighbor's yard to demonstrate slope instability. In dispute 5, the appellant testified that the clay she had found in her yard was evidence that the area was characterized by the landslide-prone combination of sand overlying clay. In dispute 7, appellants noted that a church downhill of proposed development regularly flooded, and claimed that this demonstrated that the site of proposed development experienced drainage issues. Appellants in dispute 11 similarly noted that they had witnessed surface water running off a slope on the property of proposed developing, claiming the site experienced severe drainage issues.

When neighborhood appellants did address science or technical data, it was typically by qualitatively challenging the adequacy of science and technical information upon which a decision was based. A common claim by neighborhood appellants was that not enough information had been gathered to make a well-formed decision about how, or whether, development should proceed. For example, many appellants challenged the issuance of a SEPA Determination of Nonsignificance, arguing instead, that DCI should have required the applicant to do an Environmental Impact Statement, which would require more data gathering about the site.

Appellants typically listed several reasons for their opposition to development, but failed to substantiate most of their claims. Often, a single issue was highlighted as the primary point of concern and typically, this issue was aesthetic. For example, in dispute 2, appellants expressed concerns about views, wildlife retention, and slope stability, but only provided substantial evidence for how views from the apartment building owned by the appellants would be blocked. In dispute 8, appellants expressed concerns about slope stability, parking availability, tree retention, noise, alley crowding, and structure height. However, appellants did not present evidence to support their opposition to any of their stated environmental concerns. The Hearing Examiner noted that:

The appellant in this case was straightforward in its desire to block the entire project, and it is not difficult to appreciate that sentiment. The appellant fears that this project, particularly if should serve as a precedent for future projects, will irreversibly change the character of the immediately surrounding area (City of Seattle Hearing Examiner, 2000).

In dispute 12, appellants argued that an environmental impact statement should have been required to address the property's hazard risk, which included landslide, earthquake, and liquefaction, but provided no evidence supporting the claim that further studies were needed. Instead, the majority of evidence provided by appellants concerned the impact the proposed development would have on views of Lake Union from the property owned by the appellants.

In disputes 2, 8, and 12, it can be speculated that appellants used environmental concerns like slope stability and wildlife retention to leverage their case, when their primary

concern was aesthetic. In none of these cases, however, did appellants use science to support their claims about slope stability or environment. Rather, appellants provided personal observations to support their claims or they claimed that not enough information was known.

One appellant demonstrated genuine concern for the environmental impact of proposed developing, including slope stability. In dispute 5, the appellant's argument revolved solely around the issue of slope stability. The appellant went so far as to hire her own geotechnical engineer to evaluate the stability of the subject slope. What was unique about dispute 5 was that the appellant's property was directly adjacent to the subject lot, both properties on a steep slope in an area that had experienced landslides. The appellant feared that the proposed development posed an immediate threat to the stability of her property.

In contrast, at least some appellants who voiced concerns about slope stability can be identified as living in or owning property that would likely not be affected by soil movement on the property where development was proposed. For example, the property owned by appellants in dispute 8 was separated from the subject site by at least the width of an arterial street. Neighbors who plausibly are not put at risk by slope instability issues on a different property nonetheless express slope stability concerns in their appeals. While this may be an example of 'love thy neighbor' civic action with genuine neighborly concern for the welfare of future occupants of the development, it is more likely that the expression of stability concerns is a superficial attempt to maximize likelihood of success in blocking or restricting development.

Applicants and Government Use Highly Technical Information

Despite the considerable concern that applicants and appellants have over issues of aesthetics, property rights, and neighborhood character, applicants and DCI consistently use science and technical information in arguing for their interests. At its submittal phase a land use application presents abundant science and technical information as dictated by application requirements. Applicants are required to submit with their land use applications several technical reports about the site prepared by licensed professionals. These reports, often prepared by geotechnical consultants, include conditions to which development should adhere to minimize environmental risk.

An approved land use application indicates extensive technical study and review about a subject site and proposal. DCI relies on at least three sources of science and technical information in its review process: the technical studies submitted by an applicant, expert review of the applicant's data, and the science and technical information implied or referenced within the ECA Code. DCI uses the expertise of its geotechnical engineer and sometimes that of other government agencies to review technical studies prepared by the applicant's hired experts.

In its decision making process, DCI evaluates whether a proposal is consistent with all standards within the ECA code. These codes are implicitly based on technical expert knowledge and 'best available science,' as requires through the Growth Management Act. Jurisdictions are left to compile or commission scientific studies about critical areas, determine which are the 'best,' and incorporate that information into policy (Department of Community, Trade, and Economic Development, 2007). In Seattle, 'best available science'

for geologic hazardous areas is periodically reviewed and incorporated into critical area code updates.

Some parts of the ECA code directly reference scientific studies, such as the area of the code defining and delineating ECAs. Other parts of the code do not directly reference studies from which it draws its standards, but implies, by virtue of its basis on ‘best available science’, that it is based in expert knowledge. Seattle is unique in that it has five seasoned geotechnical engineers on staff at DCI to help translate ‘best available science’ into code standards, and to review permits for proposals in geologic hazard areas. However, other jurisdictions may hire consultants to help develop code from ‘best available science’ and may rely on planners without geotechnical expertise or third parties to review proposals that require geotechnical reports.

While applicants and government agencies tend to have the resources to make science-based and technical arguments, appellants tend to rely on values-based arguments, or lack access to scientific and technical data to support their positions. The submittal of a land use application in a landslide-prone area requires an applicant to obtain extensive technical information about a site. The application review process similarly revolves around technical information and science, with DCI geotechnical engineers reviewing proposals and ensuring consistency with an ECA code that is based on ‘best available science.’ In contrast, neighbor to applicants and government, neighbor appellants, usually non-scientists, are tasked with providing more compelling information that challenges the conclusions drawn by multiple technical experts. Either without access to science and technical expertise, or unaware that the appeal system requires proof of unequivocal error, neighbor appellants rarely provide such information.

The Role of Science and Scientists in Producing Dispute Outcomes

In appeals where applicants contest denials or restrictions on development by DCI, which characterize four of the sample appeals (Disputes 1, 3, 9, and 10), both actors typically employ scientific and technical data to support their respective arguments. Applicants rely on the required technical studies previously performed by their geotechnical expert, and often enlist those experts to testify at the appeal hearing. DCI relies on its own experts, including geotechnical engineers within DCI and those in other government agencies, to provide credible testimony in support of its argument. A manager at DCI said, “I think we’re ahead because we have the landslide database, and more importantly, we have the geotechnical expertise in house. So [proposals are] getting review by people who know when an analysis is not adequate” (Anonymous, personal communication, May 3, 2016).

Both DCI and applicants rely on science and technical information to develop and support their arguments. The applicant’s consultant provides science and technical information about a site supporting development, or specific extents of development, and DCI experts analyze information about the same site in a way that supports the restriction or denial of development. In the sampled disputes, these actors come to conflicting conclusions about what action ought to be taken for one or both of the following reasons:

- The two actors disagreed about the implications of the science and technical information about the site (Disputes 9 and 10)
- The applicant disagreed with the validity of the science that underlie the regulations (Disputes 1 and 3)

In these cases, an actor’s position may be influenced by their preferred outcome. Some developers have claimed that to the extent that ECA regulations restrict development, the

government's preferred outcome is restricted or non-development, so that it can preserve green space in the City at no cost (Beason, 1995; Hadley, 1997; Hadley, 1998). However, at face value, the preferred outcome of the government is that which is consistent with local and state policies and regulations. This preferred outcome may be development, restricted development, or no development. In this light, the government has no singular outcome that it prefers.

Actors and Preferred Outcomes

An applicant's preferred outcome is transparent; he or she wishes to develop and will invest many resources to ensure that development occurs. The preferred outcome of the applicant's geotechnical consultant is a more complex question; a geotechnical consultant is hired to professionally assess the state of the site conditions and make recommendations for development to mitigate for risk, which officially puts consultants in a neutral role which no preferred outcome.

However, several geologists and planners who were interviewed argued that some consultants are concerned primarily with achieving the client's preferred outcome of development, even for proposals with irreconcilably hazardous elements.

As one government geologist noted:

Oddly enough, in lawsuits, you'll have a scientist hired by this party who is making one argument and a 'scientist' hired by the other party making the opposite argument off of the same set of facts. And the idea that they are being completely objective, and just coincidentally happened to come to the conclusion in support of their client's argument, is just ridiculous. . . . I'm not saying they don't have scientific integrity, or that they're crooks, but any party to a lawsuit can find an 'expert' who can tell them

what they want to hear if they shop around (Anonymous, personal communication, February 22, 2016).

One government planner interviewed emphasized that clients pay a consultant's salary, a setup that implicitly pressures a consultant to provide recommendations that favor the preferred outcome of the client, "You can pay for what you want, which is strange because you'd think science is science, right?" (Anonymous, personal communication, February 25, 2016).

An independent geotechnical consultant interviewed agreed with the notion that 'you get what you pay for,' and even conceded that in permitting situations, clients generally expect positive recommendations from their geotechnical consultant. He explained that obtaining more precise and more accurate data about a site requires more sophisticated and costly study methods, amounting it to, "money in, data out." A client willing to spend more money will receive a more detailed geotechnical report, and will have access to more sophisticated structural designs, "With more money comes more certainty. We're taught that anything is possible" (Anonymous, personal communication, April 14, 2016).

Within the sampled cases, consultants most often disagreed with government experts about the implications of site conditions for development. In disputes 1 and 3, consultants questioned the science that underlie the ECA regulations. Notably, three unpaid geologists and engineers testified on behalf of the applicant in dispute 1, expressing professional concerns that specific parts of the regulations might systematically impede stabilization of slopes. That three unpaid scientists would volunteer to testify in a dispute indicates that even

outside of consulting positions, scientists hold their own beliefs about how risk ought to be regulated. Some may publically advocate on behalf of their beliefs and others may not.

Actor Narratives and Fundamental Perspectives on Landslide Hazards

Four primary nodes, or themes, were evident in the content analysis of 12 disputes, 11 interviews, and 127 news articles. The theme of ‘liability’ was referenced 76 times, the most out of all nodes. It was followed by ‘engineering safety’ (34 references), ‘acceptable risk’ (26 references) and the broad theme of ‘contradiction’ (25 references). These four themes, all of them interconnected, help to illustrate the fundamental perspectives of some actors, and therefore the origins of their preferred outcomes and arguments used in disputes.

Liability and Contradiction. In a post-disaster context, one of the most salient questions is, ‘Who is to blame?’ Assigning blame not only helps victims and observers make sense of what occurred, but through lawsuits and payouts, it can financially fast-track recovery. Governments are often perceived as liable for disasters because they are responsible for developing the regulations that dictate where development occurs. Governments are also generally understood as responsible for informing their population about hazard risk. Disaster victims often sue the government claiming that it fell short of its responsibility to protect the population from hazards. Seattle’s municipal government, for example, has fought lawsuits arising from landslide-related damages for over 100 years. Often, lawsuits claim that the City was negligent, either in allowing development to occur in a hazardous area or for inadvertently triggering a landslide by failing to maintain drainage systems on public land.

Seattle has been involved in several highly publicized lawsuits over landslide damages over the past century, often following widespread landsliding from heavy rainfall. In the early 1930s, the City was sued for a total of over \$600,000 (nearly \$11 million in 2016 dollars) by homeowners alleging the Seattle had failed to maintain its drainage systems (Maier, 1997a). The City was similarly involved in multiple lawsuits after the 1996-97 winter landslides, including the one detailed in dispute 6. In dispute 6, appellants sued the City for negligence after three townhomes were rendered uninhabitable by landslide after the 1996-97 winter storms. That dispute reached the Supreme Court of Washington. In dispute 6, the City offered the plaintiffs a settlement, precluding the legal costs of prolonging the court battle.

Lawsuits not only cost governments money, but also threaten to set legal precedents, which can translate into greater future costs. In dispute 6, the lawsuit against the City threatened to set a precedent for government liability when hazards damaged structures that it had permitted to be built. To avoid such a precedent, the City fought the lawsuit to the Supreme Court, which, as noted in a Seattle Times article at the time, was unusual given that Seattle had been undergoing budget cuts (Young, 2003).

Currently, Snohomish County and Washington state are defending themselves in several wrongful-death suits over the Oso landslide of 2014. Those lawsuits allege that the government failed to inform citizens of the hazard risk, that it negligently issued logging permits, and that its structural mitigation for flood hazard contributed to the landslide (Blankstein, 2016).

Governments are often faced with a tenuous balancing act of mitigating for hazard risk while meeting the interests and needs of those in the present — interests that may directly conflict with one another. From a government's perspective, avoiding liability is

difficult; many policies that are effective at mitigating for hazard risk are unpopular. In many cases, risk-averse policies directly conflict with the interests of homeowners, developers, and even governments. For example, banning or strictly regulating development in hazardous areas, which may prevent disaster, conflicts with the interests of landowners and developers who want to improve the value of their land, lowers an area's housing stock, and reduces a government's tax base. Attempts to limit development are often met with strong opposition from property rights proponents, and in many cases, involve lawsuits that allege government taking of private property. Yet, sometimes, those that sue for the right to build in a hazardous area later hold the government liable when a hazard damages their property. Media and citizens alike took note and publically criticized this pattern. Describing these homeowners in 1997, Seattle Times reporters wrote:

They have complained, cajoled and sued in an effort to find their way around government regulations intended to protect the environment and their well-being. And on occasion, when nature laid claim to their investments, they turned again to government to rescue them, protect their property from vandalism and shore up hillsides from future slides (Nelson & Ostrom, 1997).

A 1998 letter to the editor of Seattle Times was more explicit in its criticism:

I am tired of hearing about homeowners who knowingly build in critical areas in Seattle and then turn around and sue the city when any type of damage occurs... The city (and taxpayers) should not be held accountable for damage that is caused by natural forces for people who build in critical areas. When homeowners buy property in these type of areas, they often enjoy unobstructable views that can be found

nowhere else, but they must also take the risk and pay the price. The city cannot and should not be responsible for all drainage problems either. City officials do not have crystal balls, and it is time for homeowners to accept responsibility regarding their decision to build in these high-risk areas. I am sick and tired of people blaming the city and in turn, filing lawsuits (Merz. 1998).

That the government can be sued for restricting development and for allowing development, presents a contradiction that policymakers struggle to reconcile. Disputes 1 and 10 demonstrate that the government may be sued for not allowing development in ECAs, and dispute 6 demonstrates that the government may also be sued for allowing development in ECAs after a hazard occurs. Faced with the prospect of being sued either way, policymakers in Seattle have developed a regulatory framework that allows development in ECAs, but regulates it in a way that minimizes the government's culpability in a future disaster. Development standards enforced by DCI are meant to lower probability of slope and structure failure, and because those standards are based on 'best available science,' they indicate that development is the most robust it can be. Apart from blocking development in hazard areas, holding development to the highest development standards is the best strategy a government can take in avoiding permitting-based liability claims after a disaster. When people try to sidestep these standards, they effectively heighten a government's potential for a liability suit should a disaster occur. In this light, government denial of regulatory relief, and its subsequent defense of that denial upon appeal sometimes all the way up into court, indicates the government's evaluation. Denial indicates the government has determined that

the grant of regulatory relief could potentially cause harm to people and property and also leave the government liable for that harm.

Acceptable Risk. The UNISDR (2009) defines acceptable risk as “The level of potential losses that a society or community considers acceptable given existing social, economic, political, cultural, technical and environmental conditions.” Acceptable risk may be determined by a community or individual’s cultural and religious views, economic status, or perceived benefits of accepting a situation in which risk is present. In the large majority of cases in which text was coded at the node ‘Acceptable Risk,’ the term referred to the psychological tension of desiring the views afforded by a location highly susceptible to landsliding. Homeowners weigh the perceived level of landslide risk against the benefits of the option in which risk is produce. In the context of Seattle and other highly developed areas, the benefits of living in a location with landslide risk are typically beautiful views and preferable neighborhood.

According to a University of Washington geologist interviewed:

There are very interesting differences in how we manage landslide hazards as societies. To compare Rio de Janeiro to Seattle, in Seattle you look at that map of landslide prone slopes and then you look at property values and a lot of the expensive land is in slide prone stuff - the coastal bluffs, great views, views I’ll never be able to afford. You go to Rio and you look at this topographic similar place on the steep slopes ... and what you find are favelas, you don’t find McMansions. Why? Well, their people are not willing to take that risk. And so it’s basically poor people [there], and that’s the land that’s available to them (Anonymous, personal communication, September 25, 2016).

Slovic et al. (1979) suggests that risks are more acceptable when they are perceived as voluntary and that heuristics play a large role in determining whether there is a significant risk or not. Known as the “psychometric paradigm” within risk perception studies, it is argued that individuals make complicated risk-related decisions using mental shortcuts. Thus, perceptions based on recent experience, emotions toward actions or events, or media exposure determine what level of risk is perceived and will in turn affect whether that risk is acceptable in light of any associated benefits. It is important to note that it is not risk per se that is acceptable, but the option that is associated with that risk. Individuals accept options that are associated with both risk and benefits. The ratio of cost and benefit makes an option acceptable (Fischhoff et al., 1981).

Alhakami & Slovic (1994) found that perceived levels of risk and inversely associated with perceived benefit. In other words, humans often perceive that the option associated with the highest benefit has the lowest risk, when in reality the two are often positively correlated. This perceptive tendency may be due to denial, which Slovic et al. (1979) describes as a heuristical reaction to uncertainty of risk. Individuals, when faced with the anxiety of uncertain risk, may suppress it altogether. This could explain the tendency to diminish the high risks associated with high benefits. In Seattle, residents may not perceive high landslide risks due to the perceived high benefits of living in a location with beautiful views and in a desirable neighborhood. Accordingly, they may not agree with perceivably overly stringent regulations set forth by the government for development on their property. As one government geologist explained:

There's a lot of people who are willing to take on that risk and I've been asked a number of times, 'Why can't I just build this, I'm willing to take on the risk.' And my answer is always 'Yeah, you are, but is your wife? How about your kids? The people who come visit? What about the next people who own this place? Because on the average, you're going to sell in seven years. What then?' So I have to hold them to some standard and that standard is set up by the [ECA] code (Anonymous, personal communication, February 18, 2016).

Appellants in disputes 1, 3, 9, and 10 claimed that development as planned in their proposals would stabilize the slopes in question, thus reducing risk of slope movement. Their claims that development would produce stability can be framed as a severe example of psychologically diminishing risk, of having an excellent engineer, or both.

Engineering Safety. Geotechnical engineers and many developers and homeowners argue that the appropriate way to address landslide risk is through proper engineering that reinforces the structure and slope, an argument that runs counter to the philosophy that highly hazardous areas should simply be avoided. Seattle's ECA regulations acknowledge both arguments, outlining that development in landslide-prone areas should generally be avoided unless an applicant can demonstrate that a project can meet specific standards of mitigation.

Scientists fall on both sides of the debate. Neil Twelker, a veteran geotechnical engineer in Seattle, was a proponent of risk reduction through human ingenuity and structural approaches. He told the Seattle Times in 1997, "Look, most of the slides I know have been on undeveloped property...It really depresses me when people in my own profession get out and say, 'It's caused by development or overdevelopment.' Development doesn't do that at

all” (Nelson & Ostrom, 1997). Donald Tubbs, a geologist, geotechnical engineer, and considered one of the grandfathers of landslide studies in Seattle, shares the same view that Twelker did. He told the Seattle Times in 1999 that, “I would feel perfectly comfortable living in a landslide hazard area, if the house was properly engineered” (Barber, 1999). As Twelker’s and Tubb’s quotes to the Seattle Times demonstrate, both geotechnical engineers conceive their role as experts to go beyond assessing risk, and like scientists that write op-eds, are vocal about their policy views.

Few question that modern geotechnical engineering methods have the capability to reduce the risk of living in a landslide hazard area, but even the most sophisticated geotechnical engineering techniques do not eliminate all risk of landslide. The ideological debate lies in whether humans should be willfully exposed to landslide hazard risk at all; many believe that certain hazardous areas should be completely avoided, either through personal choice or through legislation. Others believe that slopes can be safely built on with the right engineering. Fundamentally, the debate about whether to engineer the slope or whether to avoid the slope comes down to what level of risk is acceptable and this level may change drastically depending on the individual. For homeowners and developers who challenge a decision to deny a permit to build in an ECA, they are expressing not only their faith in the science of engineering, but their personal willingness to accept the balance of risk that engineering methods leave, regardless of impacts to others. In contrast, neighbor appellants who challenge permits to develop landslide-prone or steep slopes may be expressing their misgivings about the viability of engineered solutions, or at least engineered solutions devised by a technical expert paid by a risk-accepting landowner, and their concern

of increased risk exposure with none of the accompanying benefits their neighbor will receive.

Chapter 8 – Scientists, culture, and policy

Science and technical information are used extensively by applicants and government agencies in justifying their positions in disputes about landslide regulations in Seattle. Neighbor appellants, however, seldom invoke science and technical information to justify their positions, and instead rely on moral arguments of fairness and decency. Yet, all actors operate on values to an extent, even if they use science and technical information to support their arguments. Applicants and neighbors share a value of aesthetics, with both actors acting on desires for views of the landscape. Property rights and engineering safety are also discernible values of applicants. The government theoretically shares the public's values, but is also concerned with the prospects of liability and lawsuit, and these concerns guide government policy. Actor arguments and values as they relate to disputes about development in landslide-prone areas can be better understood when contextualized within the theoretical literature of ST&S.

Like the environmental issues of climate change, vaccines, and GMOs, debates about landslide regulation are characterized in part by values-based arguments. In many of the cases analyzed, the values-based arguments are masked by science arguments, as is the case with applicant appellants. In other cases, arguments for or against development on landslide-prone slopes are more apparently values-based, as is the case with neighbor appellants. In every dispute, the question of slope stability was raised by at least one actor, either explicitly as concern for slope stability, or indirectly, through concern for the issues of drainage or erosion. However, actors had different perspectives on the integrity of the slope based on their preferred outcome. For example, neighbor appellants, who opposed development and voiced concern for the aesthetic impact of development, often perceived the slope as

unstable, or of unknown stability, often advocating for more studies. On the other hand, applicants, who supported development, avowed slope stability, pointing to their geotechnical reports. As Sarewitz (2004) argues often happens in politicized environmental controversies, actors interpret science in a way that supports their preexisting views. Applicants reaffirm their desire to build through the information provided to them by hired engineers, while neighbors scrutinize the available data as insufficient in order to oppose development.

Cultural theory as laid out by Douglas & Widavsky (1982) and reframed by Kahan (2012) are helpful for contextualizing the importance of property rights, land value, freedom to choose risk, and engineering safety as values and beliefs that drive actor arguments in regulation disputes. In Seattle, such values are inherited culturally within an environment characterized by capitalism, private land tenure, and an emphasis on modernism and science. Values that focus on market freedom and freedom to choose risk are associated with ‘individualists’ within Douglas & Widavsky’s (1982) cultural typologies. While differences in cultural values are argued to fuel controversies in some cases (Douglas & Widavsky; Kahan, 2012), this is not necessarily the case for disputes about development in landslide-prone areas of Seattle. Neighbor appellants and applicants appear to share at least a limited set of values that emphasize land value and home and neighborhood as symbols of class. Disputes do not necessarily arise from differences in values, but from the inability to reconcile the implications of those values at a specific place and time. For instance, both neighbor appellants and applicants value their property values, yet neighbor appellants perceive new development as reducing their land value by blocking views and natural light, while applicants believe they must develop in order to maximize land value. Neighbors are

often concerned with the impact of new development on neighborhood character and computability, which generally refers to consistency in structure style and size, and especially in density. They may perceive deviance from the status quo, for example a stylistically different structure or the development of multi-family housing, as inconsistent with their class and cultural identity. Applicants too are concerned with representation of class and cultural identity in their development proposals. That concern is demonstrated in the very choice to purchase a landslide-prone plot of land because of the magnificent views it offers and the coveted neighborhood in which it is found.

In a cultural theory typology, the government may be considered a blend of ‘individualistic’ and ‘hierarchic’ outlooks; it attempts to cater to private development interests while also maintaining institutional order and relying on science and technical expertise for decision-making, which is characteristic of the hierarchical typology. For example, Seattle’s ECA code allows individuals to develop their properties, but requires mitigation with high standards that are based in science. Maintaining a middle ground between typologies allows the government to represent diverse public values, which may compete inherently or circumstantially. The most difficult balance of values a government must maintain is that between property rights, championed by land use applicants, and safety, a value likely shared by most but conceptualized and prioritized differently across actors. The government’s consideration of both values through its land use policy demonstrates its commitment to managing multiple interests, but it also reveals a strategy that seeks to minimize government losses. Blocking development in hazard areas leaves the government at risk for costly takings lawsuits, while allowing development in hazard areas leaves the government at risk for future negligence and wrongful death lawsuits. The government’s

middle ground policy is defined by development with mitigation, with development that adheres to standards developed through the review of best-available science. Regulation is scientized, with the burden of proof on the applicant to demonstrate through science that a project meets regulatory standards, and can satisfy a values-based public expectation of safety.

Safety is a standard public value for its inherent moral undertone. Yet the government's commitment to safety can also be seen as financial loss mitigation, in that by precluding disasters, it avoids costly lawsuits. Safety, then, is a two-toned value that the government has an interest in incorporating into regulation, and it has been able to do so through the development of scientized standards that ensure hazard mitigation. The state is responsible for scientizing regulations in this manner through GMA standards, which, when passed, was arguably based more in values of conservation than in public safety, yet those values conveniently align for the purpose of land use regulation.

Sarewitz (2004) argues that certain controversies are more likely to be scientized, rather than left to values-based decision processes, when actors believe that the use of science can help them further their interests, when “scientists are involved in the political framing of the controversy” (398), and when policy options lack political consensus. Development in landslide hazard areas is characterized by all of these factors; applicants and government alike can leverage their interests through the commissioning of science or technical studies. Scientists are often involved in the framing of hazard through the publication of op-eds and the provision of ‘best available science’ for policy. Landslide risk, like many natural hazards, is especially amenable to scientific framing – events are infrequent, based upon complex stochastic processes, and are often embedded in

environmental processes perceived to be beyond the realm of society and the politics that envelop it. Even so, the public circumstantially disagrees on policy outcomes stemming both from uncertainty about the hazard and from the competing values and different levels of acceptable risk, as seen in the values and preferred outcomes of the actors analyzed here. The GMA has allowed for science-based resolution in policy, where values may have otherwise competed to be the basis of decision-making. Science-based policy, however, benefits certain actors more than others.

Applicants often use science to mask values-based positions, employing science-based arguments, particularly arguments that development promotes slope stability, to promote an outcome that stems from values. Some applicant values, such as property rights, are supported by law, and do not need to be masked. However, the more aesthetic values that draw applicants to develop in hazardous areas must be subdued in an appeal process where such values have no weight. In their place, the actors attempt to use arguments that are based in science and technical information. The science and technical information used by applicants is not necessarily invalid, but often relies upon the imperfect science of engineering to demonstrate project feasibility.

Public opposition to development on landslide-prone slopes and skepticism of engineering as an appropriate remedy for natural hazard risk may be explained in part by growing distrust of science. Despite design for stability and strength, some of the public and government may view the engineering of stability on landslide-prone slopes with misgivings, fearing that overreliance on structural ingenuity will result in disaster, which may be a financial burden borne by taxpayers. Jasanoff (1996) suggests that the advancement of science knowledge “has also reinforced archetypal fears about science and technology that

overshadow the promises of healing, regeneration, material well-being, and unbroken progress” (63) and this may ring true for engineering science as well. Indeed, Jasanoff (1990) suggests that distrust in science may be fueled in part by a distrust in the impartiality of scientists.

The role of scientists in policymaking is controversial, and often blurry. The classically conceptualized role of a scientist is that of a neutral and objective purveyor of facts, though, as Pielke Jr (2007) argues, few scientists neatly conform to that description, and most participate in some degree of advocacy. Advocacy may be explicit, such as when scientists argue for a specific outcome or criticize a specific policy, or what Pielke Jr terms ‘stealth,’ which is a more subtle form of advocacy that occurs when scientists communicate a limited amount of information or options. Scientist advocacy is more apparent on controversial issues like climate change and vaccines, in part because these issues concern widespread environmental and human health.

Like other major debates that regard human health and the environment, natural hazard regulation are similarly contentious as natural hazards pose a threat to human lives and property, while hazard regulation has implications for property rights and values. In regards to hazard policy, scientists often advocate certain policies through writing op-eds for local newspapers or by providing their quoted opinions to a reporter. One university geologist, who has written many op-eds about landslide policy, said:

[Writing op-eds is] an interesting process because you’re trying, by doing that, to shape thinking and sometimes advocating particular policies, but you’re pretty much wearing the hat of an individual. You’re not wearing the hat of whoever you work for, you’re basically saying look, I’m a geologist, I know something about these

issues, here's what I think we should do. And in that sense, usually you write an op-ed to try to influence policy. It's sometimes to make a statement in the aftermath of a disaster but usually you're trying to shape something (Anonymous, personal communication, September 25, 2015).

All scientists who work with natural hazards likely have personal opinions about what ought to be done in hazard regulation because they are individual citizens as well as scientists. However, some scientists are purposeful about trying to separate their professional self from their personal self and many of those interviewed, especially government scientists, avowed that scientists are, and should be, separated from policy. One government geologist, when asked how he interacts with policy, said that while he provides tools for policymakers to use, he is "agnostic" about whether or not they are used, and strives to practice his profession in the most neutral way possible:

Advocacy to me, it is the biggest enemy of science. I will speak generally and not specifically but in the generations of people coming behind me . . . [T]hey are going into it because of advocacy. [These people say,] 'I want to be a scientist and I want to study this because I want this outcome. I want to change the world. I want to change the country. I want to make people safe. I want to do all of these things.' And they are coming at it as advocates, as crusaders in some ways. And that saddens and terrifies me in terms of the future of [science] because if you are coming at it as an advocate then you have confirmation bias. You are looking for things to support what you already believe, you will find them, and you will ignore contrary evidence. You might not do it consciously but you will do it. You will design experiments that are intended to find evidence for what you already believe, for what you think is the case. And

that's the broad area of what's called confirmation bias . . . and I find that deeply concerning (Anonymous, personal communication, February 22, 2016).

When scientists play advocates, the cause or position for which they argue may temporarily benefit from the support of someone viewed as a source of objectivity. Yet scientists who advocate a more neutral approach fear that over time, advocacy reduces the public's trust in science and scientific institutions if they are increasingly seen as partial to specific causes. Another government geologist said:

Science doesn't have a whole lot to say [about politics] because these are societal choice about risk perception. At some point, we get shut out of the conversation. And I don't disagree with that I guess...It's okay to inform it, but to influence, it reduces our effectiveness (Anonymous, personal communication, February 22, 2016).

Even when scientists do not participate in policy discussions, their work may be dismissed by virtue of the policy that it may imply if that policy is undesired within a specific cultural context. Actors debating development on landslide-prone or steep slopes in Seattle may dismiss scientific information when its findings do not align well with the actor's preferred values. Kahan et al. (2012) argues that people are so concerned with social cohesion and group identity that they may reject science or other information when it conflicts with group cultural values. In Seattle, neighbor appellants often dismiss scientific or technical findings that suggest low risk development if development is undesirable for them. Neighbor appellants, like applicants, operate upon their values, but do not use science or technical information in their arguments. Rather, they argue in moral terms of fairness and

decency, and often speculate that there are small inconsistencies between a proposal and standards within the land use code or SEPA without providing concrete evidence for those claims. Policies within the land use code and SEPA that cater to the values of neighborhood compatibility and aesthetics may be intentionally vague, and generally limit development only through zoning, height limits, and preservation of public spaces. They are not designed to guide development according to subjective neighbor preferences. As a result, neighbor arguments that are based in values and personal preference and not science lack advantage in changing land use decisions in ECA areas. Perhaps because of this disadvantage, neighbors tend to call for more science, dismissing applicant science as not credible or insufficient, which Oreskes & Conway (2011) describe as a tactic used by values-based actors in the science controversy over smoking and climate change in the latter half of the twentieth century.

What is clear from analysis of disputes in Seattle is that, though science matters in terms of creating sound hazard risk policy, and in assessing hazard risk on specific sites, average citizens are more concerned with maintaining their interests, regardless of what ‘science says.’ Kahan et al. (2012) found that actor beliefs on climate change were most heavily based upon cultural values, not, as is commonly believed, by science literacy. The same may be true of actors debating landslide regulations. Certain actors may use science in their arguments, but preexisting values most heavily determine whether an actor views landslide risk policy, and the science supporting it, as fair and reasonable.

Citizens may be more concerned with policies that they perceive as fair and equitable than they are with scientific risk assessments. As Rayner and Cantor (1987) suggested, “the critical question facing societal risk managers is not ‘How safe is safe enough?’ but ‘How

fair is safe enough?”(3). Of course, perceptions of what type of policy is fair may vary drastically, just as values do. While neighbors may perceive the approval of new development as unfair and burdensome to the neighborhood in its blockage of views or light, the applicants for the project may perceive the restriction of development as unfair and burdensome to them. Perception of, and support for, landslide risk regulations depend on an individual's outlook on what level of risk is acceptable, how policy outcomes affect their perceived level of wellbeing, and what level of faith they have in reducing risk through engineering. In this light, hazard risk policy based on science is acceptable to the public only insofar as it meets their cultural, social, and individual needs. When it does not, it is disputed. However, in order to influence a policy outcome, an actor must present science information that meets DCI's standards for allowing or blocking development.

Limitations and future work

The United States in general, with its penchant for free market solutions may be characterized by an individualistic cultural typology, yet this is only a broad generalization. Different communities, and individual actors within communities, may prescribe to the values, and the associated risk concerns these values entail, to greater or lesser extents. As this work finds, when actors are confronted with the development of their neighbor's property, they very well may draw upon values that compete with individualistic cultural typologies. More work is needed to understand the values and regulatory approaches of jurisdictions outside of the Seattle urban environment.

This study of land-use regulations on landslide-prone and steep slopes in Seattle examines the way in which land use policy has found a manageable equilibrium between risk-accepting values of property rights and relatively more risk-adverse values of public

safety and reduction of government liability. This particular equilibrium is specific to Seattle during the time period of study, and it is worth noting that many geologists and planners interviewed for this thesis perceive Seattle's regulatory framework for landslides as exceptionally risk-averse in comparison to other jurisdictions in Washington. Seattle's government has been purposeful in scientizing its policies through the proactive commissioning of scientific studies, and rather strict implementation practices, but this may not be the case for jurisdictions in which the values of property rights or economic development are strong enough to preclude the passage and enforcement of stringent, science-based regulations. The GMA requires that all Washington jurisdictions rely on science-based standards for hazard regulations through the leveraging of 'best available science.' The state also provides a model ordinance and guides to using 'best available science' to policymakers. However, other jurisdictions may set lower standards for development than in Seattle or interpret standards in a more flexible manner, depending on risk evaluation, and on the values and priorities of the community.

Even despite statewide adherence to 'best available science' policies, obfuscation and politicization of hazard risk science may occur where a strict, science-based standard framework for regulating development in hazard areas would be too unpopular, and values-based interpretation of science may substantially affect development decisions. In these cases, the production of more science, and specifically, incoming statewide LiDAR data, may not necessarily lead to clear, science-based policy on how development should occur in geologic hazard areas. Rather, much like in the case of climate change, such data may be contested as invalid or irrelevant by actors with different values-based preferred outcomes. Where hazard risk data suggests policy inconsistent with values-based preferences, actors

may dismiss science integrity, or dismiss its relevance in light of the perceived benefits of living in a location that has hazard risk.

Acceptable risk, while informed by risk realities, often operates more within the realm of subjective desires than in science. Alhakami & Slovic (1994)'s findings that individuals tend to perceive benefits inversely to risk suggest that where perceived benefits, or values, are strong, science information suggesting risk may be psychologically diminished. It is therefore difficult to create science-based hazard policy where a community conceptualizes hazard as an acceptable risk and where communities prefer to support policy that prioritizes their property rights, encourages economic growth, or allows individuals to build their dream homes.

It is beyond the scope of this project to evaluate the policy environments of other jurisdictions in Washington, and thus difficult to make assumptions about the use of science and values in hazard policy in other jurisdictions in Washington. However, strong values-based disputes about policy decisions in an urban area like Seattle suggests that the same is likely occurring in other jurisdictions that may not have as robust, science-based regulations. The influence of values-based advocacy on policy is likely to be much stronger in jurisdictions with less stringent regulations, and science may not meaningfully affect policy. Policymaking for other high magnitude, low frequency natural hazards such as earthquake and tsunami likely experience the same values-based challenges, because these hazards similarly have implications for development and their infrequency complicates risk cognition. Like development standards for landslides in Seattle, earthquake policy has been highly scientized in many jurisdictions through the adoption of the International Building Code (IBC), which designs for seismic loading (ICC, 2016). Adherence to IBC standards

may make development more expensive, but Seattle's municipal code has no provisions that affect location of development in earthquake hazard areas unless there is substantial liquefaction risk. California, on the other hand, has restricted development in mapped fault zones since the early 1970s (California Geological Survey, 2015). Where California has definitively taken a hierarchic and science-based approach to regulating its earthquake risk with arguably more risk-averse development restrictions than most other state or local governments, it would be valuable to investigate how values and development interests have challenged these restrictions, and the science that underlies it, over time.

While science is invaluable to understanding hazard risk and developing strategies for coping with that risk, it is essential to keep in perspective the cultural and political contexts in which that risk is located. As demonstrated in much of the discussed literature and in this thesis, values are an essential part of decision-making, and may conflict with the policy implications of science. As leaders call for more science to address landslide hazard, the importance of diverse, and potentially shifting values within communities, must be considered in order to create community-appropriate policies.

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Appendix

Semi-Structured Interview Questions for Policymakers

1. What are your professional responsibilities?
2. How do you consider or use science information to perform these responsibilities? How do your colleagues? How is it 'supposed' to work?
3. Evaluate Seattle's or King County's current landslide framework. What are its strengths and limitations? Whose interests are met by the current framework? Whose are not?
4. What are the most important characteristics of landslide risk reducing policy? What does an ideal policy look like to you? Where is it feasible?
5. What are the challenges to implementing that framework?
6. Thinking of the ideal policy you just describe, are you aware of stakeholders who would NOT be pleased by such a policy? Why?
7. How do you make informed decisions when creating policy? From what sources do you seek information? To what extent does information affect your decision? To what extent does political climate affect your decision?

Semi-Structured Interview Questions for Geologists and geotechnical experts

1. How did you get into geology and hazards? Describe your trajectory.
2. How do geologists interact with policy related to landslide risk in Western Washington? (state, county, city, private)
3. In your personal opinion, is science in most cases sufficiently reflected in policy? Why may this be?
4. Evaluate Seattle's current approach to development on slopes. What are its strengths and limitations? Whose interests are met by the current approach? Whose are not?
5. What, in your opinion, would improve the regulatory approach in Seattle? (e.g. What are the most important characteristics of landslide risk reducing policy? What does an ideal policy look like to you?)
6. With whom else should I be speaking?

INFORMED CONSENT - PARTICIPANT

This interview is being conducted to inform a Master's Thesis on how science and technical information are used in disputes about landslide regulation in Seattle, WA. Your input will help the researcher to better understand the character of landslide risk regulation in Seattle, as well as your personal and professional perspectives on the issue.

This interview will last approximately one hour. This interview is semi-structured, which means the researcher will ask you pre-determined questions, but also may ask you questions that arise during the conversation. Questions will be related to your knowledge of landslide regulations in Seattle and in Western Washington, as well as your professional and personal experience with landslide hazards or landslide regulations. The interview will be recorded, and the researcher may also take notes. Your participation is completely voluntary, and you are free to withdraw your participation at any time.

Your identity will be kept anonymous, and all interview materials, including this consent form, will be kept in a locked office at Western Washington University or on a password-protected computer. Only the researcher and her advisor, Dr. Rebekah Paci-Green, will read notes and listen to audio of this interview. Materials will be destroyed at the end of this research.

This research is conducted by Ana Miscolta-Cameron, a graduate student at Western Washington University. Any questions you have about the research or your participation may be directed to her at 206-920-8056 or by e-mail at amiscolta@gmail.com. If you have any questions about your participation or your rights as a research participant, you can contact Janai Symons, Research Compliance Officer at Western Washington University, at 360-650-3082. If during or after participation in this study you suffer from any adverse effects as a result of participation, please notify the researcher directing the study or the WWU Research Compliance Officer.

am at least 18 years old and I have read the above description and agree to participate in this research project as a participant.

Participant's Signature

Date

Participant's Printed Name