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PERSPECTIVES ON AVALANCHE RISK: THE NEED FOR A SOCIAL SCIENCES AND SYSTEMS THINKING APPROACH

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The presence of risk resulting from exposure to avalanche hazard is inherent in mountain snow environments. In this article, I discuss avalanche risk from a social sciences and systems thinking perspective. I explore how we conceptualize and perceive risk, what factors influence our risk tolerance, and why it is important to consider the context and boundary conditions that inhere in the avalanche risk assessment process. I suggest it is essential to understand how risk is perceived and evaluated within this holistic viewpoint in order to design informed and effective strategies for avalanche risk management and communication.

What is Risk?

Risk can be thought of as an expression of uncertainty in the world. Multiple conceptions of risk exist at individual, organizational and societal levels, as well as between the physical and social sciences. In statistical modeling, for example, risk is a known parameter. A common definition of risk in the physical sciences is the chance or probability that exposure to a hazard will result in damage, injury, or loss of life (McClung, 2002). However risk, as viewed by social scientists, is a social construct that is invented to help us cope with and understand the dangers and uncertainties of life (Mellers et al., 1998). Slovic (2001) argued that risk does not exist externally, waiting to be measured. “Risk assessment is inherently subjective and represents a blending of science and judgment with important psychological, social, cultural, and political factors” (p. 23). These differing conceptions of risk highlight the reality that avalanche risk is a multi-dimensional phenomenon, and how we think of it is complex and multi-faceted.

How Do We Perceive Risk?

We all experience different levels of perceived risk resulting from our attitudes, beliefs, feelings, and cognitions about risk (Aven & Kørte, 2003; Coleman, 1993). How we perceive risk depends upon our knowledge of the hazard, our past experience with that hazard, our personal attitude towards risk taking, our assessment of the probability of our exposure in the current situation and conditions, and our degree of decision confidence in relation to the level of situation uncertainty. Our propensity to take risks also has a significant effect on our behaviours, and depends upon individual factors such as our personality, life experience and lifestyle, as well as social and cultural factors such as our age, being part of a group, or having a family (McClung, 2002; Wilde, 2001).

The sense of control we feel about accomplishing a behaviour is another variable in perceived risk. People who have a high sense of control are more likely to follow positive, healthy behaviours than those who have a low sense of control (Litt, 1988). Bruns (1997) suggested that the degree of control is directly related to the extent of our risk perception, and that a high sense of control is exercised by avalanche terrain avoidance, mitigation techniques, and conscious choice.

McClung (2002) identified human factors and variations in human perception and estimation as a key uncertainty in avalanche decision-making. Most avalanche deaths in North America and Europe result from people triggering the same avalanche that kills them (McClung & Schaerer, 1993). McClung suggested the root cause of these avalanche accidents is a failure in human perception, where the victim's perception did not match the current reality of the avalanche danger.

What Factors Influence Our Risk Tolerance?

Voluntariness in risk exposure is an important consideration in perceived risk. Research suggests that our tolerance for risks that we choose to expose ourselves to is far greater than in those situations where we do not voluntarily make that choice (Wilde, 2001). For example, while the risk perceptions of winter backcountry users may vary widely, these users are voluntarily exposing themselves to the hazards inherent in winter mountain environments. This conscious choice is in contrast with people traveling on highways that are threatened by avalanches, since they may be completely naïve to the existence of avalanche hazard or their exposure to it. Thus, their risk tolerance is minimal. A third example lies somewhere in between, in situations where people hire a guide to assume responsibility for their enjoyment and safety, and while they may have an awareness of avalanche hazard, they may have little active role in the assessment and associated decisions regarding their risk exposure.

Affective (emotional) responses to risk directly correlate with whether we over or underestimate our likelihood of harm (Slovic, 1987; Wilde, 2001). McCammon (2004) identified two risk characteristics that significantly impact behaviour in winter mountain terrain: first, a great deal of control is exercised over exposure to avalanches, and second, this exposure is typically associated with highly positive, affective experiences. The physical, aesthetic, and social elements of winter backcountry environments are highly prized by winter mountain users across the world, and this poses an additional complexity in the avalanche risk equation.

Familiarity is another influence in perceived risk, since we tend to underestimate the frequency and consequences of familiar risks and overestimate those that are unfamiliar. For example, in a study of recreational avalanche accidents in the United States, McCammon (2002) found that 69% of avalanche accidents occurred on slopes that were very familiar to the accident victims. He suggested that in victims with avalanche training, familiarity with a slope tended to negate the benefits of knowledge and experience.

Personal Vs Societal Risk Perceptions

The risk equation is qualitative and complex, resulting in a broad conception of risk across the population, especially between experts and laypeople. While avalanche experts may recognize *real* risks in hazardous situations, laypeople often have a wider dimension of *perceived* risk (Coleman, 1993; Slovic, 2001). Therefore, the risk assessment of laypeople is best described with subjective risk characteristics, such as dread or controllability, than with objective risk indicators, such as expected mortality (Gurabardhi et al., 2004).

Research indicates that we make very different risk assessments for ourselves as compared to when we are making those same assessments of others (Tyler & Cooke, 1984). Our tendency is to underrate our own vulnerability to risk; yet we judge others as having a greater susceptibility (Gurabardhi et al., 2004). Thus, risk needs to be described in personal and societal categories, since the factors contributing to our personal sense of risk are not the same factors that contribute to our view of societal levels of risk (Tyler & Cooke, 1984).

What Boundary Conditions Influence Avalanche Risk Assessment?

The traditional view of risk characterized by probabilities and consequences does not capture the subjective and contextual factors inherent in avalanche risk assessment. While the search for accurate and objective probability values is a goal of the risk assessment process, the process is driven by the boundary conditions of the decision problem (Aven & Kørte, 2003). Boundary conditions in the avalanche domain include the natural and physical environment, the knowledge, values, and attitudes of the decision maker, the cultural dynamics within groups, the goals and objectives of the clients and the organization, economics, and societal and political values. Avalanche judgments and decisions need to be assessed and characterized within the context of these boundaries. In addition, considering these dimensions of risk may have a significant influence in the formation of attitudes towards risk (Slovic, 2001).

Why is it Important to Consider the Risk Context in Avalanche Decision-Making?

The avalanche risk analysis process strives to produce predictions of exposure that are complicated by inherent uncertainty resulting from complex physical (terrain), environmental (weather, snowpack), and human factors. Thus, avalanche risk assessment is dynamic and complicated, and the weighing of risk and it's associated benefits and consequences lie at the heart of the decision process. The context of the decision problem must be a key consideration.

While traditional risk assessments often utilize cost benefit analyses, the benefit component is not constant in the avalanche decision equation. Let's consider the different contexts between avalanche forecasting for backcountry skiing versus highways public safety as an example.

In back-country skiing, the decision problem is oriented to providing the best quality of skiing while minimizing exposure to avalanche hazard. While the cost of exposure may result in injury or death, the benefit of exposure is an exhilarating ski down a deep powder-covered mountain-side. Backcountry ski guides and their clients are therefore faced with a tangible trade-off between the quality of skiing and client satisfaction, and increased exposure to avalanche hazard. Conversely, avalanche decision-making for public highways has a different context. Drivers and their passengers are deriving little benefit from being exposed to avalanche hazard, other than avoiding a road delay. In this case there is less tangible benefit to increasing their exposure. The onus is on the highways avalanche forecaster to make conservative estimates of the present and forecasted avalanche risk. Highways forecasters are therefore faced with a different kind of trade-off, where the cost of increased exposure does not provide equally perceived increases in benefits.

What is Acceptable Risk?

Acceptable risk is a subjective judgment for the level of risk to which people are willing to expose themselves. This level is uniquely personal and depends upon the variables discussed earlier. Wilde (2001) proposed the Risk Homeostasis Theory to explain how people accept a certain level of subjectively estimated risk to their health, safety, and property in exchange for benefits they hope to receive from engaging in risky activities. This 'target' level of accident risk is determined by four categories of motivating factors: (1) The expected advantages of the risky behavior, for example, an exhilarating powder run; (2) the expected cost of the risky behavior, for example, injury or death from avalanche involvement; (3) the expected benefits of safe behavior, for example, returning home at the end of the day; (4) the expected costs of safe behavior, for example, failing to ski a desirable line. As a result of these theories, Wilde (2001) suggested that the only way accidents will be effectively reduced is through strategies aimed to reduce the level of risk accepted by people and society in general.

McClung (2002) proposed the Risk-Decision Matrix for back-country skiing that describes the relationship between risk propensity, risk perception, and decision-making. He suggested that error-free decisions fall within an operational risk band (ORB) that is delineated by two types of errors; accidents and excessive conservatism. These decisions are achieved by estimating the costs associated with exceeding the band limits. Decisions that exceed the upper limit of the ORB result in injury, death or structural damage, while those exceeding the lower limit include loss of freedom, loss of credibility in forecasted warnings, or significant economic implications, for example, excessive delays in opening roads or ski runs.

How is Avalanche Risk Determined?

There are stochastic (random) occurrences for which we can calculate risk over long time periods and broad scales using empirical data. This kind of quantitative assessment of risk can be described in relation to actual avalanche occurrences and return periods. Avalanche return periods are the frequency that avalanche debris reaches the run-out zone in a specific avalanche path classified in a temporal scale of years. The avalanche return period can vary significantly, from several times per year to one event per 300 years, and is used to determine the level of acceptable risk for human use and structures in the area (McClung & Schaerer, 1993). However in Canada, data are limited in many areas, therefore risk assessment predictions are bound to be less accurate. Broad trends in avalanche activity are predictable to some extent, but no one can predict exactly when and where an avalanche will occur. Quantitatively predicting avalanche risk is therefore scale dependant.

Risk can also be described qualitatively, and this method is used in Canada with the Avalanche Danger Scale. This scale describes the probability of avalanches occurring in relation to the likelihood of triggering using qualitative descriptors of low, moderate, considerable, high, and extreme. It is interesting to note that research indicates expressions of terms such as “likely” or “probable” are vague, and that people have dramatically different ideas about what these terms mean (Hönekopp, 2003).

An additional complicating factor in comprehensive avalanche risk assessment to consider is in relation to the social sciences perspective that addresses the human construction of risk. While formal assessment procedures are relied upon to minimize risk, for example snow stability evaluation forecasts and checklists, it is important to recognize that these methods are fraught with complexity and uncertainty, requiring the exercising of considerable value-laden judgment. Stefanovic (2003) argued that while scientific facts can be used to support one’s position, the facts alone are not sufficient to ensure sound decision-making. “It is simply naïve to assume that the generation of data or the interpretation of that data is ever value-free or presuppositionless” (Stevanovic, 2003, p. 241). In relation to avalanche forecasting, McClung (2002) stated, “the only entities that can truly reduce the uncertainty are more (new) information data of the right kind, or actions that deal with the resolution of variation in human perception” (p. 114).

Avalanche-related decision-making strives to minimize uncertainty about the instability in the snow cover, and to match the human perception of this instability with reality (McClung, 2002). In order to gain a better understanding of how this perceptual matching can be achieved, empirical data related to human factors in avalanche decision-making is needed. Current methods of avalanche accident data recording describe the physical properties of the avalanche and associated demographics of accident victims; however the human factors contributing to the accident are only occasionally captured. I suggest that defining criteria for the recording of human factors in avalanche accidents will offer future insight and greater accuracy in avalanche risk assessment and communication.

How Can Avalanche Risk Be Communicated Effectively?

Avalanche risk communication is an important societal need since it aims to exchange critical information that describes potential threats to people's health, safety, property, or general well-being. The concept of communicating hazard and risk contexts has been a central focus of risk management initiatives for decades. However, how to achieve this effectively has been an issue of lively debate amongst scientists and practitioners. In an attempt to define the best way to conceptualize risk communication, researchers have tried to understand public risk perception in order to design more effective risk communication that could be used by practitioners. A number of solutions resulted. Kunreuther et al. (2002) suggested the development of *prescriptive heuristics,* rules of thumb that enhance the accuracy of risk perceptions, can be an effective aid to decision-making. Presenting risk as frequencies instead of probabilities (Karelitz & Budescu, 2004), adjusting the time frame to consider the immediate consequences (Slovic, et al., 1978), and framing the outcome, (e.g. describing mortality vs. survival (Kahneman, 1991), are several examples of prescriptive heuristics. However effective these methods may be, incorporating strategies that reduce the level of risk acceptance should be an underlying principle of risk communication and management strategies (Wilde, 2001).

A Systems Thinking Approach to Avalanche Risk Management

Quantifying a phenomenon by breaking it down into its component parts is a reductionism approach that drives the thinking of contemporary natural hazards assessment (see Stefanovic, 2003). I suggest that understanding the complexities of avalanche risk requires considering the relationships between the human, physical, and environmental systems that inhere in avalanche phenomena. This approach utilizes a systems thinking perspective, and is considered essential to adequately studying and understanding complexity.

Systems thinking is integral to the study of living systems, for example ecology, however has only recently been applied to understanding humans (Senge, 1990; Flood, 1999; Wheatley, 1999). In the science of living systems, understanding interrelationships provides insight into the emergent properties of the system. The notion is that we simply can't achieve a holistic understanding through reducing a system down to its component parts, since the system is more than the sum of the parts. As the system properties combine, different properties emerge. A classic example is water. Knowing about the components of hydrogen and oxygen tells us nothing about water, which is an emergent property of the system and bears no resemblance or similar properties to its parts. It is important to consider this approach to understanding avalanche complexity, since we are part of the very system that we strive to understand.

A Few Parting Words

This discussion of risk demonstrates that how we think about avalanche risk at individual, group, organizational, and societal levels is indeed complex. I suggest it is critically important to understand how risk is perceived and evaluated within this holistic viewpoint, in order to design informed and effective strategies for avalanche risk management. "There is no single body of knowledge that explains what works and what doesn't when it comes to helping people make better decisions in the face of risk" (McCammon, 2004, p. 2).

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