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Understanding emerging environmental health risks: A framework for responding to the unknown

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Society faces risks, hazards, and crises on a seemingly daily basis. This is not new; indeed, pre-modern societies were subjected to natural hazards that could be attributed to fate (e.g., natural disasters), and human-made hazards considered manageable. However, late-modern society is increasingly exposed to risks that are products of the modernization process itself (e.g., health impacts of climate change) emerging from broad changes in human-environment interactions. We typically have insufficient or incomplete scientific knowledge to make calculated governance decisions that protect the public and our economies from these risks. Yet, a governance response is dictated. Understanding and anticipating public perceptions of emerging risks, therefore, has clear implications from both risk management and communication perspectives. Furthermore, it is essential that a response takes account of the context within which the risk is occurring. This paper describes the development of a place-based conceptual framework for characterizing public response to emerging environmental health risks with the goal of informing governance responses. A worked example is provided through the application of the framework to the apparent epidemic of food allergies in Canada. Despite some gaps in available data, the framework appears robust and exhibits the potential to contribute to debates and decision-making around risk governance.

Keywords: emerging environmental health risk, place-based framework, risk perception, risk management, governance

Comprendre les risques environnementaux émergents pour la santé : un cadre pour réagir face à l'inconnu

La société fait face quasi quotidiennement à des risques, dangers et crises. Ceci est loin d'être nouveau; en effet, les sociétés prémodernes étaient confrontées, d'une part, à des risques naturels (par exemple, des catastrophes naturelles) et croyaient être victimes de la fatalité et, d'autre part, à des risques anthropiques qu'elles croyaient pouvoir maîtriser. Toutefois, le degré d'exposition aux risques augmente pour la société moderne avancée, ces derniers étant dérivés du processus de modernisation (par exemple, les impacts sanitaires des changements climatiques) qui origine de changements majeurs dans les interactions entre l'humain et l'environnement. Les bases de connaissances scientifiques disponibles présentement sont généralement embryonnaires ou insuffisantes pour prendre des décisions éclairées de gouvernance afin de soustraire le public et nos économies à ces risques. Ainsi, des progrès de gouvernance s'imposent. Comprendre et anticiper les perceptions que le public se fait des nouveaux risques entraîne, par conséquent, des répercussions à la fois sur les modes de gestion des risques et sur la communication. En outre, il est essentiel de réagir en tenant compte du contexte dans lequel se produit le risque. Cet article retrace l'élaboration d'un cadre conceptuel fondé sur le lieu et visant à caractériser la réaction du public face aux nouveaux risques de santé environnementale afin d'éclairer les réactions de gouvernance. Un exemple pratique utilise ce cadre dans l'épidémie apparente d'allergies

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alimentaires au Canada. Malgré quelques lacunes dans les données disponibles, le cadre semble robuste et est susceptible de contribuer aux débats et à la prise de décision en matière de gouvernance des risques.

Mots clés : nouveaux risques de santé environnementale, cadre fondé sur le lieu, perception des risques, gestion des risques, gouvernance

Introduction

Environmental threats to human health are pervasive. These are most readily apparent in cases of large-scale natural disasters, or industrial catastrophes related to technological development (e.g., Chernobyl, Bhopal, Fukushima). However, human-environment interactions have also given rise to widespread environmental changes (e.g., climate change) that have been linked with emerging risks (e.g., increased mortalities from heat exposure). Other changes linked to globalization have complicated the matter further; for example, increasingly accessible and affordable international travel (a change in the economic and socio-cultural environment) sparked the outbreak and diffusion of severe acute respiratory syndrome (SARS) from Hong Kong to over 30 countries around the world in 2003 (Public Health Agency of Canada 2004).

Through the industrial revolution to late-modern society, environmental hazards have increasingly become side effects of the modernization process in and of itself (Douglas and Wildavsky 1982; Beck 1992; 2013). These differ from traditional environmental hazards considered knowable, and thus, manageable, in that exposures and effects may not be calculable, nor may they be spatially or temporally constrained (Holloway 2004). For example, human pressures on the environment (e.g., greenhouse gases) are projected to give rise to, among other risks, increasing extreme weather events, microbial proliferation, environmental displacement of populations, and (re)emerging infectious disease (Weiss and McMichael 2004; Fauci et al. 2005; McMichael et al. 2006). Due to their relative nascence, there is often insufficient scientific knowledge regarding the consequences, causes, or probabilities of such *emerging environmental health risks* to respond through classic risk management strategies (Radandt and Renn 2008; Zinn 2008). In this context, decision-makers must respond to risks perceived to be important by the general public (Gierlach et al. 2010), often without having full information or fully understanding the repercussions their actions might have.

Classical risk assessment techniques rely on objective quantification of the probability of risk and the magnitude of the consequences (Zinn 2008). Alternatively, the general public relies on intuition, knowledge, and experience to define risk (Slovic 2000). These diametrical conceptions of risk as an objectively determined threat as well as a subjective risk experience deviate from one another in a systematic fashion. Further, different actor groups (e.g., scientific experts, lay publics, interest groups) experience and perceive threats from hazards differently (Baxter 2009). It is necessary to continue to understand biases in public perception of risk to improve risk communication strategies and contribute to a base of knowledge for anticipating public response to emerging hazards (Slovic 1987) in order to manage and respond to risk from a governance perspective. While much attention has been paid to hazard characteristics as a determinant of risk perceptions (e.g., Slovic et al. 2000), relatively less has been paid to the socio-cultural influences that comprise the various places where risk is experienced. Indeed, it has been recognized by others that simplistic models of risk perception have obscured the fact that our cognitive processes are situated in a contextual social, cultural, and political context (Otway and Wynne 1989; Gaillard 2008; Abraham 2009). As these factors gain recognition as being important for understanding the perception of local (Masuda and Garvin 2006) and more global (Bickerstaff 2004) environmental risks, there is a need for a conceptualization of the interdependence among people, risk perceptions, and the places in which risk is experienced. The aim of this paper is to build upon existing theories of risk perception to describe the construction of a model for understanding the role *place* plays in the perception of emerging environmental health risks. The model is informed by three existing paradigms of risk perception, and the literature related to place effects on health, each of which is described in the following section.

Theoretical underpinning

Risk perception paradigms

We begin by noting that the strengths and weaknesses of the following risk perception paradigms have been discussed and debated quite comprehensively elsewhere (Otway and Wynne 1989; Marris et al. 1998; Sjöberg 2000; Wåhlberg 2001; Sjöberg 2003; Sjöberg et al. 2004); they are highlighted briefly here in order to set the foundation for next steps. Indeed, within human geography, these foundations go back to the study of the human impacts of natural hazards; for a full treatment, see Elliott (2009). These paradigms have proven useful for understanding the perception of some risks (e.g., nuclear technologies), though they have been relatively limited for anticipating public perception of risk (Sjöberg 2000). The *psychometric paradigm* (Slovic 1987) is rooted in the field of psychology, and research centred in this paradigm has focused on the individual demographic and cognitive characteristics that determine perceived risk. Specifically, the paradigm focuses on the qualitative characteristics of the hazard itself as factors that shape risk perceptions. These characteristics have been used to develop a taxonomy related to *dread* risk and *unknown* risk whereby catastrophic potential (e.g., fatal consequences, inequitable distribution, not easily mitigated, involuntary) and perceived level of control (e.g., unobservable, unknown to those exposed, new risk, unknown to science) combine to heighten or mitigate public perceptions. The two-factor model has been successful in predicting risk related to a number of hazards (Slovic 1987), though the individualistic nature of the psychometric paradigm has received some criticism. In particular, some authors have raised the positivistic nature of the model and the socio-cultural independence of the theory as key critiques (Sjöberg 1996; Marris et al. 1998; Zinn 2008). What is missing from these frameworks is the recognition of human agency—active although constrained decision making around risk—that occurs in place. Indeed, Sjöberg (2000) attempted to answer the question: why do people perceive risk as they do? His studies were done using a Swedish population sample, using nuclear and radiation risks as the outcomes of interest. In so doing, he asserts that psychometric measures of risk may explain up to 20 percent of the variation in risk perception, while cultural theories explain about 5-10 percent. Using an alternative model that incorporates three concepts—risk sensitivity, attitude, and specific fear—Sjöberg claims he can explain up to 40 percent of risk perception. Imagine how much more of the variance we might explain if we incorporate "place" as a key explanatory variable?

The *cultural theory* paradigm of risk perception recognizes that particular groups select particular hazards as risky in order to sustain and strengthen social relations and cultural values (Douglas and Wildavsky 1982). These groups develop particular orienting dispositions based on the conditions in which they live their lives, which guide their responses to hazards and potential risks (Dake 1991; Slovic 2000). These perspectives are termed *worldviews*, and the crux of the argument for cultural theory is that these vary systematically according to cultural biases (e.g., fatalism, hierarchical, individualism, and egalitarianism) apparent in different societies, groups, and by extension, places (Bickerstaff 2004). Groups associated with these categories often differ in their level of perceived risk of, and risk acceptance for particular hazards. For example, Peters and Slovic (1996) found that egalitarian groups, who have a preference for an equitable distribution of power and wealth in society, had higher perceived risks of a number of hazards, and nuclear power in particular. Comparatively, those who preferred and trusted experts and authorities to assume control of risks (i.e., hierarchical worldviews) had much more favourable attitudes towards nuclear power. Worldviews are developed in the context of particular social, political, economic, and cultural environments, and as such, differences in risk perceptions can be geographically defined. For example, Baxter and Greenlaw (2005) explored—through the cultural theory of risk—how explicitly place-contingent ways of life and the worldviews that support those ways of life help to explain risk perception, using four Canadian communities differentially exposed to a hazardous waste facility. These authors found risk perception strongly linked to attachment to place and (rural/agrarian) ways of life. Another example comes from Gierlach and colleagues (2010) who recently found that Japanese groups have high perceptions of natural disasters and terrorist events, and that North American and Argentinean groups had low perceived risk of terrorist events.

A third theoretical approach to risk perception, the *social amplification of risk framework (SARF)*, developed from communications theory. This framework binds insights of the previously mentioned paradigms of risk, and suggests that the

public experience of risk must also reflect how informational "processes, institutional structures, social group behaviour, and individual responses shape the social experience of risk" (Kasperson et al. 1988, 181). The SARF's central thesis posits that uncertainties about risk and amplification/attenuation of particular risks can occur at various stages in the risk perception process. Risk information—and by implication, the mass media—is given an influential role in the development of risk perceptions in this framework. The theory suggests that the interpretation of a risk message by an individual depends on the nature of the message, as well as the relevance of the message to that person, situated in a particular sociocultural context (Kasperson et al. 1988; Slovic 2000). For example, in their qualitative analysis of a community faced with a proposed large scale industrial complex in Alberta, Canada, Masuda and Garvin (2006, 437) found "risk communication occurred in relation to situated experiences of place that were based on conflicting cultural worldviews" and further that "….place is a useful component of the SARF, providing a spatial explanation for why some people amplify, and others attenuate, risks in locally contentious environmental debates."

Critiques of these traditional approaches frequently point to the lack of attention to the importance of social, economic, and political context in the process of risk perception and risk communication (Otway and Wynne 1989; Marris et al. 1998; Gaillard 2008; Abraham 2009). Similar critiques were once levelled at health researchers who neglected these important elements as key determinants, along with the role of place (Gatrell and Elliott 2009). For a fuller critique of the applications of SARF, see Pidgeon et al. (2003).

Place, health and risk

There is an inherent spatiality to the risk construct that emphasizes distance, direction, position, and co-location of hazards with other social or physical phenomena (Agnew 2005). The concept of *place*, however, extends the notion of spatiality to include the characteristics and meanings of these spaces. A place-based approach focuses on the various environmental influences existing in a particular place, and the ways in which these shape and determine the health, behaviours, and perceptions of individuals and populations (Macintyre et al. 2002). Thus, place is a construct that shapes *how* risk is experienced, rather than just a spatial boundary representing *where* risk perception happens (Kearns and Moon 2002). In particular, this idea draws from other research, namely from health geography, that has recognized the value in situating risk perceptions of industrial and technical hazards within a particular local context (e.g., Eyles et al. 1993; Litva and Eyles 1995; Elliott et al. 1999; Bickerstaff and Walker 2001; Masuda and Garvin 2006; Baxter 2009).

Research on the geographies of risk has a strong tradition exploring the experience of living near industrial sources of pollution. Though these studies are situated in particular localities, their findings make the role of social, economic, and political context explicit. For example, in a study of an eco-industrial development proposal near Edmonton, Alberta, Masuda and Garvin (2006) examined the relationships between culture, place, and the social construction of risk. This research focused on the communication of risks to the public that occurs during the planning of an industrial land use as a determinant of perceived risk. The authors argue that risk communication is a cultural process that occurs in place, and can explain the differential impacts that risk communication can have for local communities. The overall theme from this literature is that risk perception outcomes and processes are thoroughly embedded in place-based issues (Bickerstaff 2004). Though many emerging environmental health risks are widespread, even global (e.g., climate change), there is strong evidence that indicates—despite the democratization of such risks—the meanings ascribed to them remain highly local (e.g., Burningham and O'Brien 1994; Bush et al. 2002).

The limitations of existing risk perception paradigms point to the need for continued development and refinement of conceptual frameworks. Research in this vein is especially important to respond to newly emerging hazards. The remainder of this paper will describe the development and application of a framework that blends existing perspectives on risk, and contributes to the conceptualization of place as a currently understudied factor.

Development of the framework

A structural framework

Figure 1a depicts a simplified structural version of the framework. In general, structural frameworks

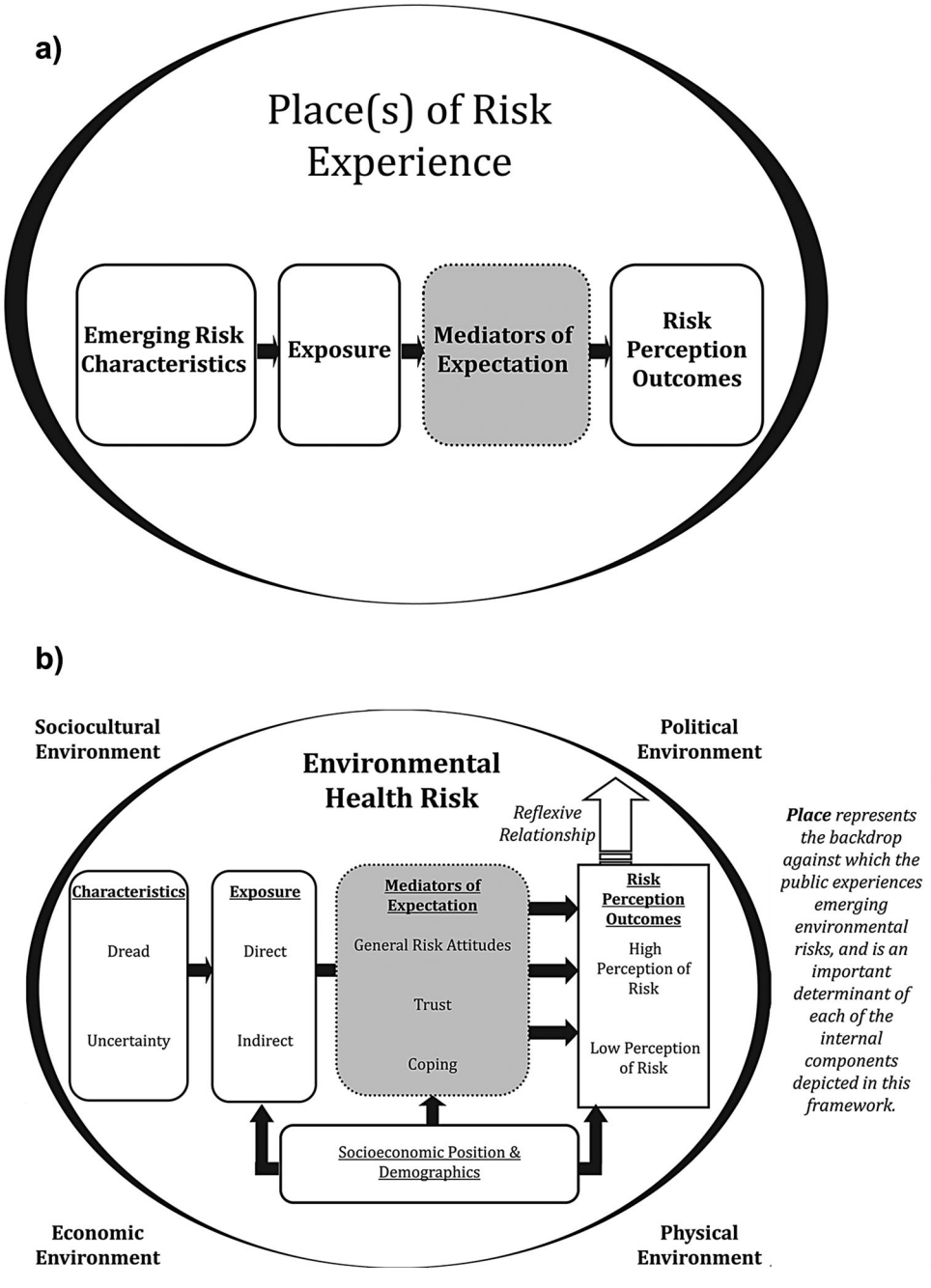

Figure 1
a) Structural framework of the public experience of risk. b) Relational framework of risk perception with individual- and contextual-level influences.

are useful for framing issues more broadly (Knol et al. 2010), and in this instance, the framework used to conceptualize the risk perception "system" as being situated in place, is not limited to a particular scale.

Dissecting the framework

Based on the structural framework (Figure 1a), place represents the backdrop against which the public experiences emerging environmental risks, and represents an important determinant of each of the internal components of the risk perception system. These are defined as: risk characteristics, exposure, mediators of expectation, and outcomes. Figure 1b magnifies the framework and outlines how these central concepts are functionally linked. To allow for operationalization of contextual-level influences, we have adopted Swinburn and colleagues' (1999) categorization of environment into four types: physical, economic, political, and sociocultural. We acknowledge that places are substantially more dynamic than reification into these seemingly concrete categories, and that there exists other interrelated contextual influences that shape perceptions. However, with an intention to deductively test the framework at the population level, this categorization is useful for conceptualizing the potential role played by the natural or built environment (physical), political rules and regulations (political), economic costs (economic), and collective attitudes and beliefs (sociocultural) in the development of risk perceptions. Table 1 presents examples of some of the measurable environmental concepts that may be associated with each environmental type, using air pollution as an example.

Table 1
Examples of contextual influences on risk perceptions around air pollution

Environment Type	Example Influence
Physical Environment	Distance to source of pollution
	Prevailing winds
	Visibility of smog
Economic Environment	Dependence on industry for employment
	Location of industrial polluter in marginalized or poor communities
Sociocultural Environment	Attachment to place
	Stigmatization of a place as "dirty" or "polluter-friendly"
	Social capital/networks
	Automobile dependence
Political Environment	Smog advisories
	Regulations regarding production/output
	Regulatory institution in charge

Emerging risk characteristics. Despite critiques of the psychometric paradigm, characteristics of a hazard are indeed deterministic of perceptions to some degree. As mentioned in the previous section, the two factors found to be most relevant are dread risk and unknown risk (Slovic 1987). We maintain that these characteristics are salient for risk perception; however, we likewise acknowledge that the social construction of these characteristics, and therefore the meaning of these risks to the general public, is contingent upon other important processes. Thus, risk characteristics represent a necessary but not sufficient condition.

Exposure. The second process outlined in Figure 1b reflects direct personal exposure to risk as well as indirect exposure through informal information channels (e.g., the media, other people) (Kasperson et al. 1988). Direct experience has a complex interaction with risk perception, in that it may act to intensify, or abate, risk perceptions. In the case of driving automobiles, for example, repeated experiences can attenuate the perceived risk of automobile accidents, which remain a leading cause of death, particularly for young people (Statistics Canada 2011). Conversely, direct experience with natural disasters or infectious diseases can cause increased alarm about future events, thereby heightening risk perceptions (Slovic 2000). This relationship is partly determined by the risk characteristics (e.g., dread, unknown), though the interaction also differs between and within social experiences and social groups (Gierlach et al. 2010).

Given that many emerging health risks have only recently appeared on the landscape, and therefore have not been experienced by large numbers of people, there is less "direct experience" influencing perceptions. Lack of familiarity with risk as well as "facing the unknown" are well-recognized determinants of risk (Slovic 1987). Information from sources other than direct experience is therefore key to evaluating risk and forming a response. The flow of information occurs most often through news media and informal social networks (Kasperson

et al. 1988; Slovic 2000). The news media in particular are recognized as key in the transmission of risk information to the population in a form they can understand, digest, and act upon (McCarthy et al. 2008). However, media coverage of a risk is often unrelated to the true seriousness of that risk, and may focus on the exceptional nature, or emotionally provocative aspects of a risk issue, thereby amplifying the perception of that risk (Kasperson et al. 1988; Slovic 2000). Several factors have been conceptualized as influencing public risk perceptions through this role, primarily the volume of coverage a hazard receives (Koné and Mullet 1994; Wåhlberg and Sjöberg 2000; Young et al. 2009) and accuracy of reporting (Wakefield and Elliott 2003; McCarthy et al. 2008). It is also important to note that concern around a risk often does decline with experience/familiarity (e.g., Elliott et al. 1997; Elliott 1998; Wakefield and Elliott 2000; Luginaah et al. 2000); as a result, levels of perception measured at times of media coverage may actually decrease over time as individuals and communities adapt.

Mediators of expectation. Previous experience with risks, trust in institutions (e.g., government) to mitigate risks, and individual agency for dealing with risk each contribute to what one might consider to be a significant risk, and determine expectations about risks (Zinn 2008). These translate into three concepts populating this cloud of mediating factors: attitudes towards risk, trust, and coping. As an example, worldviews (Dake 1991; Douglas and Wildavsky 1982) represent one dimension of attitudes towards risk. These attitudes are pre-dispositions towards risk in general that are dependent on individual characteristics, but also developed in the various contexts in which individuals experience risk (Slovic 2000). Thus, by this definition, worldviews imply the role of place in risk perceptions and attitudes.

In this framework, trust refers to trust in those responsible for risk management (e.g., politicians, authorities, scientists) and trust in the sources of risk information based on perceived competence and honesty of the source (Frewer 1999; Bickerstaff 2004). Trust in such authorities has emerged in the risk perception literature as an important determinant of risk perception (Siegrist and Cvetkovich 2000; Slovic 2000). Viklund (2003), for example, found social trust to be a significant explanatory factor in models of risk perception both between and within four European countries, indicating that social trust is constructed in a particular cultural or place-based context.

In the case of complex and uncertain emerging environmental health risks, trust is particularly salient. This is evidenced most strongly by the Bovine Spongiform Encephalopathy-Creutzfeldt-Jacob Disease (BSE-CJD) crisis in Britain in the mid-1980s to mid-1990s. During the time of the BSE-CJD crisis, public trust in authorities with regard to safety of the food supply was extremely low (Jacob and Hellström 2000). Thus, when the announcement was made that British beef was unsafe, following nearly a decade of reassurance to the contrary, there was a strong public response to the threats to human health (Powell and Weiss 1997; Jacob and Hellström 2000). The lack of trust in British government by its public in this case was a precursor to this intensified response.

The final element mediating expectations is the ability to cope with emerging risks, or adaptive capacity. While the act of adopting a coping response typically follows perceived threats, the capacity to cope with risk is framed as a mediating factor in the framework. The mere *belief* that risks can be minimized through coping strategies has been found to be sufficient for mitigating perceived risks (Grothman and Reusswig 2006). The capacity to adapt to (perceived) risks requires resources that may be financially based, at individual or collective levels, but may also be related to feelings of social capital and social support (Wilkinson and Marmot 2003).

The reflexive relationship. As place shapes the perception of risk, these perceptions can also work to shape the very places in which they are experienced. This reciprocal relationship is represented by the arrow emerging from the risk perception outcomes (Figure 1b). The reflexive relationship is akin to Kasperson and colleagues' (1988) description of secondary impacts from the amplification of risk, encompassing the development of stigma, changing political and educational practices, and changes in social order. Accordingly, the framework views the relationship between perceived risk and place as being mutually constitutive over time.

Socioeconomic position and demographics. We note here that socioeconomic position and demographics are implicit determinants of exposure, expectation, and risk perception outcomes. The relationships with gender, ethnicity, and socioeconomic status are well-developed in the risk perception literature—such as the so-called "white male effect" (Flynn et al. 1994). With respect to exposure, any number of examples from the environmental justice literature can provide further support to this claim. The environmental justice literature is based on a large volume of research that demonstrates that vulnerable populations, such as visible minorities or persons of low-income, are disproportionately exposed to environmental hazards (Bowen 2002). These hazards include exposures to toxic waste, polluted air and water, as well as more social hazards such as unsafe and hazardous employment, crime and violence, and lax environmental policies/laws (Anand 2004). This disproportionate burden is also evident at different spatial scales, from the community (Buzzelli et al. 2003) to the country level (Anand 2004). Since socioeconomic and demographic relationships are so pervasive in the literature, they have been included in the framework as important determinants of risk perception outcomes.

Operationalizing the framework

Food allergies: An emerging environmental health risk

Food allergies are abnormal responses by the body to specific proteins in foods. In particular, the immune system recognizes a protein as harmful to the body, and releases chemicals that adversely impact the respiratory and cardiovascular systems, as well as the gastrointestinal tract, and the skin with varying severity from mild to life-threatening (e.g., anaphylactic reactions) (Lieberman 2008). Peanuts, tree nuts, seafood, eggs, milk, wheat, soy, sesame, and sulphites are responsible for more than 90 percent of food allergies, though the first three are most commonly related to anaphylaxis, and are also the least likely to resolve during an individual's lifetime (Al-Muhsen et al. 2003). In addition to risk of physical harm, living with the potential of suffering an allergic or anaphylactic reaction has adverse psychological impacts for allergic individuals and their caregivers (Primeau et al. 2000; Uguz et al. 2005). Fenton and colleagues (2010), for example, reported a substantial emotional burden for anaphylactic adolescents and children when negotiating environments where there is a potential for exposure to an allergen. In particular, there is a sharing of the burden of managing and coping with risk by the parents and families of younger children (Fenton et al. 2010).

Though estimates of incidence are contested (Ben-Shoshan et al. 2009; Venter et al. 2010), living with food allergies appears to be becoming a reality for a growing number of families globally, though primarily in more affluent countries (Grundy 2002; Sicherer et al. 2003; Branum and Lukacs 2008). The emergence of food allergies has been relatively recent, and as such, there has been increasing interest from the mass media, science, and the commercial sector (Harrington et al. 2012a). This increased attention has been paralleled by inflated perceptions of the associated risk of food allergies in the general population. For example, lay estimates of the prevalence of food allergies often amplify systematic estimates by three-fold or more (Rona 2007; Harrington et al. 2012b). As affected people learn to cope, and decision-makers attempt to respond to the (perceived) increases in prevalence, the rules around food and eating are changing in terms of what is, and is not, allowed in particular environments. For example, Sabrina's Law was enacted by the provincial government in Ontario in 2006 following the death of 13-year-old Sabrina Shannon in her school as a result of an anaphylactic reaction from cross-contamination of cafeteria food. This legislation requires all publicly funded schools to have specific mechanisms in place for managing students with life-threatening food allergies. In this political context, many schools have banned some primary allergens altogether, in particular peanuts. These changes have generated important debates related to protection versus rights (of the non-allergic population), particularly around school-based policies (Young et al. 2009). Policies in other Canadian provinces range widely, as school boards and/or individual schools develop independent risk management strategies. The resulting varied policy landscape around food allergies is also the case elsewhere in the developed world (Schneider Chafen et al. 2010).

While genetic predisposition governs individual susceptibility to allergies, the supposed rise in

allergic conditions has occurred over a timeline too short to be explained by genetic changes in the population (Bloomfield et al. 2006). This implicates environment and lifestyle factors, which can change over shorter periods of time, interacting with genetically predisposed individuals as the underlying cause(s) of the increase in allergy. For example, the hygiene hypothesis is a dominant theory of cause in the allergy literature. This hypothesis posits that children exposed to westernized lifestyles are protected from the traditional infectious burdens of early life that those in developing and underdeveloped countries continue to experience. Eliminating background environmental exposure to protective microbes is necessary for immune system development, and as such, these children develop increased risks of allergies and other conditions related to hypersensitive immune systems (e.g., eczema) (Bjorksten 2004; Bloomfield et al. 2006). Thus, though food allergies are expressed genetically at the individual level, the gene-environment interaction component indicates that food allergies are emerging *environmental* health risks.

Applying the framework

Having established the importance of food allergies as an emerging environmental threat to health, we piloted the framework using a recently assembled national data set, collected as part of the *Surveying Canadians to Assess the Prevalence of Common Food Allergies and Attitudes Towards Food Labelling and Risk* (SCAAALAR) survey. The survey had three overarching objectives: (1) to assess the prevalence of food allergies in Canada, (2) to assess societal attitudes towards allergen precautionary statements on packaged foods, and (3) to explore the perception of food allergy and anaphylaxis risk. Administered to a representative sample of the ten Canadian provinces, the survey collected data from 3666 households. The main finding with respect to risk perception was that despite the relatively low prevalence (Ben-Shoshan et al. 2010) of food allergies (7.5 percent reported being allergic to any food) almost 70 percent of the sample ranked the risks of food allergies as high or moderate risks to the Canadian population, indicating that food allergies were a serious concern (Harrington et al. 2012b). Application of the framework to these data provides unique opportunities to (1) explore the perception of a widespread, newly emerging environmental health risk, and to (2) investigate differences in perceptions between and within places. The framework was used to organize the survey data collection, and subsequent logistic regression analysis (Harrington et al. 2012b) to predict respondents who would rank risks as high/moderate (the rightmost box in Figure 2). In particular, we were interested in the potential role of the political environment, as defined by provincial school-based policies.

Figure 2 presents the framework as populated by relevant data from the questionnaire. What follows is a brief summary of the key elements of each concept within the framework, and how they interconnected. Before we explicate the framework, we provide a brief summary of the empirical findings in order to provide the reader with some context; a full treatment of the analysis can be found elsewhere (Ben-Shoshan et al. 2010; 2012; Harrington et al. 2012b; Soller et al. 2012). First, food allergies as an emerging health risk affect children at a greater rate than adults (Soller et al. 2012), and are recognized as conditions that primarily affect industrialized countries (Sicherer et al. 2003). Second, the literature shows that the risks associated with food allergies are perceived to be high by certain socio-demographic groups. These include those unfamiliar with the risk (e.g., new immigrants to areas where food allergies appear to be an issue), people with children, people of low socioeconomic status, the older population, and those living in jurisdictions with little or no regulation related to food allergy (Harrington et al. 2012b).

Due to the nature of large-scale population-based surveys, some elements of the framework were not populated. For example, no data were collected from respondents regarding the perceived dread or uncertainty related to food allergies. Realizing this limitation, the characteristics outlined in the leftmost box of Figure 2 are based on assumptions about food allergies, informed by the relevant literature and the central tenets of the psychometric paradigm. We assume a high level of dread risk due to the potentially fatal consequences of food allergy—particularly for young children, the inequitable distribution (i.e., disproportionately affecting children), the fact that food allergies are involuntary risks, and the evidence to suggest that food allergies are apparently increasing. Likewise, we assume that due to the lack of curative therapies,

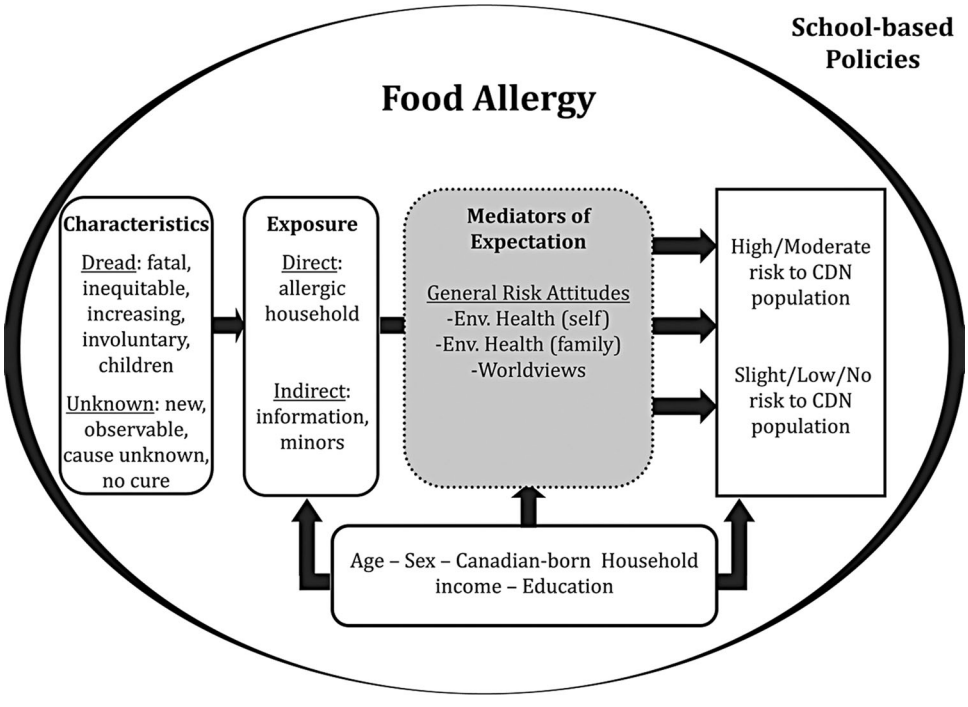

Figure 2
Application of the framework to the SCAAALAR data.

and the uncertainty regarding etiology and incidence that food allergies are relatively unknown risks. These characteristics are shared by many emerging environmental hazards that are new to the risk landscape.

The middle two boxes in Figure 2 (Exposure and Mediators of Expectation) were populated using self-reported prevalence data, and data regarding indirect exposure to food allergies through the news media. In terms of direct exposure to food allergies, only households reporting multiple food allergies were likely to have amplified risk perceptions. This result was somewhat unexpected, and suggests that simple exposure to a risk may not be as important as other determinants of perception. Interestingly, *indirect* exposure to food allergies via reading or hearing information about food allergies in the past six months was a more important predictor of risk perception. The SARF indicates that the general population must rely on the media and other informal networks for developing orienting attitudes and perceptions about that risk, particularly during the emergence of the risk, which may be surrounded by uncertainties (Kasperson et al. 1988; Slovic 2000). A recent media analysis of food allergy messages in the media indicates that disproportionate media representation of actors from particular social groups, namely affected individuals and advocates, may be echoing and potentially amplifying the public understanding of food allergy risk (Harrington 2012a). Presence of minors in the household was also included as a measure of indirect exposure, due to the increasing exposure of all children and their families to issues of allergy and allergy-controlled environments, particularly in schools.

General risk attitudes included worry about the impact of environmental risks on the respondent (self) or their families, along with indicators of worldviews (e.g., fatalist, hierarchical, egalitarian, etc.). These concepts, along with socioeconomic and demographic predictors, were used to characterize

the heterogeneity of the people situated in differing policy environments, and supported some well-established relationships with risk perceptions. For example, females and older individuals were most likely to express concern about the societal risks of food allergies. As well, those with higher socioeconomic positions defined by level of education and household income were less likely to be concerned about the risks of food allergies.

After characterizing the SCAAALAR respondents, we were able to explore differences between households living in differing political environments (defined by school-based risk management strategy) using postal codes. Controlling for individual-level characteristics, broad provincial differences were found, particularly in Québec, a province that at the time of data collection had no provincial school-based policy related to food allergies. In particular, Québecers were more than twice as likely to perceive the risks of food allergies as high/moderate than respondents from other provinces. Based on our conceptualization, the political environment appears to have some overarching influence on risk perception, beyond reported exposure to the risk in terms of having an allergic individual in the household, or indirectly hearing/reading food allergy information in the past six months. This finding further supports the theoretical basis of the socio-cultural perspective of risk, namely that perceptions of and responses to environmental risks are situated in and partially determined by social, cultural, and political contexts.

There are potential policy implications that flow from this particular application of the framework. If there is indeed increasing incidence of food allergies, it will be necessary to develop and integrate sustainable risk management strategies in a variety of settings—particularly as the (potentially growing) number of allergic children of today begin operating as young adults in the social, economic, and political spheres of tomorrow. Given that the policy solutions implemented by each province vary so widely—on a continuum from nothing to full legislation—we anticipated at the outset of the study that there would be substantial variation in risk perceptions between regions. However, only Québec stood out as being significantly different. The lack of variation in this instance may be indicating that differences in risk perceptions should be explored at smaller, more homogeneous levels of geography (e.g., municipalities, neighbourhoods). Indeed others have found perceptions of widespread environmental risks to be highly local (Bush et al. 2002; Bickerstaff 2004). Despite this limitation, we argue that processes at broad macro-level scales (e.g., province) do have some modifying influence on risk perceptions in the general population, and application of the framework to food allergies has proven useful for conceptualizing this relationship.

Conclusion

Knowledge of the public experience of risk is necessary for effective risk governance. Public perception of risk, however, is inherently complex and is founded on psychological constructs, as well as issues of power, values, and trust (Bickerstaff 2004). Over the past several decades, disciplines such as geography, anthropology, and sociology have increasingly contributed to our understanding of the broad social, cultural, and political factors that influence perceptions of and responses to risk. Typically, these efforts have contrasted with traditional approaches to risk perception by grounding public understanding of environmental risk in the social, cultural, and political *places* where risk is experienced. As developments continue in this arena, it is clear that there is a need for an organizational framework that explicitly incorporates existing theories of risk perception, and affords place an explicit and privileged role in the process. We have proposed such a conceptual framework in this paper to begin to understand how the different types of environment (i.e., physical, sociocultural, economic, and political) produce and are influenced by public perception of emerging environmental health risks.

It is important to note that the framework is not meant to replace the existing perspectives for understanding the social experience of emerging risks, and is likely destined for further refinement. As the framework was tested deductively using an exploratory national survey of risk perceptions, there are certainly some limitations to this application, including a lack of direct attribution from perceptions to the political environment. The empirical value of the framework will depend on future testing (currently ongoing) using different hazards, in different contexts, at different scales, with different populations, and using different ways of knowing (e.g., qualitative inquiry). In so doing, it

will be essential to test the framework across a range of groups, including those more vulnerable to the emerging epidemic of food allergy as well as other emerging environmental health risks. The classic and guiding work of Susan Cutter (see especially, Cutter 2006) will prove useful here.

We also recognize that the relationship between perceptions and places is more complex than the categories presented in our framework. However, the framework contributes by offering a model that can be used to deductively test the complex relationships between hazards, exposures, communications, and place. If its merit is confirmed through future empirical testing, the framework may become an important guide for informing risk management and risk communication efforts. This would prove crucial for risk governance and risk communication as new and increasingly complex technological and environmental risks emerge on the landscape.

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