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Climate change awareness and strategies for communicating the risk of coastal flooding: A Canadian Maritime case example

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ABSTRACT

Rising sea levels, due to thermal expansion of the ocean, and higher frequency and intensity of coastal and inland storms threaten coastal communities worldwide. The implementation of pro-active, planned adaptation to reduce community vulnerability is strongly dependent upon people's perception of the threat posed to their communities at the local scale. Unfortunately, the scarcity of research into effective risk communication limits our understanding of how climate change evidence can most effectively raise risk awareness and inspire community adaptation.

With a focus on a case study situated in the Tantramar area of South-East New Brunswick, Canada – an area subject to very large tidal forces from the Bay of Fundy – this study set out to assess public awareness about the link between climate change and elevated risk of regional dyke failure, measure how different multi-media visualizations influence public risk perception, and provide general recommendations for the development of flood risk communication strategies in coastal zones.

The results from 14 focus groups ($n = 157$ participants) revealed that 81% of respondents felt that the problem of climate change was considerable or severe. However, when asked for their assessment of personal vulnerability to dyke failure and subsequent coastal flooding, only 35.6% considered themselves to be at considerable or severe personal risk. Gender, education, and age were found to significantly influence initial risk perception to varying degrees, and were also associated with changes in risk perception following the communication session. While geovisually-enhanced communication strategies, involving 3D flood animations and web-based GIS maps, were no more effective at raising risk awareness than a non-enhanced communication package, qualitative responses suggested that the geovisualizations had greater emotional impact ("shock"), and contributed disproportionately to an expressed desire to become politically and socially active around the issue. In conclusion, in addition to presenting evidence in a clear and compelling way, effective coastal flood risk communication requires a supportive framework capable of building trust and encouraging public dialogue. Recommendations towards creating this framework are provided.

1. Introduction

Climate change is a problem of global scope, with significant consequences for coastal communities. Risks include increased sea levels due to thermal expansion of the ocean, a higher frequency and intensity of coastal and inland storms, and accelerated erosion (Dronkers et al., 1990; Wu et al., 2002). Unfortunately, these zones are also heavily populated (Dronkers et al., 1990). In the face of these threats, pro-active, planned adaptation to reduce community vulnerability is highly desirable. But the implementation of particular adaptation strategies is complicated by the 'wicked' nature of the climate change problem (Bord et al., 1998): there is a general lack of public awareness, or worse, complete misunderstanding, which undermines the public's willingness to participate or support adaptation efforts (Seacrest et al., 2000; Lorenzoni et al., 2007; Jude, 2008); differential perception of the appropriate balance between long- and short-term considerations can lead to divergent opinions about the efficacy of candidate options (Lorenzoni and Pidgeon, 2006); and the fact that people generally resist making uncomfortable behavioural changes (Bord et al., 1998; McKenzie-Mohr, 2000; Seacrest et al., 2000).

A recent Gallup Poll reported that 55% of Americans worry a great deal or fair amount about global warming (Newport, 2012), but historically, this has varied between 50% and 72% (Lorenzoni

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and Pidgeon, 2006). As summarized by Lorenzoni and Pidgeon (2006), a 1992 Gallup Health of the Planet (HOP) survey revealed that 13 of 24 countries (of which eight were European) had >50% of respondents indicate climate change to be a serious problem. In a more recent, 2004 European survey poll, the greatest proportions of concerned respondents resided in Sweden (68%), Luxembourg (58%), Germany (57%), the Netherlands (53%) and Finland (53%). Twenty-six percent of all EU-25 respondents felt they lacked information specifically about climate change (Lorenzoni and Pidgeon, 2006). While perceptions vary, there is a general and widespread belief in the seriousness of global climate change (Bord et al., 1998; Lorenzoni and Pidgeon, 2006).

How does this general acceptance of the immediacy of the climate change problem translate to the local scale? Do people understand the threats facing their own community? Bickerstaff et al. (2004, cited in Lorenzoni and Pidgeon, 2006; Burningham et al., 2008) provide evidence that in the U.K., individuals in areas directly vulnerable to climate change are often unaware of the connection to their local areas, or fail to see a potential impact on their day-to-day lives. A key challenge facing regional coastal managers, therefore, is how to develop public communication tools capable of effectively illustrating possible future scenarios at meaningful scales while simultaneously involving the public in the difficult discussions surrounding adaptation (Jude, 2008).

Risk communication is complicated by idiosyncrasies in the way people perceive environmental threats, and research has shown that this is partially shaped by human psychology. For example, people tend to draw inferences from information without regard for the weight of the evidence ('insensitivity to sample size', Tsversky and Kahneman, 1974), display overconfidence in their ability to derive accurate inferences (Slovic, 1987), and exhibit arbitrariness in their risk tolerances (Burgman, 2005). Research has also shown that peoples' perceptions of climate change are also heavily influenced by such factors as social background, cultural orientation, and behavioural disposition, which complicates the planning of risk communication materials (Slovic, 1987; Nicholson-Cole, 2005). The paucity of research on effective risk communication led Sterman (2011) to declare this a major bottleneck limiting the effective application of science to climate policy. At worst, poor risk communication efforts leave a "knowledge vacuum" that will be filled by "error, disinformation and falsehood" (Sterman, 2011: 402). Left to their own devices, risk communication recipients will create their own "mental models" to interpret the information they are exposed to (Moser and Dilling, 2004).

Even if clearly articulated adaptation plans are in place, gaining public support (i.e., instilling the intention to adapt, Grothmann and Patt, 2005) is very unlikely to occur without successfully communicating the risk of inaction. Sterman (2011) further argues that risk communication strategies will only be successful when they are informed by a thorough understanding of the publics' beliefs. Further to this notion, Pelletier and Sharp (2008) suggest that the form and nature of the communication has also to accommodate the "psychological state" of the intended recipient. The general public is unlikely to accept adaptation strategies (i.e., be in a "decision phase") without first passing through a "detection phase".

In practice, risk communicators often rely too heavily on technical experts' opinions about what should be communicated rather than directly assessing the perception states of their intended audiences. Also, most communication products are produced for and by domain experts, leaving their effectiveness in the public communication arena unevaluated (Lieske, 2012). People respond differently to the presentation of different information, coloured by education, gender, etc. Willingness to act is also eroded by overreliance on public infrastructure, e.g., dykes. This can lead to a dangerous, false sense of security in their integrity and reliability (see Tobin, 1995).

The present study originated out of a number of pragmatic concerns. First, while global models for temperature increases and sea level rise are widely available, community planners typically have no specific information on potential impacts at the local level. Second, a significant role played by local planning authorities is to advise and make recommendations to existing and prospective land owners in flood risk zones. Sporadic and episodic events can be difficult to imagine until they actually occur, so visualizations offer a way to "talk about" the associated risks and vulnerabilities.

The chief question posed by this study is whether it is possible to communicate coastal flood risk in a way that appeals to the widest range of people's personalities but is, at the same time, constructive, and less likely to push people into maladaptive positions (e.g., fatalism, anti-social behaviour). Visualizations, ranging from conventional 2D maps to 3D animations, may have an important role to play in raising people's awareness and encouraging them to form an adaptation intention. As a theoretical tool to support spatial reasoning, and as a means to stimulate spatial imagination, visualization has a long and established history in geographic research (Tukey, 1977; MacEachern et al., 1992; Andrienko et al., 2003; Keim et al., 2005). It is expected that visualization has an important role to play in climate change communication through its capacity to make sporadic (e.g., flooding) or gradual (e.g., erosion) risks 'visible'. With a focus on the Tantramar area of South East New Brunswick, this article builds on the research described in Lieske (2012) to advance the following goals:

1. Assess public awareness about local climate-change impacts, in particular, elevated risk of coastal flooding in the Tantramar;
2. Measure how different multi-media visualizations influence public risk perception and assess their potential for enhancing risk communication;
3. Provide general recommendations for the development of flood risk communication strategies in coastal zones.

2. Methods

2.1. Tantramar study area

The Tantramar Region is situated in South-East New Brunswick, Canada, and is governed by four municipal governments (of which the Town of Sackville is one), one aboriginal First Nation, and nine local service districts. Situated at the head of the Bay of Fundy (Fig. 1), the region is subjected to strong tidal forces, and relies on a dyke system to protect the Town of Sackville, an interprovincial railway and highway, and surrounding agricultural lands. Current 1-in-10 year extreme storm levels are estimated at 8.9 m ± 0.1 m (CGVD28 datum), which has the capacity to overtop 89% of the existing dyke system (average height: 8.6 m) and flood approximately 20.6% of the town (Lieske and Bornemann, 2011). As summarized by Roness and Lieske (2012), the population is well educated (14% have university certificates, diplomas or degrees, 12% have apprenticeship or trades certificates or diplomas, and 18% have college, CEGEP or other non-university certificates or diplomas), with a median age of 42 (compared to the Canadian median age of 40.6, based on 2011 census), and generally high rates of labour force participation (64.6%), and high levels of home ownership (82%).

2.2. Sampling design

Initially, potential focus group participants were randomly and individually solicited via newspaper advertising, media presentation, and word-of-mouth. This survey approach was largely