MANAGING FLASH FLOODS:
RISK PERCEPTION FROM A CULTURAL PERSPECTIVE

by

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A Thesis Submitted to the Faculty of the

DEPARTMENT OF GEOGRAPHY AND REGIONAL DEVELOPMENT

In Partial Fulfillment of the Requirements

For the Degree of

MASTER OF ARTS
WITH A MAJOR IN GEOGRAPHY

In the Graduate College

THE UNIVERSITY OF ARIZONA

STATEMENT BY AUTHOR

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ACKNOWLEDGEMENTS

Special thanks to Rolando Díaz, Abigail Martínez-Sotelo, and Dr. Sarah Moore for assistance with the Spanish translation.

I would also like to thank Susan Kaleita, Helen Yoon, and Jesse O'Brien for graciously preparing the surveys for mailing.

For patience and advice on statistical procedures, I am grateful to Dr. Sheldon Drobot, Dr. Mark Borgstrom, and Stephen Delgado.

I appreciate the advice and guidance in shaping this project provided by my mentors and peers throughout all stages of this research, including Dr. Paul Robbins, Dr. Sallie Marston, Robin Lewis, Shoshana Mayden, Stephen Martin, Joseph Hoover, and many others.

I would especially like to thank my committee, Dr. Katie Hirschboeck, Dr. Marv Waterstone, Dr. Stephanie Fryberg, and Dr. Eve Gruntfest, for their encouragement, advice, and mentoring throughout this project. The diversity of perspectives among the committee members combined with the time and energy provided by each of them have enabled me to design and critically analyze a unique and important study.

And I am eternally grateful to the Climate Assessment for the Southwest at the University of Arizona for providing the funding and support that have made all stages of this research possible.

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ABSTRACT

Flood risk managers educate the public on the dangers of driving through flooded roadways, yet losses to life and property continue to occur. This study integrates cultural psychology and risk perception theory to explore how culture, psychological processes, and behavior influence one another. Flood risk managers in Tucson, Arizona collaborated in the development of a questionnaire mailed to local residents. Questions regarding levels of trust, self-efficacy, social autonomy, social incorporation, time perspective, and situational factors were analyzed with respect to whether respondents stated that they have or have not driven through a flooded roadway. Respondents' decisions are influenced by the presence of signs and barricades, passengers, risk of personal injury or damage to the vehicle, and the availability of flood-related information. The most influential factor is the prior successful crossing of other vehicles. The results illuminate complex interrelations among the cultural factors and provide considerations for future risk perception research.

INTRODUCTION

Explanation of the Problem and Its Context

Floods have the highest mortality rates of all severe weather events in the United States, with an average of 100 deaths per year (Ashley & Ashley, 2008; NWS, 2008a). Approximately half of all flood fatalities are vehicle-related, with some individuals drowning within their vehicles and others drowning upon trying to escape from them (Drobot et al., 2007; Ashley & Ashley, 2008). Flood risk managers charged with reducing loss to life and property associated with floods have initiated a number of outreach and awareness campaigns, such as "Turn Around Don't Drown" by the National Weather Service (NWS, 2008b) and "Operation Splash" by the Tucson Department of Transportation (TDOT, 2008). Despite these efforts, losses continue to occur, suggesting that the outreach and awareness campaigns do not address some of the fundamental factors that influence risk perception and behavior. Typical risk perception research lacks the assessment of how cultural and social context influence risk perception and behavior, or focuses on a single aspect of culture without considering how other aspects may complicate the results. This study explores how several cultural factors influence risk perception and behavior, as well as how these factors interrelate and may produce ambiguous results.

Review of the Literature

This research follows within the tradition of investigating the social dimensions of hazards that rose to prominence through the work of Gilbert White, Ian Burton, and

Robert Kates. Risk perception research comprises a subset of this field that generally focuses on the perceptions of the lay public, although many studies have compared lay and expert opinions (Slovic, 2000). These studies tend to operate under the psychometric paradigm, which focuses psychological analysis on the individual level. The use of this paradigm in risk perception research has been criticized for attempting to understand why laypersons err in judgment so that experts can work to correct popular misunderstandings, revealing the privilege ascribed to expert knowledge over lay knowledge (Jasanoff, 1998; Slovic, 1999; Frewer, 2004). Other research challenges the relative privilege of expert knowledge by demonstrating how cultural and social contexts co-develop with risk perception (Douglas, 1992; Parker & Handmer, 1998; Handmer, 2001). Cultural psychology theory explains how culture, psychological processes, and behavior mutually constitute one another through interactions with peers and the co-development of values, attitudes, and beliefs (Fiske et al., 1998; Kitayama & Markus, 1995; Markus et al., 1997; Shweder, 1995). The application of these theories to risk perception research reveals the depth and complexity of cultural factors, how they are interrelated, and how they potentially complicate the results of psychometric risk perception studies.

Organization of the Thesis

This thesis is organized as follows. The following section titled "Present Study" summarizes the methods, results and conclusions of my research. Appendix A contains the thesis manuscript that is under preparation for submission to the journal *Risk*

Analysis. This manuscript contains an introduction to this study that includes a review of the relevant literature, the theoretical framework for this study, and a description of the case study context. The methods section describes how the focus group interview and the survey questionnaire were conducted and analyzed. The results section provides a thorough analysis of how demographic characteristics, cultural factors, and situational factors relate to whether or not respondents indicated that they had driven through flooded roadways, and the discussion section provides a synthesis of the results and recommendations for future research. Appendix B contains the figures and tables relevant to the manuscript in Appendix A. Appendix C contains a copy of the survey questionnaire that was filled out by Tucson residents and analyzed for this study.

I developed the theoretical framework and a comprehensive literature review for this study, building on existing theory in risk perception and cultural psychology research. I conducted the focus group interview, developed the survey questionnaire in collaboration with the focus group participants, conducted the survey, analyzed its results and wrote the initial manuscript. Collaborative input by my advisor, Dr. Katie Hirschboeck, and my committee members, Dr. Marv Waterstone, Dr. Stephanie Fryberg, and Dr. Eve Gruntfest greatly improved the thesis.

PRESENT STUDY

The methods, results, and conclusions of this study are presented in the paper appended to this thesis. The following is a summary of the methods and most important findings in this document.

In order to ensure the utility of this research for flood risk managers, I coordinated and mediated a focus group interview with representatives from the major flood risk management agencies in Tucson, Arizona on May 21, 2007. The participants were briefed on the background and theoretical framework of this research study, after which the discussion was opened to their experiences in flood risk management and their suggestions for the structure and content of the survey instrument. Topics discussed also included locations of flood-prone areas, possible factors that influence an individual's decision to cross or not to cross a flooded roadway, and the effects of stigma and the inconsistent enforcement of "the Stupid Motorist Law." Many of the suggestions and considerations provided by focus group participants were used in the development of the survey instrument, which was completed in the fall of 2007.

Survey questionnaires were mailed to 1,000 Tucson residents selected at random from the area-wide residence directory. Questions elicited information regarding five cultural factors: (a) trust, (b) social incorporation, (c) self-efficacy, (d) social autonomy, and (e) time perspective, as they manifest themselves in the participants' every day practices and beliefs, as well as in explicit situations related to flash floods. This information was compared to participants' stated typical or hypothetical responses to situations in which they encounter a flooded street crossing. Types of possible answers

to structured survey questions included discrete categories and Likert scale ratings. Since multiple choice answers tend to limit responses to those preconceived by the investigator, the survey also included space for optional short answer responses that allowed the participant to elaborate or explain their selection (McGuirk and O'Neill, 2005). The number of returned surveys was 173 for a response rate of 17.3 percent. Thirteen of the surveys were discarded for providing contradictory information, so 160 surveys were retained for analysis. Survey responses were analyzed according to whether the respondent indicated that they have or have not driven through a flooded roadway and tested for significant difference between those who answered yes (crossers) and no (non-crossers) using Pearsons χ^2 statistics for categorical responses and Mann-Whitney U statistics for scalar responses.

Demographic disparities exist between the U.S. Census 2000 data for Tucson and the older, more educated, predominantly White survey sample population (U.S. Census Bureau, 2000). Therefore, instead of claiming that results apply to the wider population, this research illuminates methodological considerations for psychometric risk perception studies by demonstrating the importance of cultural influences on risk perception, and how their complexities and interconnectedness obfuscate the relationships between social interactions, psychological processes, and behavior.

Following is a summary of key results regarding crossing behavior for each cultural factor analyzed.

Trust. In general, those who indicated they had never crossed a flooded roadway (hereafter referred to as non-crossers) reported higher trust in all of the flood information sources than those who stated they had crossed a flooded roadway (crossers). However, these results are only statistically significant for "The Weather Channel" and "City or county officials" when analyzed individually. When the sources were aggregated into categories, the differences in levels of trust between crossers and non-crossers were statistically significant for the categories of Safety Officers, Community Sources, and Signs and Barricades, but not for the National Weather Service or the Media, both of which are largely responsible for disseminating information and warnings about flash floods. Results also showed that the presence or absence of signs and barricades appears to deliver an ambiguous message to motorists regarding flash flood hazards. Respondents generally agreed that the flood signs indicate the likelihood of flood dangers in a particular section of roadway, but not the degree of danger. The fact that the signs remain in place when the roads are dry or when the flow is "a trickle" leaves the motorist to assess the hazard based on environmental cues, such as water flowing over the curb level, or perhaps the behavior of other motorists. However, as motorists become accustomed to the presence of signs at flood-prone intersections, the lack of a sign creates a false sense of security for those who trust the signs and will not cross when they are present.

Self-Efficacy & Social Autonomy. Out of all the questions that addressed self-efficacy and social autonomy (SE/SA), only two showed significant differences between crossers

and non-crossers. More crossers than non-crossers feel that conditions outside of their control inhibit their ability to prepare for or avoid flash floods, and more crossers than non-crossers feel that they do not have access to information about flash floods any time they need it. These results suggest that individuals with low SE/SA and fatalistic beliefs will be more likely to drive into flooded roadways than those with high SE/SA, but the lack of statistical significance among the other questions suggests that risk-taking behaviors associated with high SE/SA may be occurring as well.

Social Incorporation. Results showed little difference between the crossers and non-crossers for the questions related to social incorporation. However, the results provide important information about how respondents use their social networks to exchange information about flash flood hazards. Three-quarters of the respondents seek advice or help from others during a flash flood, while just less than half discuss flood-related information in between flood events. While fewer respondents discuss flood-related information in between events than during events, the topic is still being widely discussed. Other results suggest that it is important for risk managers to consider that, in addition to their own messages, information about risks circulates among members of social networks and possibly affects how those messages are received and interpreted.

Following is a summary of key results regarding the influence on crossing behavior for each situational factor analyzed.

Influence to cross. More non-crossers than crossers reported that each of the situations presented would have "No influence" on their decision to drive through a flooded roadway, presumably because they would never attempt to do so in the first place. Crossers, however, indicated that most of the situations would have some influence more often than no influence. Exceptions include the availability of a shorter route, the presence of passengers, and evidence that conditions are getting worse, which suggests that these factors are less influential for the decision to cross a flooded roadway. However, each of the respondents who indicated in the free-response section that they had conferred with their passengers before crossing a flooded roadway had selected "no influence" for both situations regarding the presence of passengers. This reveals that they do in fact consider the opinions of their passengers despite claiming that "peer pressure" did not influence them.

Results showed that the key factor that appeared to provide the most influence to cross was the prior successful crossing of other vehicles. For this factor alone, more non-crossers reported some influence than no influence, and the majority of all respondents indicated that this would have some influence on their decision to cross a flooded roadway. Many respondents specifically mentioned that they would be more likely to cross if their own vehicle is larger, heavier, has a higher clearance, or has four-wheel drive. However, some respondents said that they would cross in a larger vehicle such as a truck or SUV whether or not others were attempting to cross. These statements are consistent with the findings that the majority of respondents who drive larger vehicles such as trucks and SUVs identified as crossers.

Influence not to cross. Of the situational factors that influence respondents not to cross flooded roadways, the only ones that demonstrate a significant difference between crossers and non-crossers are the presence of a barricade or sign, the presence of passengers, and the risk of citation, each influencing the non-crossers more than the crossers. For all respondents in general, the situations with the strongest influence not to cross are the presence of signs or barricades, passengers, the risk of injury or death, the risk of damage to the vehicle, the risk of citation, and knowing another route. The situations that appear to have a weaker influence include the presence of others outside of the car, embarrassment from being stuck or swept away, and not wanting or being able to pay for rescue. These results contradict the predictions of the flood risk managers, who suggested that embarrassment and not wanting to pay for rescue would have a strong influence on an individual's decision not to cross a flooded roadway.

Although fewer respondents indicated that embarrassment would strongly influence them not to cross a flooded roadway, evidence of the effects of stigma associated with this behavior appears within the data. Many respondents referred to the "Stupid Motorist Law" by its popular name and indicated that they would never do anything so "fool-hardy" as to drive through flooded roadways. While these statements do not automatically imply that respondents provided deceptive answers, they demonstrate that this behavior remains stigmatized despite the methodological precautions taken in the design of the survey. The fact that several respondents identified as non-crossers but then proceeded to describe a situation in which they had crossed a flooded roadway seems to support the suspicion that self-enhancement occurred among

respondents. Whether the response rate was affected by stigma also cannot be determined, but remains a possibility.

This research demonstrates the complexities and interrelations among cultural factors thought to influence risk perception and the challenges they present for psychometric risk perception studies. The substantive results are not meant to represent the risk perception and behavior of all Tucson residents, but the combination of quantitative and qualitative survey responses illuminate important issues that future researchers should consider in order to better understand the ways in which culture, psychological processes, and behavior influence one another.

REFERENCES

Ashley, S.T., and Ashley, W.S. (2008). Flood fatalities in the United States. *Journal of Applied Meteorology and Climatology*, 47, 805-818.

Douglas, M. (1992). *Risk and Blame: Essays in Cultural Theory*. New York: Routledge.

Dow, K. & Cutter, S.L. (2000). Public orders and personal opinions: Household strategies for hurricane risk assessment. *Environmental Hazards, 2,* 143-155.

Drobot, S.D., Benight, C., and Gruntfest, E.C. (2007). Risk factors for driving into flooded roads. *Environmental Hazards*, 7, 227-234.

Fiske, A. P., Kitayama, S., Markus, H. R., & Nisbett, R. E. (1998). The cultural matrix of social psychology. In D.T. Gilbert, S.T. Fiske, & G. Lindzey (Eds.), *Handbook of Social Psychology* (pp. 915-930). New York: McGraw-Hill.

Frewer, L. (2004). The public and effective risk communication. *Toxicology Letters, 149*, 391-397.

Handmer, J. (2001). "Improving flood warnings in Europe: a research and policy agenda." Environmental Hazards **3**: 19-28.

Jasanoff, S. (1998). The political science of risk perception. *Reliability Engineering and System Safety, 59*, 91-99.

Kitayama, S. & Markus, H.R. (1995). Culture and the self: Implications for internationalizing psychology. In N.R. Goldberger & J.B. Veroff (Eds.), *The culture and psychology reader* (pp. 366-385). New York: New York University Press.

Markus, H.R., Mullally, P.R., & Kitayama, S. (1997). Selfways: Diversity in modes of cultural participation. In U. Neisser & D. Jopling (Eds.), *The conceptual self in context: Culture, experience, self-understanding* (pp. 13-26). New York: Cambridge University Press.

McGuirk, P.M., & O'Neill, P. (2005). Using questionnaires in qualitative human geography. In I. Hay (Ed.), *Qualitative Research Methods in Human Geography* (2nd ed., pp. 147-162). Oxford: Oxford University Press.

National Weather Service, (2008a). Weather Fatalities. http://www.weather.gov/os/hazstats.shtml (accessed 7 April, 2008).

National Weather Service, (2008b). Turn Around, Don't Drown. http://www.weather.gov/os/water/tadd/ (accessed 9 April, 2008)

Parker, D. J. and J. W. Handmer (1998). "The role of unofficial flood warning systems." Journal of Contingencies and Crisis Management **6**(1): 45-60.

Shweder, R. (1995). Cultural psychology: What is it? In N.R. Goldberger and J.B. Veroff (Eds.), *The Culture and Psychology Reader* (pp. 41-86). New York: New York University Press.

Slovic, P. (1999). Trust, emotion, sex, politics, and science: Surveying the risk-assessment battlefield. *Risk Analysis, 19(4)*, 689-701.

Slovic, P. (2000). *The Perception of Risk*. London: Earthscan Publications, Ltd.

Tucson Department of Transportation (2008). Operation Splash: When in doubt, change your route! Or wait it out! http://www.dot.ci.tucson.az.us/hottopics/downloads/OperationSplash.pdf (accessed 9 April, 2008)

U.S. Census Bureau, 2000. http://quickfacts.census.gov/qfd/states/04/0477000.html Accessed 3 April 2008

APPENDIX A

MANAGING FLASH FLOODS:

RISK PERCEPTION FROM A CULTURAL PERSPECTIVE

1. Introduction

Risk perception research has been used in natural hazards mitigation to investigate how people might respond to hazard information, and how risk managers might alter warnings or dissemination methods to stimulate a wider practice of what they consider the "appropriate" response. These studies often assume that actions result from either universal human nature or from psychological traits unique to each individual. In most cases, risk managers attribute failure to respond appropriately to irrationality or lack of information (Douglas, 1992; Jasanoff, 1998; Slovic, 1999; Frewer, 2004). Thus, risk communication research and practice have focused on tailoring the message until people understand and cease engagement in risk-taking behaviors (Douglas, 1992; Kasperson & Kasperson, 2005). However, risk perception studies often fail to include the assessment of how factors such as cultural context and social networks may affect how people perceive threats and respond to warnings, not to mention how cultural norms may influence the distribution of vulnerability. The studies that do consider the effects of culture tend to focus on a singular aspect, and many do not contain information that risk managers may utilize in practical application.

This study aims to fill this research gap by working directly with risk managers to create a comprehensive understanding of how several cultural factors affect propensity to engage in risk-taking behavior, using the example of crossing a flooded roadway or wash.

Five key cultural factors known to affect risk perception were examined, as well as how these factors predict participants' historical or typical behavior in flash flood scenarios. These factors include (a) trust in the hazard science as well as the government; (b) social incorporation, meaning the extent of social networks; (c) self-efficacy, which describes how confident people feel in their ability to handle both extreme events and ordinary life; (d) social autonomy, defined as the degree of freedom to fill any social role; and (e) time perspective, whether people focus on the past, present, or future.

The survey also addressed the effects of situational factors on an individual's decision-making and behavior. While traditional methods of risk perception analysis assume that perceptions and decisions happen only within the mind, this approach adds the dimension of interactions between the mind and the social and situational context. The information gathered in this project may help flood control managers understand risk-taking behavior as it varies with culture and situational context, rather than attributing such behaviors to irrationality or lack of information.

1.1 Literature Review

Douglas (1992) recommends that risk assessments include moral and political implications to supplement technological ones, which would also enable researchers to explore intentional risk-taking behaviors without writing them off as irrational. The consequences of precaution must be considered as well, as the benefits of disregarding a warning may (or may appear to) outweigh the degree of risk involved. Douglas (1992) also suggests that the lens through which to view risk perception and response is culture.

Culture refers to a way of life learned from and shared by a social unit, including – but not limited to – attitudes, beliefs, values, and habits. Values and social norms shape an individual's worldview, and therefore affect how the individual will understand threats and determine appropriate methods of threat avoidance or amelioration (Douglas, 1992). Tobin and Montz (1997) also recognize the need to consider non-geophysical factors to understand all aspects of natural hazards. They define natural hazards as the "potential interaction between humans and extreme natural events (p. 5)," and natural disasters as the actual interactions that have impacts on society economically or physically. They claim that humans are not only necessarily part of this system, but that everyday social factors such as goals, concerns, values, and institutions play a large role in how people perceive, mitigate, and respond to hazard events. This is not to say that other factors, such as previous experience with a particular hazard, do not influence behavior before, during, and after an event, but that in fact the enormous impact of culture on people's values and beliefs may affect just how these other factors play a role in an individual's actions.

Cultural psychologists explain that culture has such a strong effect on an individual's actions because culture and psyche mutually and constantly constitute one another. Norms, values, and practices shape how individuals process information and make decisions, and the resulting behaviors either maintain or reshape those norms, values, and practices (Fiske et al., 1998; Kitayama & Markus, 1995; Markus et al., 1997; Shweder, 1995). While many regard culture as a national or multi-national variable, it also includes subgroups based on "gender, ethnicity, religion, cohort or generation,

historical period, profession, social class, and country of origin" (Kitayama & Markus, 1995, p. 368). Identification with these groups overlap in different ways among individuals, so in order to obtain a comprehensive understanding of how culture and behavior construct one another, researchers must consider multiple levels as well as multiple factors of culture.

Douglas (1992) presents a model of cultural organization in vertical and horizontal dimensions, which she refers to as grid/group analysis. The model describes people's social relationships with each other in terms of incorporation and autonomy. Incorporation, or group, refers to the degree of solidarity in a social unit, with competitive individuals having little or no social network on the "weak" end of the spectrum, and collectives with extensive social networks on the "strong" end (Douglas 1992). On the vertical axis, autonomy or grid describes how social roles related to hierarchy such as race, gender, and age affect the nature of social interactions. Low autonomy/grid refers to egalitarian social units, where anyone may participate in any role, whereas high autonomy/grid involves social behavioral restrictions that depend on the aforementioned and other factors (Douglas, 1992). This led Douglas to the creation of four society types: individualist/market societies, hierarchies/bureaucracies, sects/enclaves, and isolates. Each has a different value system and set of accepted norms, depends on a different type of authoritative source, and casts blame for hazards upon different subjects. While no social unit or individual is exclusively one type or another, the norms and values associated with these categories permeate communities and have the potential to affect risk perception, hazard mitigation strategies, and warning response

behavior. Understanding which norms and values influence perception – and how – will provide insight into the most effective way to induce the appropriate behaviors before and during a hazard warning.

Douglas (1992) describes each of the four types of societies according to five cultural factors that influence risk perception and behavior, including trust, social incorporation, self-efficacy, social autonomy, and time perspective. Theoretical and applied hazards research has explored the ways in which these factors influence risk perception and behavior, although the studies tend to focus on one factor alone (e.g., Slovic, 1999; McGee & Russell, 2003).

Trust holds such strong influence over an individual's risk perception because it serves as an adaptation to an increasingly complex environment. To reduce the necessity for learning every detail about every possible risk, individuals place trust in those whom they believe to both have the knowledge and willingness to share accurate information about particular risks (Earle & Cvetkovich, 1995; Slovic, 1999; Siegrist and Cvetkovich, 2000; Savadori et al., 2004; Lang & Hallman, 2005). In the case of flash floods, the public must place trust in the science behind risk assessment, the agency or individual delivering the warning or information, and the message itself. Some research has shown that the lay public may lack trust in an agency because they perceive the agency to be too far removed from both daily situations and extreme events (Parker & Handmer, 1998; Handmer, 2001; Sáenz, 2003). As a result, individuals may seek hazard information from the sources they do trust, such as friends and family (Mileti, 1995; Parker & Handmer, 1998; Handmer, 2001). The fragility of trust makes the issue much more

salient, particularly in matters of risk management. As Slovic (1999) notes, "distrust, once initiated, tends to reinforce and perpetuate distrust" (p. 698). Once an institution has earned a reputation for distrust, individuals tend to avoid contact or automatically reject even trust-building information. The resilience of opinions formed based on distrust thus often creates a barrier that prevents experts from communicating new or amended hazard information. The search for appropriate media and messages for risk communication becomes futile when the public lacks trust in the messenger, because "if trust is lacking, no form or process of communication will be satisfactory" (Slovic, 1999, p. 697).

Social incorporation as defined by Douglas (1992) refers to the extent of an individual's social network as well as the degree of connection between its members. Extensive social networks may facilitate appropriate precautions and actions for hazard events by increasing the likelihood that information will be heard and believed by individuals. Many studies have shown that people seek confirmation of the severity of a hazard and the need to prepare or respond appropriately from a variety of sources before they will take action (Mileti, 1995; Brilly & Polic, 2005). These sources may be different agencies, government or emergency management officials, or the media, but people frequently consult with friends, family, or neighbors before making a decision. For this reason, Parker and Handmer (1998) and Handmer (2001) recommend that risk management agencies attempt to understand how people exchange information within their social networks. Scherer and Cho (2003) have developed the social contagion theory, which states that individuals model their attitudes and behaviors after those of the

members of their social networks. This helps to explain studies that have shown that people evacuate more readily if they know that neighbors, friends, or family members are evacuating and vice versa (Mileti 1995; Dow & Cutter, 2000). The social amplification of risk framework (SARF) provides a theoretical model for how information about hazards and risk perceptions may be amplified or attenuated as people consult with their social networks (Kasperson, 1992; Masuda & Garvin, 2006). Rumors or information will be propagated as it fits preconceived mental models, beliefs, or values (Kasperson, 1992). This means that if the hazard message conforms to these prior perceptions of reality, the receiver will attempt to spread information and amplify the apparent risk. Otherwise, the threat will be explicitly attenuated by circulating contrary information or implicitly attenuated through failure to propagate any information at all. Kasperson (1992) describes culture as a "super-variable" that affects all stages within SARF, including amplification and attenuation processes. Since culture influences an individual's worldview, it is likely to affect whether individuals amplify or attenuate hazard information (Kasperson, 1992; Masuda & Garvin, 2006). Sáenz (2003) would agree, and states that just educating the public is insufficient, because "individuals and groups possess a series of subjective or affective components that impede or allow for the incorporation of new knowledge" (p. 124). Social contagion theory and SARF both imply that exchanging information with others enables individuals to establish similar conceptualizations of the nature of hazards, including the best and worst ways to prepare for and respond to events (Morris-Oswald & Sinclair, 2005).

Self-efficacy describes whether individuals determine that a risk may actually be reduced as well as whether they are capable of taking the proper precautions or reactions during a hazard event (Tobin & Montz, 1997; Paton & Johnston, 2001). Self-efficacy primarily refers to an individual's apparent locus of control (Bandura, 1997; Scholz et al., 2002). An internal locus of control puts the individual in charge of his or her own destiny, and the resulting higher sense of self-efficacy may increase the likelihood that an individual will react to warnings and take measures to secure their life and property. However, should the individual assume they have complete control over their destiny, regardless of their awareness of the hazard in question, they may feel invincible and take no precautionary or reactionary measures. Individuals with an external locus of control tend to feel helpless in hazard situations and depend on others for protection, rather than attempt to protect themselves. Low self-efficacy may also contribute to fatalistic tendencies because individuals may assume that they cannot alter their pre-determined destiny by taking precautionary or reactionary measures, or may have little faith in their decision making capability (Douglas, 1992; Inelman et al., 2004). Thus, self-efficacy produces a variety of possible responses among individuals and requires careful consideration.

Social autonomy measures variation in both real and perceived access to information and materials as a function of the degree to which individuals have the freedom to move between various social roles (Douglas, 1992). Many factors determine social status including age, gender, race, ethnicity, education, socioeconomic status, or

any other standards by which societies produce social hierarchies. Markus, Steele, and Steele (2000) define downward social constitution as

> the experience of being in a setting where, based on a given group identity, one is exposed to a potentially limiting and devaluing concert of representations, historical narratives, possible judgments, treatments, interactions, expectations, and affective reactions. (p. 235)

Thus, not only will certain groups find access to resources limited, they will come to expect such limitations. This may drastically affect decision-making not only by restricting which options an individual has available, but also which options an individual even considers. According to Wisner and colleagues (2004), "…people who are economically and politically marginal are more likely to stop trusting their own methods for self-protection, and to lose confidence in their own local knowledge (p. 53)." Social marginalization therefore also produces a sense of fatalism by reducing resources and options available to people during exposure to a hazard, which demonstrates the close connection between social autonomy and self-efficacy.

Time perspective refers to whether individuals focus on the past, present, or future. Individuals that focus on the past tend to have difficulty conceptualizing unforeseen or unpredictable events (Douglas, 1992). This produces beliefs that because an event has failed to occur in the past, it probably will not occur in the future. When a major event does occur, however, many see it as anomalous and believe that it will not happen again within their lifetime (Tobin & Montz, 1997). This also fails to account for natural and anthropogenic changes in the environment, which will affect the magnitude and frequency of future hazards. On the other hand, little emphasis on the past causes

people to disregard the frequency of hazard events despite experience with them, and little emphasis on the future leads to the tendency to take action (or fail to take action) in order to improve current conditions at the expense of those to come. In the context of natural hazards, present-focused individuals may worry more about meeting current needs or wants than planning for the future. This occurs despite knowledge of past events and probability of future events to come. This does not necessarily reflect lack of reasoning, as Douglas (1992) is quick to point out, but rather indicates a preference. Wisner and colleagues (2004) would agree that these individuals have merely decided that their current standard of living is more important than their future one, which may or may not include a hazard event. Present-oriented individuals may also express fatalistic beliefs and take risks because they perceive a lack of control over their future and do not attempt to challenge fate. Those with a particular concern for the future will likely exercise more caution for fear of the unknown, and will therefore engage in risk-taking behavior less often (Douglas, 1992).

1.2. Theoretical Framework

This research attempts to quantitatively measure psychological and cultural traits associated with risk perception and behavior, and therefore falls within the psychometric paradigm. However, this study challenges the way that this paradigm has been traditionally applied in hazards and risk perception research (Slovic, 2000). Previous risk perception studies conducted under this paradigm have been criticized for attempting to understand why laypersons err in judgment so that experts can work to correct popular

misunderstandings (Jasanoff, 1998; Slovic, 1999; Frewer, 2004). These studies mostly focus on psychological functioning at an individual level. This project also works from the individual level, but integrates cultural psychology theory by attempting to discern how culture, psychological processes, and behavior mutually influence and constitute one another. The result is the conceptual framework illustrated in Figure 1. This approach allows flood risk managers to discover the complex, dynamic social context within which their messages are heard and interpreted, and demonstrates the potential for multiple rationalities. This study also challenges the use of psychometrics to generate assumptions about psychological processes and behavior by demonstrating how contradictory responses may lead to ambiguous results.

1.3 Case study: Tucson, Arizona

Floods are among the leading causes of weather-related mortalities in the United States with an average of approximately 100 deaths reported each year, second only to heat-related mortalities (Ashley & Ashley, 2008; NWS, 2008a). Over half of all flood deaths in the United States are related to vehicles, with some drowning within the vehicles and others drowning upon trying to escape from their vehicles (Ashley & Ashley, 2008). As a result, the National Weather Service (NWS) and a number of local flood risk agencies have initiated flood awareness programs such as "Turn Around Don't Drown" in order to reduce life and property losses associated with driving into flooded roadways (NWS, 2008b).

Tucson, Arizona provides an optimal site for this case study for both physical and socio-political reasons. Hundreds of streets and intersections flood when it rains due to a combination of numerous wash crossings without bridges and streets designed to convey stormwater during heavy rainfall events. Flood risk managers have created several sign and road barrier projects in an attempt to deter motorists from driving into flooded roadways, known as "Operation Splash" (TDOT, 2008). The locations of barriers and other flood-prone areas are frequently mentioned in outreach programs and through the local television and print media (e.g. TDOT, 2008). An Arizona state law now requires individuals to pay fines in order to offset costs incurred by the city if they drive around a barricade and require rescue (Arizona Revised Statutes, 2006). This law is popularly known in the area as "the Stupid Motorist Law." Despite the publicity surrounding the law and the programs designed to convey the dangers of driving through flooded roadways and otherwise discourage such behavior, losses to life and property continue to occur.

This work also draws upon similar research conducted through The Warning Project, which assesses risk factors related to an individual's decision to drive through flooded roadways in Denver, Colorado and Austin, Texas (Drobot et al., 2007). While not explicitly cultural in nature, the factors identified by Drobot and colleagues (2007) inform the analyses within the present study.

2. Methods

2.1 Focus Group Interview

In order to ensure the relevance and utility of information gathered in this study, flood risk managers in Tucson were invited to participate, beginning with the earliest stages of the project. A focus group interview was held with flood risk managers from the agencies responsible for flood management and the dissemination of flood information in Tucson. Participants were identified and invited based on internet searches of personnel on the agency websites or by referral from the individuals initially contacted by e-mail. The five interview participants included members of the Tucson National Weather Service Weather Forecast Office, the Pima County Regional Flood Control District, and the Tucson Department of Transportation. All participants indicated that their jobs include flood risk awareness outreach programs.

The meeting was held May 21, 2007 in a workshop supported by the Climate Assessment of the Southwest (CLIMAS) held at the Institute for the Study of Planet Earth (ISPE) on the University of Arizona campus. The participants were briefed on the background and theoretical framework of this research study, after which the discussion was opened to their experiences in flood risk management and their suggestions for the structure and content of the survey instrument. Topics discussed also included locations of flood-prone areas, possible factors that influence an individual's decision to cross or not to cross a flooded roadway, and the effects of stigma and the inconsistent enforcement of "the Stupid Motorist Law." Many of the suggestions and considerations

provided by focus group participants were used in the development of the survey instrument, which was completed in the fall of 2007.

2.2 Survey Design and Sampling Method

Survey questionnaires were mailed to 1,000 Tucson residents selected at random from the area-wide residence directory. Many residents of Tucson do not speak English (U.S. Census, 2000), so a Spanish version of the survey was developed with the aid of a native Spanish speaker and tested for consistency by a fluent speaker and another native speaker. In order to reduce the effects of stigma associated with driving through flooded roadways as illustrated by the label "the Stupid Motorist Law," survey instructions and questions were designed to normalize the decision to cross. This was done by providing examples of common reasons to cross and by framing the experience of street flooding as a fact of life in Tucson (Iarossi, 2006). Also, a self-completed survey was used rather than interviews to encourage honest responses that participants might be reluctant to provide in face-to-face contact (Buckingham and Saunders, 2004).

Questions elicited information regarding the five cultural factors outlined above through every day practices and beliefs by asking participants whether they agreed or disagreed with a series of statements. Other questions provided explicit situations related to flash floods and asked participants to indicate how much each situation would influence them to cross or not to cross a flooded roadway. This information was compared to participants' stated typical or hypothetical responses to situations in which they encounter a flooded street crossing. Types of possible answers to structured survey

questions included discrete categories and Likert scale ratings. Since multiple choice answers tend to limit responses to those preconceived by the investigator, the survey also included space for optional short answer responses that allowed the participant to elaborate or explain their selection (McGuirk and O'Neill, 2005). This survey design allows investigators to perform quantitative analyses on the data without sacrificing the opportunity for participants to provide deep, rich, and varied information that may open discussions for later studies.

Each address received a copy of the survey and instructions in both English and Spanish. In order to increase the response rate, a second copy of the survey was sent to the same addresses two weeks after the first mailing, and survey participants were offered the opportunity to enter a drawing to win one of four $25 prepaid debit cards (McGuirk & O'Neill, 2005). The number of returned surveys was 173, for a response rate of 17.3 percent.

2.3 Survey Sample Demographics

Of the 173 surveys returned, 13 were from individuals who refused to indicate whether they had crossed flooded roadways or provided contradictory answers regarding that question have been left out of the statistical analysis. While they constitute an interesting subset of respondents by themselves, the small sample size of these individuals would have reduced the robustness of the statistical analysis. Therefore, their questionnaires were removed, resulting in a final sample size of 160 for the statistical analysis. Survey respondents did not reflect a sample representative of Tucson

demographics according to the 2000 Census data in the categories of age, ethnicity, and education (U.S. Census, 2000). Only gender statistics closely matched the 2000 Census data. This probably occurred because of self-selecting sampling bias, which predicts higher-than-expected numbers of respondents with higher ages and education levels.

Age

The ages of respondents ranged from 24 to 87, with a mean and median age of 58. The age structure of this sample is not representative of Tucson, according to Census 2000 data. The percentage of sample respondents over the age of 65 is 27 percent, while the 2000 Census recorded only 12 percent of Tucsonans over the age of 65.

Gender

Approximately 53 percent of survey respondents were female, which closely resembles the Census 2000 percentage at 51 percent of Tucson residents.

Education

Education levels did not match Census 2000 data for Tucson residents. The census data report that 80 percent of Tucson residents over the age of 25 have graduated from high school, while 98 percent of the sample of survey respondents reported having at least graduated from high school. One respondent declined to answer, and only one respondent reported less than a high school diploma. In terms of higher education, the census data report that 23 percent of Tucson residents over the age of 25 hold at least a

bachelor's degree, while 62 percent of survey respondents hold at least a bachelor's degree. The only survey respondent under the age of 25 reported an education level of "some college."

Ethnic Identity

Eighty-five percent of the respondents selected White as their ethnic identity. This value is higher than the 70.2 percent reported in the 2000 census (US Census, 2000). The next largest group of respondents were those who reported Hispanic or Latino/a at 4.4 percent of the sample, which is considerably lower than the census report of 35.7 percent of Tucson residents. The next highest response was Other, which was selected by 3.8 percent of the sample and filled in with their choice of descriptor.[1] The small number of non-white participants precludes any statistical analysis, so this category was not further explored in the analysis.

2.4 Method of Analysis

The objective of this study was to determine which factors influence an individual's decision to drive through a flooded roadway, so each factor was analyzed with respect to the question "Have you ever driven through a flooded roadway?" Respondents answered yes or no to this question and then provided details about the situational context and their thought processes regarding the decision in a free-response format. A narrative analysis was performed on the free response answers, which were

[1] A single individual filled in each of Arab American, Scandinavian, European American, Middle Eastern, and Mexican, and two individuals filled in American.

used to triangulate the responses individuals provided to other questions and to determine possible causes for ambiguity in the results. For simplicity, those who responded "yes" have been labeled "crossers" and those who responded "no" have been labeled "non-crossers." Of the 160 respondents included in this analysis, 39 percent identified as non-crossers and 61 percent identified as crossers. It is not clear whether the ratio of crossers to non-crossers in this sample is similar to that of the city of Tucson. Self-selection bias may produce either higher numbers of crossers than would be expected because the survey would be more relevant for them, or may produce lower numbers of crossers than would be expected because of the stigma attached to the behavior.

The primary statistical analyses performed include Pearson χ^2 statistics for categorical responses and Mann-Whitney U two-sample parametric tests for scalar responses. Both techniques were used to determine whether the responses of each question differed statistically significantly between crossers and non-crossers. A statistically significant difference between the responses of crossers and non-crossers would suggest that the factor in question is related to whether or not the respondent reported that they had driven through a flooded roadway.

3. Results

3.1 Demographic Factors and Reported Crossing Behavior

Age

Many risk perception studies tend to break age into bins to determine whether a correlation exists between age and risk-taking or risk-averse behaviors. For example,

Drobot and colleagues (2007) showed that drivers between the ages of 18 and 35 were much more likely to report that they would drive through flooded roadways than their counterparts over the age of 36. However, the distribution of ages within the Tucson sample is centered on a mean that is higher than the population mean, and only 8 respondents fit within the 18-35 age category. The analysis is also complicated by the fact that many respondents indicated that they had crossed a flooded roadway many years ago, and the lack of consistency among responses created difficulty in simply calculating the respondent's age at the time of crossing. Future studies should take these complications into consideration if age is of particular interest, and more specificity would reduce the variation of responses, although it would also limit the possible responses to those preconceived by investigators. Otherwise, given the influx of retirement-aged individuals into Tucson, studies of their risk perception and behavior as a subset of the wider population could have important implications.

Gender

Statistics compiled by the National Weather Service show that in the United States, males comprise two-thirds of flood mortalities involving vehicles (NWS, 2008; Ashley & Ashley, 2008; Drobot et al., 2007). Despite the higher mortality rate of males in the NWS study, self-questionnaires in general do not show a statistically significant difference in the gender distributions of people who cross flooded roadways. In this study, for the respondents who identify themselves as crossers, approximately the same percentage of crossers are males and females (M = 51 percent, F = 49 percent), whereas

the gender distribution for the respondents who identify themselves as non-crossers is 59 percent female and only 38 percent male. These data have a Pearson χ^2 statistic $p = .11$, thus they are not significant at the $p \leq .10$ level. They do, however, resemble the results of a similar study in Austin, Texas and Denver, Colorado that found males are more likely to report driving through flooded roadways than females are (Drobot et al., 2007).

Both of these studies show differences in gender distributions that are not statistically significant. In order to explain this phenomenon, Drobot and colleagues (2007) suggest that survey design might account for a lack of significant differences in gender distribution and cite studies that do show differences for actual risk-taking behavior but not for self-administered questionnaires (Byrnes et al., 1999; Ronay & Kim, 2006). It is also possible that males may face higher mortality rates because they are more willing to cross flooded roadways in riskier situations, or that women are less prone to risk-taking behavior in general but do so out of necessity.

Education

The relationship between education level and reported crossing behavior was inconclusive (Table 1). Crossers and non-crossers reported similar percentages in each education level category up through "some college." The percentage of non-crossers with a 4-year college degree is 32 percent, somewhat higher than the 21 percent reported for crossers. For the category "graduate school or further," however, the percentage of crossers is higher at 45 percent than the percentage of non-crossers, which is 25 percent. A Pearson χ^2 calculation shows that these differences are statistically significant at the

level $p \leq .10$ with $p = .07$, but the relationship between education level and willingness to drive through a flooded roadway is not clear. It is possible that individuals with education levels of graduate school or further might be more risk-taking, might be more confident in their ability to judge their personal safety, or they may be more willing to admit to such behaviors despite the effects of stigma.

Vehicle Type

Focus group participants frequently suggested that vehicle type would influence an individual's decision to cross or not to cross a flooded roadway. Respondents were asked about their primary mode of transportation within the city, and were allowed to select multiple answers. Choices included car, sport utility vehicle (SUV), truck, motorcycle/scooter, bus, bicycle, walking, and other. With the exception of motorcycle/scooter and bus – two small samples that contained equal numbers of crossers and non-crossers – a higher percentage within each vehicle type identified as crossers than as non-crossers (Figure 2). The percentage of crossers within each vehicle type is much higher for trucks (84 percent) and SUVs (73 percent) than for cars (57 percent). A Pearson χ^2 and Fisher's exact statistics were calculated for each vehicle type to determine whether vehicle types differed significantly between crossers and non-crossers (Table 2). For the Pearson χ^2 and Fisher's 1-sided statistics, the results for cars were significant at level $p \leq .10$, and the results for trucks were significant at level $p \leq .001$. Results for SUVs were not statistically significant, with Pearson χ^2 at $p = .11$. For Fisher's 2-sided

statistic, the results for car were significant at level $p \leq .05$, the results for SUV were significant at $p \leq .10$, and the results for truck were significant at $p \leq .001$.

These results support the predictions of the flood risk managers, who suggested that people feel more confident about driving through flooded roadways in larger vehicles. Many survey respondents indicated in the free-response that they consider the size, weight, or clearance of their vehicles in their decision to cross or not to cross. Many of the respondents indicated that they will cross if vehicles of a similar or smaller size successfully cross. However, some respondents will not wait to see if other vehicles cross successfully if they feel confident that their vehicle is large or safe enough. One respondent said that "although some cars refused to drive through I thought my truck could make it. I didn't, but the truck behind me pushed me out." Other respondents indicated that having four-wheel drive factors into their decision to cross as well.

3.2. Cultural Factors and Reported Crossing Behavior

Trust

Each of the flood risk managers indicated that one of their major concerns was building the public's level of trust in their information and warnings. Whether the public is more skeptical about the nature of the hazard, the message, or the messenger, the goals of the focus group participants include "trying to figure out how we can have people heed the warnings that we put out." Flood risk managers were particularly interested in finding out whether people trust the general flood risk information that they distribute,

the National Weather Service flash flood warnings, and the flood warning signs located at low water crossings.

Survey respondents indicated the level of trust they had in various sources of flash flood information. These sources include various media outlets, National Weather Service warnings and general flood information, safety officers such as police and firefighters, and barricades or signs. Answer choices along a 6-point Likert scale included "Do not trust at all," "Mostly do not trust," " Neutral," "Mostly trust," "Completely trust," and "Not applicable/Do not use." For explanatory purposes, responses were aggregated into "Do not trust", "Trust," and "Neutral/Do not use."

A greater percentage of respondents indicated that they trust each source than indicated that they do not trust each source. At least half of the respondents indicated trust in each of the sources except for "Local radio station" and "NOAA Weather Radio," the latter of which is only used by approximately one-third of the respondents. A Pearson χ^2 statistic was used to determine if trust in a particular source was significantly different between crossers and non-crossers (Table 3). The only two sources that showed significant differences in this analysis were "The Weather Channel" and "City or county officials." About 59 percent of non-crossers trust The Weather Channel, while only 3 percent report that they do not trust The Weather Channel. In contrast, although 41 percent of crossers trust The Weather Channel, 24 percent do not. For city or county officials, 71 percent of non-crossers and 54 percent of crossers say they trust the source, while levels of distrust are fairly similar at 5 and 8 percent, respectively. However, 34 percent of crossers and 21 percent of non-crossers reported neutral/do not use.

The implications of these results are not clear, partially because the "City or county officials" category is quite vague, and may or may not include employees of the Pima County Regional Flood Control District or the Tucson Department of Transportation for individual respondents. As these two agencies are responsible for disseminating flood risk information to residents of Tucson and Pima County, it would be beneficial for future studies to distinguish these agencies from other city or county offices that presumably do not possess flood expertise.

The lack of trust in The Weather Channel among crossers is also interesting, considering that The Weather Channel provides much of the same information as the National Weather Service, which most respondents claim to trust. For both crossers and non-crossers, approximately two-thirds of survey respondents trust the general information from the National Weather Service, while nearly three quarters of respondents trust the flash flood warnings. The Weather Channel provides general information on the national level about the definitions of floods, flash floods, watches, and warnings, but does not provide the flood risk information related to vehicles or Tucson-specific information about flood-prone areas to avoid that some of the local sources provide. The Weather Channel also provides the official watches and warnings issued by the National Weather Service when they are in effect for the Tucson area. These results that show relatively low levels of trust in The Weather Channel despite high levels of trust in the National Weather Service thus deserve further attention. Since levels of trust for most of the sources are lower among crossers than non-crossers but only significant for two sources not broadly construed as flash flood information sources,

it is possible that levels of trust in multiple sources might provide more explanatory power.

An exploratory factor analysis was performed to determine whether people report similar levels of trust in similar types of sources, such as various media sources, and to see if the level of trust in these grouped sources differs significantly between crossers and non-crossers. Five factors were extracted using principal component analysis, rotating the matrix with a quartimax rotation, and accepting all factors with eigenvalues greater than 1. The flood information sources were grouped with the factor upon which it loaded the highest. The first factor includes police officers, firefighters, and emergency responders, so Factor 1 represents the category of "Safety Officers." The second factor includes all information from the National Weather Service, including flash flood warnings, general flood information, and NOAA (National Oceanic and Atmospheric Administration) Weather Radio. Neighbors, friends, and family and city or county officials load on Factor 3, forming the new category "Community sources." Factor 4, "Signs and barricades," is a category that includes the "Dip: Do not enter when flooded" signs and the "Flood Area" barricades posted at low water crossings. Factor 5 includes the "Media" sources the local television news, local radio station, and The Weather Channel. Environmental cues, such as heavy rainfall or water on the road, failed to load highly on any factor. No respondents reported that they did not trust environmental cues, so this source has been eliminated from the analysis with the other factors.

The levels of trust among the sources within each factor were averaged for each respondent, and then a Mann-Whitney U statistic was calculated for each factor to

determine whether trust levels for each factor varied significantly between crossers and non-crossers (Table 4). Crossers consistently report a lower level of trust in the grouped sources than non-crossers, but these differences are only statistically significant for the Signs and barricades ($p = .00$), Safety officers ($p = .02$), and Community sources ($p = .06$) factors.

Respondents were also asked a series of questions regarding trust in the science behind flash flood warnings and how well the signs or barricades indicate flash flood dangers. Respondents were asked whether they agreed or disagreed with four statements, based on a 5-point Likert scale with answer choices ranging from strongly disagree to strongly agree. The results were aggregated into agree, disagree, and neutral, and then a Pearson χ^2 was used to determine whether the responses of crossers and non-crossers varied significantly. None of the results were statistically significant at $p \leq .10$. Respondents mostly agreed that "Scientists understand what causes flash floods," and that "Scientists understand how flash floods behave," suggesting that respondents generally trust that scientists understand the nature of flash floods.

The other two questions further addressed level of trust in the presence of signs and barricades. Each of the flood risk managers had expressed concern that individuals do not trust the signs. The "dip" signs are permanent, and the barricades are now semi-permanent because of the expense and time delays associated with getting them set up and taken down before and after each flood event. One focus group participant suggested that the daily presence of the signs causes them to become "background noise." Nearly 90 percent of all respondents agreed that signs or barricades indicate the likelihood of

flash floods occurring in that particular section of the roadway, but less than half agreed that the signs or barricades indicate the degree of danger. These results suggest that the respondents note the possibility of danger at low water crossings marked with signs and barricades, but do not assume that their presence automatically signifies that water on the roadway is not passable. Indeed, some respondents noted in their free-responses that the barricades are up even when the water is "a trickle, not flooded" and that when they decided to cross they relied more on environmental cues than the presence of a sign.

Others, including both non-crossers and crossers, indicated a great deal of trust in the barricades. Many respondents reported in their free-responses that the lack of a barricade or sign influenced their decision to cross and that they would never cross if a barricade is present. These responses support the suggestion brought up by one focus group participant that the signs and barricades produce a false sense of security in unmarked areas, leading individuals to believe that the lack of a sign indicates the lack of flood danger. Therefore, it appears that the signs and barricades provide a vague yet important message for motorists caught traveling during a flash flood event, and that many if not most motorists are willing to heed that message if it is available and unambiguous.

Self-Efficacy and Social Autonomy

Self-efficacy and social autonomy are theoretically similar constructs, so for the purposes of this analysis they were combined into one category called self-efficacy/social autonomy (SE/SA). Some questions were adapted from the General Self-Efficacy Scale

(GSES) first developed by Jerusalem and Schwarzer in 1979 and later tested for intra- and inter-group consistency by Scholz and colleagues (2002). Questions from the GSES that were used for this survey include asking whether a respondent agrees or disagrees with statements such as, "I can handle whatever comes my way." To keep the survey format consistent, the answer choices were adapted to a 5-point Likert scale from the GSES 4-point scale, and the wording was slightly changed from degree of statement truth to degree of agreement with the statement. Other questions related to self-efficacy were borrowed from The Warning Project survey used by Drobot and colleagues (2007), such as "I consider myself a good judge of whether flood waters are dangerous." Answer choices from The Warning Project questions also fit a 4-point scale as the category "neutral" was not included, so the answer choices were expanded to include the neutral category for this analysis. Three original questions related to SE/SA were also designed for this survey, including questions inquiring about perceived access to information about flash floods.

Answer choices ranged along a 5-point Likert scale ranging from strongly disagree to strongly agree. For explanatory analysis, responses were aggregated into agree, disagree, neutral, and a Pearson χ^2 statistic was calculated to determine if crossers and non-crossers reported statistically significant differences in levels of SE/SA. For all except two of the questions, an "agree" response indicates a high level of SE/SA.

Prior to analysis, it was unclear whether crossers or non-crossers would report higher levels of SE/SA. An individual with high SE/SA may take more risks because their internal locus of control places their actions and destiny in their own hands

(Douglas, 1992; Scholz et al., 2002). However, an individual with low SE/SA may take risks because of fatalistic beliefs that an external locus of control will determine their destiny, regardless of what actions they take (Douglas, 1992; Inelman et al., 2004). The flood risk managers predicted that individuals high SE/SA would be more likely to cross, and indeed many crossers indicated a high level of confidence that they would successfully cross the flooded roadway in their free responses. However, the statistical analysis suggests that for each question, more crossers reported low SE/SA than non-crossers (Table 5). Results are statistically significant at level $p \leq .10$ for only two of the nine questions, which may be due to the fact that SE/SA level could influence an individual's decision in either direction.

One question that showed significant differences between crossers and non-crossers ($p = .10$) was whether or not the respondent agreed with the statement "My ability to prepare for or avoid flash floods is limited by conditions outside of my control." Respondents that indicate agreement with this statement demonstrate low SE/SA, and a higher number of crossers indicated agreement than non-crossers, which is consistent with the results for other SE/SA questions and the theories mentioned above that link fatalism and risk-taking behavior.

More non-crossers (50 percent) than crossers (34 percent) agreed with the statement "I have access to information about flash floods any time I need it." These results are statistically significant ($p = .06$). Responses to a similar follow-up question regarding access to information and instructions when a flash flood is actually occurring showed an apparent shift from disagree to agree among both crossers and non-crossers,

suggesting that for at least some people, it is easier to find information about flash floods during an event than in between events. The difference between crossers and non-crossers for the follow-up question is not statistically significant ($p = .12$). It is not clear from these results whether respondents: (a) would like to have more access to information in between flash flood events, (b) do not know where to find such information, or (c) seek information only when a flash flood is in progress.

Time Perspective

To determine whether time perspective influences an individual's decision to cross or not to cross a flooded roadway, a number of questions were borrowed from the Zimbardo Time Perspective Inventory (ZTPI) developed by Zimbardo and Boyd (1999). Inserting the entire scale of 56 ZTPI questions would have significantly lengthened the survey and reduced willingness to participate, so only the 19 questions that appeared most relevant to this study and that showed high levels of internal consistency within the ZPTI were selected for this survey. The original answer choices were slightly modified to measure degree of agreement along a 5-point Likert scale instead of how characteristic each statement is for the individual (for example, in the original metric 1 = very uncharacteristic, 5 = very characteristic).

Three additional questions regarding time perspective were formulated specifically for this study. These questions intended to address the effects of previous risk-related experience on future behaviors, differentiating whether these experiences were successful or not and whether these experiences were the individual's own or

someone else's. Answer categories again measured degree of agreement on a 5-point Likert scale ranging from strongly disagree to strongly agree. Responses for all time perspective questions were aggregated into agree, disagree, or neutral, and a Pearson χ^2 statistic was calculated to determine if a respondent's time perspective was related to whether or not the individual had crossed a flooded roadway.

There were no significant statistical differences between crossers and non-crossers on any of the time perspective questions. A review of these results suggests that the phrasing of some of the questions also address the respondent's self-efficacy, which may have produced embedded effects that lead to ambiguous results for the time perspective questions. It was therefore concluded that self-efficacy/social autonomy and time perspective cannot be interpreted as separate constructs when studying risk perception and behavior. The conflation of the two may create ambiguous or non-statistically significant results for questions related to risk-taking or risk-averse behaviors.

Social Incorporation

Less than one third of the survey respondents answered the questions intended to quantitatively measure the size of the social networks within which respondents send and receive information about flash floods, possibly because the survey page layout or directions were not clear. However, the open-ended follow-up questions provide insight into how the respondents use their social networks, which is more useful and important for the social amplification of risk framework (SARF, Kasperson, 1992; Masuda &

Garvin, 2006) than the size of the social network. The first question asked how many people the respondents would go to for advice or help during a flash flood, and then a follow-up question asked respondents to indicate whom, providing response examples such as "brother" or "neighbor." While many did not answer the numerical question, 78 percent of all respondents listed at least one person that they would go to for advice or help during a flash flood. The relative percentages were approximately equal for crossers and non-crossers. These responses primarily include family, friends, and neighbors, but co-workers, police, and firefighters are also frequently mentioned. Other responses were more specific to the situation, such as "someone who might be familiar with route I am taking," and "If I got caught in one – dad, brother. Where it is and how to avoid – dad, brother, friends."

The second question asked how many people the respondents discuss flood-related information with when it is not currently flooding, and the follow-up question again asked respondents to indicate whom. Again, the relative percentages of crossers and non-crossers were approximately equal, but only 48 percent of all respondents listed at least one person with whom they discuss flood-related information when it is not currently flooding. The responses were mostly family, friends, neighbors, and co-workers. As an example of the type of information that propagates through social networks, several respondents mentioned in a later free-response section that upon moving to Tucson they had been warned to stay out of the washes and underpasses by friends or colleagues. One respondent mentioned that they "tell newcomers to pull off the road and have a cup of coffee during heavy rains," indicating that they relay the

dangers of driving during rains as well as the relatively brief duration of the inconvenience.

Other respondents, however, indicated that they discuss floods with no one when it is not flooding and described the information as "not relevant" in between events or mentioned that it "doesn't often come up in conversation." One respondent does not discuss flood-related information when it is not flooding, "unless it is monsoon season." To build on the previous example, while some newcomers to Tucson were warned about the floods, others lamented that they had not been warned and were surprised to see so much water on the roads. One of the focus group participants suggested that for newcomers, the mental "disconnect" created by the experience of flooding in the desert "may short-circuit their rational ability" such that in their confusion they drive through the flooded roadway. From the survey responses, however, it appears that people are not so much confused about the presence of flooding in the desert as they are about the presence of flooding through the streets, rather than through storm drains. For these respondents the "disconnect" is that when it rains, the streets transport water instead of vehicles, and their decision to drive through is based more on the belief that roads should be safe to drive on when it rains as well as the lack of knowledge of flood-prone locations and alternate routes. Fortunately, many respondents indicated that they actively exchange information about flood-prone areas and alternate routes with others either by volunteering the information or asking for it.

These results support the earlier hypothesis that people are more likely to seek information about floods during an event than in between events, which seems reasonable

considering the relative importance of such information in circumstances that require flood-related decisions compared to those that do not. However, the fact that individuals discuss floods at all has important implications related to SARF. Knowing what information is circulating as well as whether the risks are being amplified or attenuated could help risk managers understand risk-taking or risk-averse behavior as a product not only of the information that they provide themselves, but also the information spreading among people's social networks. From these results it appears that individuals tend to amplify the risk of driving into flooded roadways, but the lack of evidence of attenuation within this study does not imply that attenuation is not occurring.

3.3 Situational Factors and Reported Crossing Behavior

The objective of the third section of the survey was to determine what situational factors might influence an individual's decision to cross or not to cross a flooded street. Many of the factors chosen for the survey were derived from suggestions provided by the flood risk managers during the focus group interview. For the first question, survey participants were asked to indicate how much each of the factors would influence their decision to cross a flooded roadway. Conversely, the second question asked how much each of a different set of factors would influence their decision *not* to cross a flooded roadway. Answer choices along a 4-point Likert scale included "No influence," "Slight influence," "Moderate influence," and "Strong influence."

Influence to cross

For ease of analysis, the answer categories for the "influence to cross" question were aggregated into "No influence" and "Some influence," the latter of which includes Slight, Moderate, and Strong influence. The responses were tested for significant difference between crossers and non-crossers using the Pearsons χ^2 statistic. For every situation presented, a higher percentage of respondents who answered that they had not crossed a flooded roadway reported that the situation had no influence over their decision than those who had crossed a flooded roadway (Table 6). These results are significant for all situations at level $p \leq .10$. Notably, the non-crossers reported a higher percentage of no influence than some influence for every situation except one, that the "car ahead of me made it through." In this category, both crossers and non-crossers more frequently reported that this would have at least some influence on their decision. Several respondents noted in the free-response section that they typically wait to see if other vehicles successfully cross, and will follow if they perceive their own vehicle to be larger, have a higher clearance, or be heavier than the vehicles that successfully crossed. Some also reported using the vehicles in front of them to determine how deep and swift the water is moving across the roadway, and if it appears safe they will cross as well.

There was more variation in the frequency with which crossers reported no influence or some influence. They more frequently reported at least some influence for most of the situations presented, except for "shorter than another possible route," the presence of family or friends in the vehicle, and that "conditions are getting worse." Approximately two-thirds of crossers reported that peer pressure from passengers would

not influence their decision to cross, yet several of these respondents noted in their free-response section that they had been encouraged to cross by their passengers, or that they had discussed with their passengers the availability of alternate route options or the probability of a successful crossing. It is possible that the questionnaire's use of the term "peer pressure" has a negative connotations with which the respondents did not wish to identify, or that the term seems to reference an explicit urging that discounts the often subtle nature of peer pressure. Therefore it appears that the influence of SARF on a respondent's decision requires much deeper analysis that avoids framing the influence factor as peer pressure.

Influence not to cross

When the responses about situations that influenced a respondent not to cross a flooded roadway are aggregated like the results above, only the presence of a barricade or sign shows statistically significant differences between crossers and non-crossers. This is because most respondents, including both crossers and non-crossers, answered that each factor has at least some influence on their decision not to cross a flooded roadway. Additionally, the trends among the categories of influence are much more visible for this question, so these data were left non-aggregated for the analysis (Table 7). Four situations presented to the respondents show statistically significant differences between crossers and non-crossers when deciding not to cross a flooded roadway: the presence of a barricade or sign, having family in the vehicle, having friends in the vehicle, and the risk of citation. For a few of the other situations presented, the differences between non-

crossers and crossers were negligible, including risk of injury or death, risk of damage to the vehicle, knowledge of an alternate route, and willingness or ability to pay for rescue. For most of the situational factors, crossers tend to report slight or moderate influence more frequently than non-crossers. Overall, non-crossers report a strong influence not to cross more frequently than crossers.

The distribution of responses among the different situational factors provides additional insight into which factors influence the respondents the most (Figure 3). For some of the situations, most respondents among both crossers and non-crossers selected "strong influence" and very few respondents answered no influence, slight influence, or moderate influence. These situations were: presence of a barricade or sign, having family or friends in the car, risk of injury or death, risk of damage to the vehicle, risk of citation, and knowing another possible route. These situations appear to strongly influence individuals to avoid crossing flooded roadways, and respondents frequently mentioned these factors in their free-responses. It is important to note that while many respondents indicated that these factors have influenced them never to drive into a flooded roadway, many others indicated that these factors became strong influences not to cross only after personally having a bad experience while attempting to cross a flooded roadway.

The responses were more evenly distributed among the degrees of influence for factors such as embarrassment at getting stuck or swept away, not being able or willing to pay to be rescued, and the presence of others outside of the car. This information indicates that the risks to the driver, passengers, and the vehicle, as well as the presence

of alternate routes, barricades, and the "Stupid Motorist Law" (but not necessarily the costs that rescued individuals incur because of the law) provide the strongest incentive to avoid crossing through flooded roadways.

While embarrassment and rescue cost do provide incentive not to cross flooded roadways, these factors seem to have less influence on individuals' decisions than the factors mentioned above. However, three of the flood risk managers in the focus group attributed a substantial amount of influence to the potential for embarrassment from observers on the scene or the headlines in the newspaper the following day. One shared an observation of an individual that he saw nearly attempting to cross a flooded roadway:

> And then finally he backed up and went back the way he came. But you could almost picture him looking at us on the other side thinking, "Hmm… if I try to cross this, I'm going to look like a complete idiot if I get washed downhill." So I think that there is a certain perception of, "is anybody going to see me if something doesn't go right?"

Rather than attributing the individual's decision to environmental cues or the presence of emergency vehicles on the opposite side of the low water crossing, his decision was entirely attributed to potential embarrassment in the event of an unsuccessful crossing.

Rescue costs also featured prominently in the focus group discussion, as most participants lamented the lack of enforcement of the "Stupid Motorist Law" despite numerous rescues of stranded or swept motorists since the law's inception in 1995. One participant suggested that

> …maybe the Stupid Motorist Law is poorly worded, and that maybe <u>anyone</u> who drives into <u>any</u> wash and gets swept gets cited… <u>and</u> hauled before the court on the

> nightly news with the orange jumpsuit to start creating the cognitive dissonance that's needed to change the behavior.

In other words, perhaps increasing the level of embarrassment and enforcing the rescue costs would reduce the number of attempted crossings. Whether these suggestions would actually reduce the number of attempted crossings is not clear, but it remains an interesting conjecture in light of the survey results that suggest that these factors currently do not strongly influence the respondents as much as other factors.

4. Discussion and Conclusions

The results of this study represent the attitudes and behaviors of a sample of Tucson residents. There are important demographic disparities between the U.S. Census 2000 data for Tucson and the older, more educated, predominantly White survey respondents. Future studies should address the causes of self-selection, particularly for mail-in survey participation, and should use a potential pool of respondents that is broader than the area residence directory. Although limited in its ability to generalize results to a wider population, this research illuminates methodological considerations for psychometric risk perception studies by demonstrating the importance of cultural influences on risk perception, and how their interconnectedness complexifies the relationships between social interactions, psychological processes, and behavior. The results of this study are therefore potentially useful for future studies and risk management outreach programs.

In general, non-crossers report higher trust than crossers in all of the flood information sources, although the results for the individual sources are significant for

only The Weather Channel and for city or county officials. Future studies should consider further exploration into why respondents indicated trust in the National Weather Service but no trust in the Weather Channel despite the fact that both disseminate similar information. Future studies should also clearly differentiate between officials that are directly involved with flood-related activities, such as the Department of Transportation or the Regional Flood Control District, and those who are not, such as the mayor or city council. When the sources are aggregated into categories, the differences in levels of trust between crossers and non-crossers are significant for safety officers, community sources, and flood signs and barricades. Statistically significant differences between crossers and non-crossers do not exist for the National Weather Service or the media because respondents in both categories measured similar levels of trust.

The flood signs and barricades appear to deliver an ambiguous message to motorists regarding flash flood hazards. Respondents generally agreed that the flood signs indicate the likelihood of flood dangers in a particular section of roadway, but not the degree of danger. The fact that the signs remain in place when the roads are dry or when the flow is "a trickle" leaves the motorist to assess the hazard based on environmental cues, or perhaps the behavior of other motorists as mentioned before. However, as motorists become accustomed to the presence of signs at flood-prone intersections, the lack of a sign creates a false sense of security for those who trust the signs and will not cross when they are present.

Out of all the questions that addressed self-efficacy and social autonomy (SE/SA), only two showed significant differences between crossers and non-crossers. More

crossers than non-crossers feel that conditions outside of their control inhibit their ability to prepare for or avoid flash floods, and more crossers than non-crossers feel that they do not have access to information on flash floods any time they need it. These results suggest that individuals with low SE/SA and fatalistic beliefs will be more likely to drive into flooded roadways than those with high SE/SA, but the lack of significance among other related questions suggests that risk-taking behaviors associated with high SE/SA may be occurring as well. It is possible that the time perspective questions related to SE/SA did not show significant differences between crossers and non-crossers for this reason, although the lack of significance among all time perspective questions also suggests that this cultural factor may not be as important as previously proposed.

While no statistical differences exist between the crossers and non-crossers for the questions related to social incorporation, the results provide important information about how respondents use their social networks to exchange information about flash flood hazards. Three-quarters of the respondents seek advice or help from others during a flash flood, while just less than half discuss flood-related information in between flood events. These results possibly explain why a greater number of respondents agreed that they have access to flash flood information during events than agreed that they have access any time they need it. While it is likely that more information is available and is easier to find during a flash flood, it is also likely that people more often seek flood information during events than in between them. However, it is important to note that while fewer respondents discuss flood-related information in between events than during events, the topic is being widely discussed. By including statements on whether they warn

newcomers to Tucson about the dangers of driving when it is raining or seek information about alternate routes, many of the respondents contribute to an overall picture of how information about flood hazards is dispersed among social networks. All of the types of information mentioned by respondents amplify the risks associated with driving through flooded roadways, but the lack of explicit risk attenuation within these results does not imply that either explicit or implicit attenuation does not occur. Either way, it is important for risk managers to consider that in addition to their own messages, information about risks circulates among members of social networks and possibly affects how the risk mangers' messages are received and interpreted. Future research might benefit from combining questions of trust and social incorporation more explicitly to determine how information or beliefs about the sources of flood information spread through social networks.

As expected, more non-crossers than crossers reported that each of the specific situations presented would not influence their decision to drive through a flooded roadway, presumably because they would never attempt to do so in the first place. Crossers expressed more variation in whether the different situations had any influence on their crossing behavior. Crossers indicated some influence more often than no influence for most of the situational factors. Exceptions include the availability of a shorter route, the presence of passengers, and that conditions are getting worse, which suggests that these factors are less influential for the decision to cross a flooded roadway. However, each of the respondents who indicated in the free-response section that they had conferred with their passengers before crossing a flooded roadway had selected "no

influence" for both situations regarding the presence of passengers. This reveals that they do in fact consider the opinions of their passengers despite claiming that "peer pressure" did not influence them, suggesting that the "peer pressure" term itself has negative connotations with which they do not wish to identify. Future studies should take care to replace the term, because it is clear from the free-response sections that many of the respondents do in fact consider the opinions of their passengers or others.

Based on the survey results, the factor that appears to provide the most influence to cross a flooded roadway is the successful prior crossing of other vehicles. For this factor alone, more non-crossers reported some influence than no influence, and the majority of all respondents indicated that this would have some influence on their decision to cross a flooded roadway. Many respondents specifically mentioned that they would be more likely to do so if their own vehicle is larger, heavier, has a higher clearance, or has four-wheel drive. However, some respondents said that they would cross in a larger vehicle such as a truck or SUV whether or not others were attempting to cross. These statements are consistent with the findings that the majority of respondents who drive larger vehicles such as trucks and SUVs identified as crossers.

Of the factors that influence respondents not to cross flooded roadways, the only ones that demonstrate significant difference between crossers and non-crossers are the presence of a barricade or sign, the presence of passengers, and the risk of citation, each influencing the non-crossers more than the crossers. For all respondents in general, the factors with the strongest influence not to cross are the presence of signs or barricades, passengers, the risk of injury or death, the risk of damage to the vehicle, the risk of

citation, and knowing another route. The situational factors that appear to have a weaker influence include the presence of others outside of the car, embarrassment from being stuck or swept away, and not wanting or being able to pay for rescue. These results contradict the predictions of the flood risk managers, who suggested that embarrassment and not wanting to pay for rescue would have a strong influence on an individual's decision not to cross a flooded roadway. One of the flood risk managers suggested that an increase in citation enforcement and embarrassment might influence more motorists to avoid crossing flooded roadways, but whether these factors would continue to have lower influence or would increase in influence with these measures is not clear.

It is possible that increasing the level of stigma associated with driving through flooded roadways would reduce the number of motorists who get stranded or swept away, but this measure might decrease the willingness of individuals to participate in future studies and increase the level of self-enhancement at the expense of honesty. Evidence of the effects of stigma appears within the responses in this study despite efforts to reduce these effects. Many respondents referred to the "Stupid Motorist Law" by its popular name and indicated that they would never do anything so "fool-hardy" as to drive through flooded roadways. While these statements do not automatically imply that respondents provided deceptive answers, they demonstrate that this behavior remains stigmatized despite the methodological precautions. The fact that several respondents identified themselves as non-crossers but then proceeded to describe a situation in which they had crossed a flooded roadway seems to support the suspicion that self-enhancement occurred

among respondents. Whether the response rate was affected by stigma also cannot be determined, but remains a possibility.

This research demonstrates the complexities and interrelations among cultural factors thought to influence risk perception and the challenges they present for psychometric risk perception studies. This approach allows flood risk managers to discover the complex, dynamic social context within which their messages are heard and interpreted, and demonstrates the potential for multiple rationalities. The substantive results reflect the risk perception behavior of a sample of Tucson residents that is not fully representative of the city's demographics. Nevertheless, the combination of quantitative and qualitative survey responses illuminate important issues that future researchers should consider in order to better understand the ways in which culture, psychological processes, and behavior influence one another in risk-related scenarios.

5. References

Arizona Revised Statutes (2006). Liability for emergency responses in flood areas. Title 28, Article 10, Section 910. Retrieved December 9, 2006 from http://www.azleg.state.az.us/ArizonaRevisedStatutes.asp

Ashley, S.T., and Ashley, W.S. (2008). Flood fatalities in the United States. *Journal of Applied Meteorology and Climatology*, 47, 805-818.

Bandura, A. (1997). *Self-efficacy: The Exercise of Control*. New York: Freeman

Brilly, M. & Polic, M. (2005). Public perception of flood risks, flood forecasting and mitigation. *Natural Hazards and Earth System Sciences, 5,* 345-355.

Buckingham, A. & Saunders, P. (2004). *The Survey Methods Workbook: From Design to Analysis*. Cambridge: Polity Press.

Byrnes, J.P., Miller, D.C., and Schafer, W.D. (1999). Gender differences in risk taking: A meta-analysis. *Psychological Bulletin*, 125, 367-383.

Douglas, M. (1992). *Risk and Blame: Essays in Cultural Theory*. New York: Routledge.

Dow, K. & Cutter, S.L. (2000). Public orders and personal opinions: Household strategies for hurricane risk assessment. *Environmental Hazards, 2,* 143-155.

Drobot, S.D., Benight, C., and Gruntfest, E.C. (2007). Risk factors for driving into flooded roads. *Environmental Hazards*, 7, 227-234.

Earle, T.C. & Cvetkovich, G.T. (1995). *Social Trust: Toward a Cosmopolitan Society*. Westport: Praeger.

Fiske, A. P., Kitayama, S., Markus, H. R., & Nisbett, R. E. (1998). The cultural matrix of social psychology. In D.T. Gilbert, S.T. Fiske, & G. Lindzey (Eds.), *Handbook of Social Psychology* (pp. 915-930). New York: McGraw-Hill.

Frewer, L. (2004). The public and effective risk communication. *Toxicology Letters, 149*, 391-397.

Handmer, J. (2001). "Improving flood warnings in Europe: a research and policy agenda." Environmental Hazards **3**: 19-28.

Iarossi, G. (2006). *The Power of Survey Design*. Washington, D.C.: The World Bank.

Inelmen, K., Say, A.I., & Kabasakal, H. (2004). Participation lethargy in disaster preparedness organization within the framework of a Turkish CBO. *International Journal of Sociology and Social Policy, 24(10),* 130-158.

Jasanoff, S. (1998). The political science of risk perception. *Reliability Engineering and System Safety, 59*, 91-99.

Kasperson, R.E. (1992). The social amplification of risk: Progress in developing an integrative framework. In S. Krimsky & D. Golding (Eds.), *Social Theories of Risk*. Westport: Praeger Publishers.

Kasperson, J.X. & Kasperson, R.E. (2005). *The Social Contours of Risk Volume I: Publics, Risk Communication and the Social Amplification of Risk.* London: Earthscan.

Kitayama, S. & Markus, H.R. (1995). Culture and the self: Implications for internationalizing psychology. In N.R. Goldberger & J.B. Veroff (Eds.), *The culture and psychology reader* (pp. 366-385). New York: New York University Press.

Lang, J.T. & Hallman, W.K. (2005). Who does the public trust? The case of genetically modified food in the United States. *Risk Analysis, 25(5),* 1241-1252.

Markus, H.R., Mullally, P.R., & Kitayama, S. (1997). Selfways: Diversity in modes of cultural participation. In U. Neisser & D. Jopling (Eds.), *The conceptual self in context: Culture, experience, self-understanding* (pp. 13-26). New York: Cambridge University Press.

Markus, H.R., Steele, C.M., & Steele, D.M. (2000). Colorblindness as a barrier to inclusion: Assimilation and nonimmigrant minorities. *Daedalus, 129(4),* 233-257.

Masuda, J. R. & Garvin, T. (2006). Place, Culture, and the Social Amplification of Risk. *Risk Analysis, 26(2)*, 437-454.

McGee, T. K. & Russell, S. (2003). "It's just a natural way of life..." an investigation of wildfire preparedness in rural Australia. *Environmental Hazards, 5,* 1-12.

McGuirk, P.M., & O'Neill, P. (2005). Using questionnaires in qualitative human geography. In I. Hay (Ed.), *Qualitative Research Methods in Human Geography* (2nd ed., pp. 147-162). Oxford: Oxford University Press.

Mileti, D. S. (1995). *Factors related to flood warning response*. US-Italy Research Workshop on the Hydrometeorology, Impacts, and Management of Extreme Floods. Perugia, Italy.

Morris-Oswald, T. and A. J. Sinclair (2005). "Values and floodplain management: Case studies from the Red River Basin, Canada." Environmental Hazards **6**: 9-22.

National Weather Service, (2008a). Weather Fatalities. http://www.weather.gov/os/hazstats.shtml (accessed 7 April, 2008).

National Weather Service, (2008b). Turn Around, Don't Drown. http://www.weather.gov/os/water/tadd/ (accessed 9 April, 2008)

Parker, D. J. and J. W. Handmer (1998). "The role of unofficial flood warning systems." Journal of Contingencies and Crisis Management **6**(1): 45-60.

Paton, D. & Johnston, D. (2001). Disasters and communities: vulnerability, resilience and preparedness. *Disaster Prevention and Management, 10(4),* 270-277.

Ronay, R. and Kim, D. (1996). Gender differences in explicit and implicit risk attitudes: A socially facilitated phenomenon. *British Journal of Social Psychology*, 45, 397-419.

Sáenz Segreda, L. (2003). Psychological interventions in disaster situations. In J. Zschau & A. Küppers (Eds.), *Early Warning Systems for Natural Disaster Reduction* (pp. 119-124). Berlin: Springer-Verlag.

Savadori, L., Savio, S., Nicotra, E., Rumiati, R., Finucane, M., & Slovic, P. (2004). Expert and public perception of risk from biotechnology. *Risk Analysis, 24(5),* 1289-1299.

Scherer, C. W. & Cho, H. (2003). A social network contagion theory of risk perception. *Risk Analysis, 23(2),* 261-267.

Scholz, U., Doña, B.G., Sud, S., and Schwarzer, R. (2002). Is General Self-Efficacy a universal construct? Psychometric findings from 25 countries. *European Journal of Psychological Assessment*, 18(3), 242-251.

Shweder, R. (1995). Cultural psychology: What is it? In N.R. Goldberger and J.B. Veroff (Eds.), *The Culture and Psychology Reader* (pp. 41-86). New York: New York University Press.

Siegrist, M. & Cvetkovich, G. (2000). Perception of hazards: The role of social trust and knowledge. *Risk Analysis, 20(5)*, 713-719.

Slovic, P. (1999). Trust, emotion, sex, politics, and science: Surveying the risk-assessment battlefield. *Risk Analysis, 19(4)*, 689-701.

Slovic, P. (2000). *The Perception of Risk*. London: Earthscan Publications, Ltd.

Tucson Department of Transportation (2008). Operation Splash: When in doubt, change your route! Or wait it out! http://www.dot.ci.tucson.az.us/hottopics/downloads/OperationSplash.pdf (accessed 9 April, 2008)

Tobin, G.A., & Montz, B.E. (1997). *Natural Hazards: Explanation and Integration*. New York: The Guilford Press.

U.S. Census Bureau, 2000. http://quickfacts.census.gov/qfd/states/04/0477000.html Accessed 3 April 2008

Wisner, B., Blaikie, P., Cannon, T., & Davis, I. (2004). *At Risk: Natural Hazards, People's Vulnerability and Disasters*. New York: Routledge.

Zimbardo, P.G. and Boyd, J.N. (1999). Putting time in perspective: A valid, reliable individual-differences metric. *Journal of Personality and Social Psychology*, 77(6), 1271-1288.

APPENDIX B: TABLES AND FIGURES

TABLES

Education level	Non-crossers		Crossers	
	N	%	N	%
Junior high school	0	0	0	0
Some high school	1	2	0	0
High school graduate/GED	6	10	5	5
Some college	19	30	28	29
4-year or baccalaureate degree	20	32	20	21
Graduate school or further	16	25	44	45
No response	1	2	0	0
Total	63	100	97	100

Table 1: Crossing behavior by education level

This table shows the highest education level attained by respondents as a percentage of crossers and non-crossers.

Vehicle type	Non-crossers		Crossers		p		
	N	%	N	%	χ^2	Fisher 2s	Fisher 1s
Car	53	43	69	57	.06*	.09*	.04*
SUV	8	27	22	73	.11	.15	.08*
Truck	6	16	30	84	.00*	.00*	.00*
Motorcycle/Scooter	1	50	1	50	.76	1.00	.63
Bus	3	50	3	50	.59	.68	.44
Bicycle	4	25	12	75	.21	.28	.17
Walk	9	47	10	53	.45	.46	.30
Other	1	33	2	67			

Table 2: Crossing behavior by vehicle type

This table shows the percentage of crossers and of non-crossers who reported using each vehicle type. The p values for each of the tests for significance are also shown. An asterisk (*) indicates statistical significance at level $p \leq .10$.

Source	Non-crossers (%)			Crossers (%)			p
	Trust	Do not trust	Neutral/ Do not use	Trust	Do not trust	Neutral/ Do not use	
Local television news channel	79	2	17	76	3	18	.83
Local radio station	46	3	40	52	6	35	.58
The Weather Channel	59	3	37	41	24	44	.08*
National Weather Service general information	68	2	29	66	4	26	.64
National Weather Service flash flood warnings	75	0	22	71	3	24	.36
Environmental cues (heavy rainfall, water on street)	87	0	11	89	0	8	.56
NOAA Weather Radio	24	2	68	24	1	68	.95
"Flood Area" barricades	90	3	5	79	8	9	.21
"Dip: Do not enter when flooded" signs	79	3	14	73	9	14	.32
Neighbors, friends, or family	60	3	33	56	10	31	.25
City or county officials	71	5	21	54	8	34	.08*
Police officers	92	0	6	82	6	8	.11
Firefighters	94	0	5	89	4	4	.26
Emergency responders	84	0	13	82	4	8	.19

Table 3: Crossing behavior by trust in individual sources

This table shows the level of trust in the individual flood information sources reported as a percentage of non-crossers and of crossers. The p values for the Pearson χ^2 tests for significance are also included. An asterisk (*) indicates statistical significance at level $p \leq .10$.

Factors		Ranks			Test Statistics		
		N	Mean Rank	Sum of Ranks	Mann-Whitney U	Z	p
Safety officers Police officers Firefighters Emergency responders	Non-crossers	62	88.35	5478	2303	-2.43	.02*
	Crossers	94	72	6768			
	Total	156					
National Weather Service General information Flash flood warnings NOAA Weather Radio	Non-crossers	61	82.80	5051	2635	-0.97	.33
	Crossers	95	75.74	7195			
	Total	156					
Community Neighbors, friends, family City or county officials	Non-crossers	60	85.31	5118.50	2291.5	-1.90	.06*
	Crossers	93	71.64	6662.50			
	Total	153					
Flood signs "Flood Area" barricades "Dip" signs	Non-crossers	62	91.69	5685	2096	-3.12	.00*
	Crossers	94	69.80	6561			
	Total	156					
Media Local television news Local radio station The Weather Channel	Non-crossers	62	84.57	5243.5	2537.5	-1.39	.17
	Crossers	94	74.49	7002.5			
	Total	156					

Table 4: Crossing behavior by trust in multiple sources

This table shows the level of trust in the flood information sources grouped in the factor analysis, reported as a percentage of non-crossers and of crossers. The statistics for the Mann-Whitney U tests for significance are also included. An asterisk (*) indicates statistical significance at level $p \leq .10$.

Self-Efficacy/Social Autonomy Questions	Non-Crossers			Crossers			p
	A	D	N	A	D	N	
I can handle whatever comes my way. (GSES)	71	13	14	68	12	19	.79
I can remain calm when facing difficult situations because I can rely on my coping skills. (GSES)	81	10	8	73	7	19	.17
I am confident that I can handle unforeseen situations. (GSES)	79	6	13	70	6	23	.24
I rely on the advice of others to make difficult decisions. (Original)	25	46	27	23	37	40	.25
I can easily get food, water, and other supplies if there is an emergency. (Original)	62	10	27	52	20	29	.20
I consider myself a good judge of whether flood waters are dangerous. (TWP)	71	19	10	69	14	17	.39
I have access to information about flash floods any time I need it. (Original)	50	33	16	34	37	29	.06*
I have access to information and instructions when a flash flood is occurring in my area. (Original)	65	19	16	51	21	29	.12
My ability to prepare for or avoid flash floods is limited by conditions outside of my control. (Original)	6	75	19	18	62	21	.10*

Table 5: Crossing behavior by self-efficacy and social autonomy

Respondents were asked to indicate their level of agreement with each of the statements. In this table, A indicates a response of "Strongly agree" or "Agree," D indicates a response of "Strongly disagree" or "Disagree," and N indicates a response of "Neutral." Each value is expressed as a percentage of crossers and non-crossers. The p values for the Pearson χ^2 tests for significance are also included. An asterisk (*) indicates statistical significance at level $p \leq .10$.

Situational Factors	Non-crossers (%)		Crossers (%)		p
	None	Some	None	Some	
Late for an appointment or in a hurry	70	29	40	58	.00*
Shorter than another possible route	76	19	59	39	.01*
Family on the other side	63	33	33	66	.00*
Family in the car with you (peer pressure)	78	19	65	33	.06*
Friends in the car with you (peer pressure)	78	19	67	31	.10*
Don't know another possible route	63	33	35	62	.00*
Road surface is paved (as opposed to a dirt road)	78	19	42	56	.00*
It doesn't look that deep	60	37	33	64	.00*
Car ahead of me made it through	37	60	11	87	.00*
Presence of other people outside of the car (other cars, bystanders)	67	27	44	53	.00*
Conditions are getting worse (still raining, water is rising)	75	22	48	47	.00*

Table 6: Crossing behavior by influence to cross

This table shows the level of influence that each situational factor has on the respondents' decision to drive through a flooded roadway, expressed as a percentage of crossers and of non-crossers. The "None" category refers to a response of "No influence," while the "Some" category refers to a response of "Slight influence," "Moderate influence," or "Strong influence." The p values for the Pearson χ^2 tests for significance are also included. An asterisk (*) indicates statistical significance at level $p \leq .10$.

Situational Factors	Non-crossers (%)				Crossers (%)				p
	No	Slight	Mod.	Strong	No	Slight	Mod.	Strong	
Presence of a barricade or sign	5	3	6	84	0	5	20	73	.02*
Family in the car with you (protection)	6	2	8	81	9	7	21	61	.02*
Friends in the car with you (protection)	6	5	5	81	8	10	23	57	.00*
Presence of other people outside of the car (other cars, bystanders)	24	14	21	38	30	16	26	25	.34
Dangerous (risk injury or death)	3	0	3	92	0	1	8	88	.20
Might damage or destroy the car	6	6	10	76	1	8	12	75	.36
Against the law	5	0	11	81	6	10	20	60	.02*
Would be embarrassed if I got stuck or swept away	22	8	13	56	22	9	18	49	.82
Can't or don't want to pay to be rescued	25	8	10	54	22	7	15	54	.73
Know another possible route	8	8	8	71	5	6	20	67	.24

Table 7: Crossing behavior by situational influence not to cross

This table shows the level of influence that each situational factor has on the respondents' decision not to drive through a flooded roadway, expressed as a percentage of crossers and of non-crossers. The answer choices include "No influence," "Slight influence," "Moderate influence," or "Strong influence." The p values for the Pearson χ^2 tests for significance are also included. An asterisk (*) indicates statistical significance at level $p \leq .10$.

FIGURES

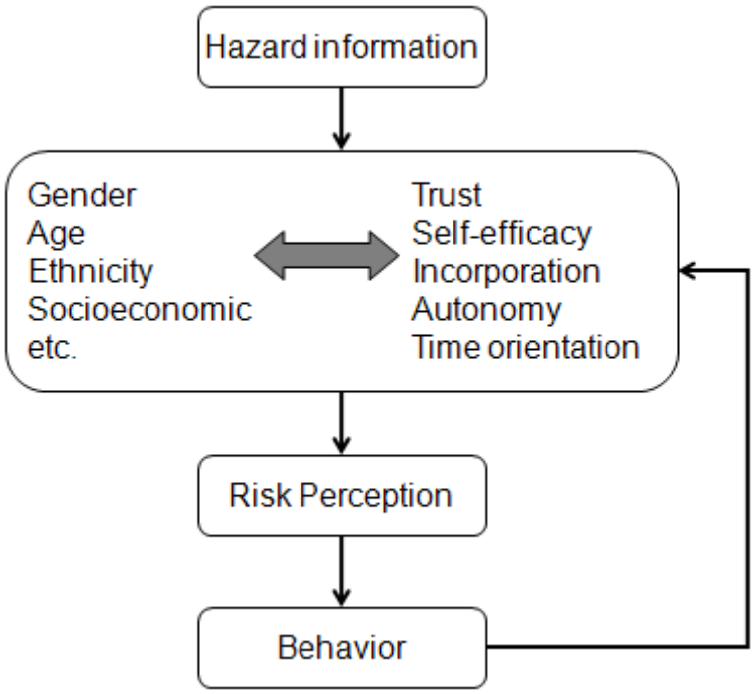

Figure 1: Conceptual model

An individual living within a particular cultural context receives a message regarding hazard information, whether this message comes from a warning agency, friends, or environmental cues. This message is interpreted through the individual's values and beliefs systems, which influence the level of risk perceived and thus the behavior that the individual takes. This behavior then contributes to the cultural context by providing an example of how or how not to behave.

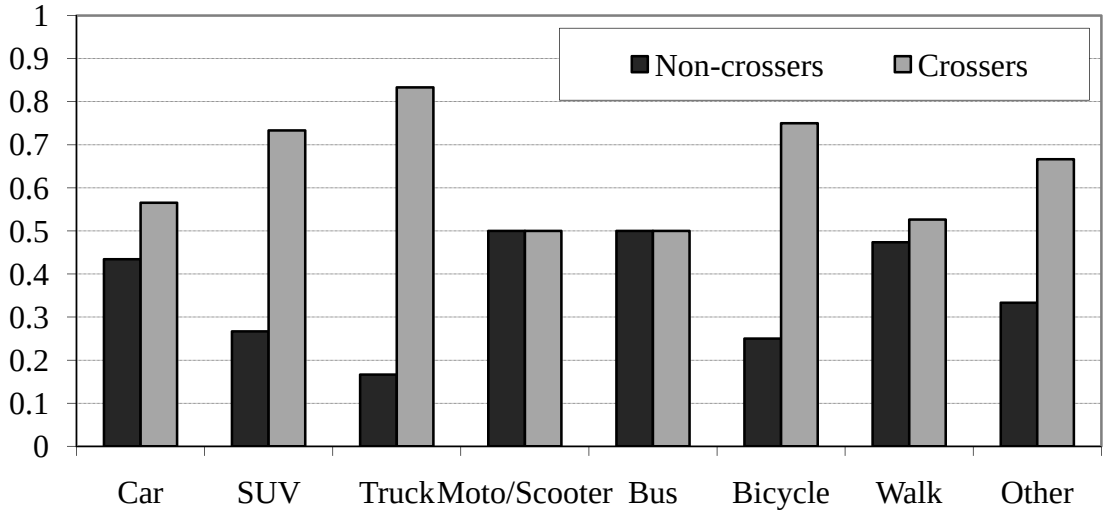

Figure 2: Crossing behavior by vehicle type

The graph shows the proportion (1.00 = 100%) of crossers and non-crossers for each type of vehicle. The total number of respondents for each type of vehicle was: Cars (N= 122), SUV (N = 30), Truck (N = 36), Motorcycle or scooter (N = 2), Bicycle (N = 16), Walk (N = 19), Other (N = 3).

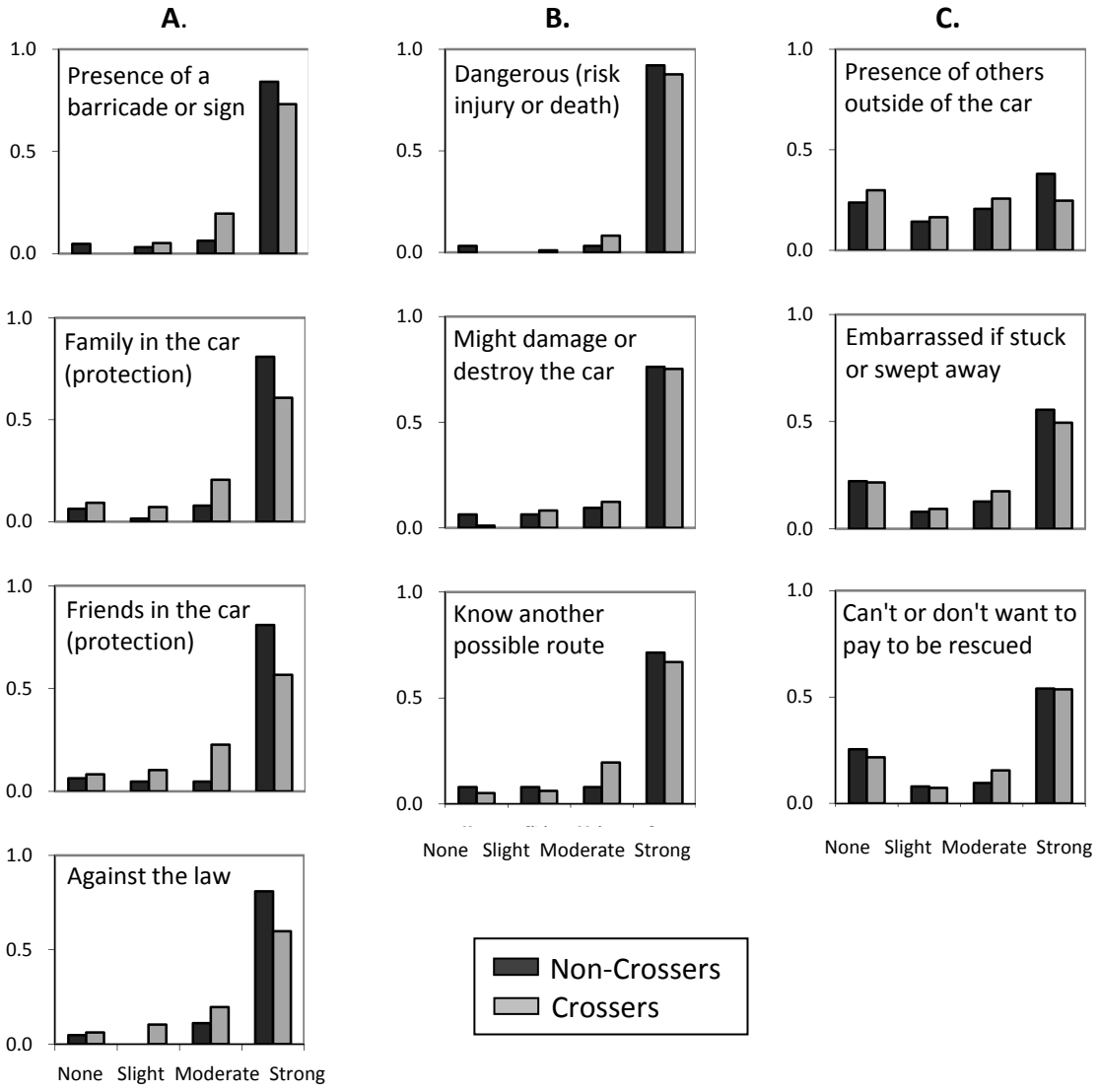

Figure 3: Situational influences and crossing behavior

The graphs display the varying influence of ten different situations by indicating the proportion (1.0 = 100%) of non-crossers and crossers who rated each situation as having no, slight, moderate, or strong influence on their decision not to cross flooded roadways. Column A contains the situational factors that have a strong influence on respondents' decisions not to cross and which showed significant statistical differences between crossers and non-crossers. Column B contains the situational factors that have a strong influence on respondents' decisions not to cross, but which showed no significant statistical differences between crossers and non-crossers. Column C contains those situational factors that appear to have a weaker influence on respondents' decisions not to cross and which do not distinguish between crossers and non-crossers.

APPENDIX C: SURVEY

This appendix contains the English version of the survey that was mailed to Tucson residents. The formatting and page layout have not been reproduced below, but the directions and questions have been reproduced verbatim.

Section A: Your general attitudes

In this section, we would like to learn about some of your general attitudes. For each of the statements below, please indicate whether you agree or disagree with each of the statements by marking the appropriate box with a [√] or [X]**.** (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree).

1. I can handle whatever comes my way.

2. I can remain calm when facing difficult situations because I can rely on my coping skills.

3. I am confident that I can handle unforeseen situations.

4. I often think of what I should have done differently in my life.

5. My decisions are mostly influenced by the people and things around me.

6. I rely on the advice of others to make difficult decisions.

7. I like to think about my past.

8. If things don't get done on time, I don't worry about it.

9. If I take a risk and something bad happens, I usually avoid that risk afterwards.

10. If other people take a risk and something bad happens, I usually avoid that risk afterwards.

11. If I take a risk and nothing bad happens, I am more likely to take the same risk in the future.

12. Meeting tomorrow's deadlines and doing other necessary work comes before having fun tonight.

13. I can easily get food, water, and other supplies if there is an emergency.

14. I worry about taking care of important needs in the present more than planning for the future.

15. It upsets me to be late for appointments.

16. I make decisions on the spur of the moment.

17. I take each day as it is rather than try to plan it out.

18. It is important to have excitement in my life.

19. I feel that it's more important to enjoy what you're doing than to get work done on time.

20. Before making a decision, I weigh the costs against the benefits.

21. Even when I am enjoying the present, I am drawn back to comparisons with similar past experiences.

22. My life path is controlled by forces I cannot influence.

23. It doesn't make sense to worry about the future, since there is nothing that I can do about it anyway.

24. I make lists of things to do.

25. I often think about the bad things that have happened to me in the past.

26. Spending money on leisure today is better than saving for tomorrow.

27. Taking risks keeps my life from becoming boring.

28. I consider myself a good judge of whether flood waters on a roadway are dangerous.

29. I have access to information about flash floods any time I need it.

30. I have access to information and instructions when a flash flood is occurring in my area.

31. My ability to prepare for or avoid flash floods is limited by conditions outside of my control.

Section B: Information and warnings about flash floods

We would like to know what you think about the information and warnings you receive about flash floods, as well as the sources of information.

32. Of the following possible flash flood information sources, please indicate how much you trust each source to provide accurate information about flash flood hazards. (1 = do not trust at all, 2 = mostly do not trust, 3 = neutral, 4 = mostly trust, 5 = completely trust, N/A = not applicable or do not use)

    a. Local television news channel
       Which one(s)?
    b. Local radio station
       Which one(s)?
    c. The Weather Channel
    d. National Weather Service general flood information
    e. National Weather Service flash flood warnings
    f. Environmental cues (heavy rainfall, water on street)
    g. NOAA Weather Radio*
    h. "Flood area" barricades
    i. "Dip: Do not enter when flooded" signs
    j. Neighbors, friends, or family
    k. City or county officials
    l. Police officers
    m. Firefighters
    n. Emergency responders
    o. Other(s)

33. Which of the sources mentioned above do you use MOST to find information about flash floods? Please list them in order of most to least importance to you.

34. Out of all of the people you know, how many of them would you go to for advice or help during a flash flood?
    Who? (Instead of names, please list relations such as "brother" or "neighbor.")

35. Out of all of the people you know, how many of them do you discuss flood-related information with when it is NOT currently flooding?
    Who? (Instead of names, please list relations such as "brother" or "neighbor.")

* NOAA is the National Oceanic and Atmospheric Administration. NOAA Weather Radio is an inexpensive radio that broadcasts National Weather Service forecasts, observations, warnings, and other hazard information 24 hours a day. This definition was provided as a footnote in the survey questionnaire.

(For the following, 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree.)

36. Scientists understand what causes flash floods.

37. Scientists understand how flash floods behave.

38. The presence of a sign or barricade indicates the <u>likelihood</u> of flash flood dangers in that particular section of the roadway.

39. The presence of a flood sign or barricade indicates the <u>degree</u> of flash flood dangers in that particular section of the roadway.

<u>Section C: Flash flood experiences</u>

This section asks questions about your previous experiences with flash floods, your typical experiences, and hypothetical future experiences. Please answer all questions as honestly as possible.

40. How long have you lived in Tucson? _____ Years / Months (please circle one)

41. There are many reasons why a person might decide to drive through a flooded roadway (NOTE: Refer to the top of page one for a reminder of the definition of flooded roadway). How much influence would the following factors have on your decision to drive through a flooded roadway? <u>If the factor does not influence your decision at all, please select "0."</u> (0 = no influence at all, 1 = slight influence to cross, 2 = moderate influence to cross, 3 = strong influence to cross)

    a. Late for an appointment or in a hurry
    b. Shorter than another possible route
    c. Family on the other side
    d. Family in the car with you (peer pressure)
    e. Friends in the car with you (peer pressure)
    f. Don't know another possible route
    g. Road surface is paved (as opposed to a dirt road)
    h. It doesn't look that deep
    i. Car ahead of me made it through
    j. Presence of other people outside of the car (other cars, bystanders)
    k. Conditions are getting worse (still raining, water is rising)
    l. Other(s) _____

42. You might also decide NOT to drive through. How much influence would the following factors have on your decision NOT to drive through a flooded roadway? If the factor does not influence your decision at all, please select "0." (0 = no influence at all, 1 = slight influence NOT to cross, 2 = moderate influence NOT to cross, 3 = strong influence NOT to cross)

    m. Presence of a barricade or sign
    n. Family in the car with you (protection)
    o. Friends in the car with you (protection)
    p. Presence of other people outside of the car (other cars, bystanders)
    q. Dangerous (risk injury or death)
    r. Might damage or destroy the car
    s. Against the law
    t. Would be embarrassed if I got stuck or swept away
    u. Can't or don't want to pay to be rescued
    v. Know another possible route
    w. Other(s) _____

44. Have you ever driven through a flooded roadway?
    [ ] Yes [ ] No

    If yes, please proceed with Question 45.
    If no, you may skip to Question 47. If you have crossed a flooded roadway on foot, bicycle, or any other method, feel free to answer Questions 45 and 46, but please specify what form of transportation you were using.

45. It is possible that you have driven through flooded roadways many times. Think about a particular time when the decision to cross was very difficult, and please answer the questions below about this experience.

    a. How many years ago?
    b. What was your destination?
    c. Did you succeed in getting across? [ ] Yes [ ] No
    If not,
    d. Did you abandon your vehicle? [ ] Yes [ ] No
    e. Were you rescued? [ ] Yes [ ] No
    f. Which location?

46. Can you please describe the situation in which you found yourself, your thoughts at the time, and the factors that led to your decision to drive through the flooded roadway? Please consider the factors mentioned in Question 42 above, as well as any others that may have made a difference. (Feel free to describe your typical behavior instead of or in addition to this particular case, but please specify which you are describing.)

47. Have you ever considered driving through a flooded roadway, and then decided not to?
[ ] Yes [ ] No

If yes, why did you decide not to cross?

Section D: Demographic information

48. Age:

49. Ethnic identity (Please choose all that apply):
[ ] Hispanic or Latino/Latina
[ ] African American
[ ] American Indian or Alaskan Native
[ ] Asian/Asian American/Other Pacific Islander
[ ] White
[ ] Other (please describe)

50. Gender: [ ] Male [ ] Female

51. Highest level of education completed?
[ ] Junior high school
[ ] Some high school
[ ] High school graduate/GED
[ ] Some college
[ ] 4-year or baccalaureate degree
[ ] Graduate school or further

52. Total household income expected this year:
[ ] Less than $14,999
[ ] $15,000 - $24,999
[ ] $25,000 - $49,999
[ ] $50,000 - $74,999
[ ] $75,000 - $99,999
[ ] More than $100,000

53. The language spoken most often in my home is:

54. Other languages spoken in my home:

55. Number of dependents who live in my home (children, adults with special needs):

56. I usually get around the city by (please choose all that you frequently use):
[ ] Car
[ ] Sport Utility Vehicle (SUV)
[ ] Truck
[ ] Motorcycle/Scooter
[ ] Bus
[ ] Bicycle
[ ] Walking
[ ] Other