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Efficient and Effective? The Hundred Year Flood in the Communication and Perception of Flood Risk

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The Hundred Year Flood in the Communication and Perception of Flood Risk

by

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ABSTRACT

In response to the rising costs of floods, the United States has adopted sophisticated programs to mitigate the loss of life and property. However, the efficient implementation of certain aspects of flood policy has taken precedence over effective communication. The scope of the National Flood Insurance Program and the efficient coding of “the 100 year flood” have led to a pervasive use of the term in both formal and informal risk communication. When officials began consciously communicating flood policy to the public, they assumed a narrow “engineering” model and did not fully anticipate the influence of informal communication on the perception of flood risk. The effectiveness of the “100 year flood” as a means to change attitudes or motivate behaviors was not assessed. Nor was its utility in increasing public understanding of flood risk.

New explanatory methods have been introduced, but they, too, have yet to be tested. This project evaluated the effectiveness of four methods commonly used to communicate the risk associated with policy’s benchmark flood. These include: a 100 year flood; a flood with a 1 percent chance of occurring in any year; a flood with a 26 percent chance of occurring in 30 years; and a flood risk map available through Project Impact.

Data were collected using a structured face to face questionnaire survey of residents living in Wimberley, Texas. Respondents included individuals who lived inside the boundaries of official flood plains, as well as those who did not. Comparable questions regarding uncertainty, perceived need for protection, and levels of concern were asked using each of the four methods of description. Qualitative observations were made during both the interviews and the collection of secondary data.

Results showed a significant disjuncture of understanding and persuasion with each method; potentially serious problems with the 26 percent chance method; and a preference for concrete references in describing risk. It recommended that use of the 26 percent chance method be discontinued. Both the 100 year flood and the map performed better than expected; these descriptions are recommended with reservations in lieu of more contextually appropriate methods of communication and policy formation.

Chapter One: Theoretical Context

Introduction

“Effective communication requires the sharing of either abstract codes or contexts between sender and receiver” (Boisot, 1995, 93).

Information is required in order for individuals and societies to function; communication is a means of exchanging information. In order to move information from one conceptual or physical space to another, some form of contact is required between the parties involved. Contact may take the form of a verbal or visual code, a shared context, or both, but does not guarantee the successful transmission of an intended message. When neither codes nor contexts overlap, communication is both inefficient and ineffective.

The assumption of shared codes and context throughout social and spatial categories can be problematic. Establishing actual shared codes and contexts, or learning ways to communicate through the differences is difficult, but necessary for meaningful communication. Without this effort, real debate and understanding are impossible. Any exchange becomes a frustrating power play where all parties feel ill used as they talk (or yell) past one another.

The problems of communication in general are amplified in risk communication, where the stakes may be higher. A lack of shared context or code can mean that both lives and substantial amounts of money are lost as stakeholders run round different problems while assuming everybody is addressing the same issue. When these assumptions are enshrined in risk policy, mistrust, anger, lawsuits, death, financial loss, panic, or overconfidence may result. In the formation and communication of risk policy, effectiveness is often traded for efficiency, though communication will be neither effective nor efficient if codification is not shared with those the policy affects.

This problem is especially evident in the official approach to flood risk communication. The “100-year flood” has become the cornerstone of government flood policy and communication. The words are simple, but what they codify is not. They are shorthand for a probability concept familiar to scientists, but less familiar to lay folk. Explanations of the term often do not clearly address the element of chance or uncertainty, though it is exactly these elements of science that the 100-year flood represents. I believe the ubiquitous use of the 100-year flood to be a privileging of efficiency over effectiveness in both risk policy and risk communication. The prioritization of efficiency may encourage misunderstanding and overconfidence and could contribute to both death and financial loss. Might there a better way?

This project examines the public perception of the 100 year flood and evaluates the effectiveness of this term and three other methods commonly used to describe policy’s benchmark flood. These methods include “a flood with a 1 percent chance of occurring in any year”, “a flood with a 26 percent chance of occurring in 30 years”, and a flood risk map. The project also attempts to identify alternative, and potentially more effective, methods of communicating flood risk.

In order to make a meaningful assessment, it is necessary to look at relevant concepts of communication. These include the ideas of codification and context mentioned above, as well as those of efficiency and effectiveness. These general concepts must in turn be related to risk communication, risk perception, and uncertainty. Then we might be able to understand, evaluate, and perhaps alter, the pervasive use of the 100-year flood in regulation and communication.

Coding and Context

We are constantly bombarded by information. Our brains cannot handle the infinite individual data coming through our ears, tongue, eyes, nose, and skin simultaneously. Our processor is not fast enough. Coding is a coping mechanism that prevents information overload by categorizing incoming data. It is an organizational method that allows us to pick out relevant information, lump it together, and put it into boxes which take up less cognitive space and time. Instead of recognizing and processing each component of a specific road individually, the combined perception of black, yellow, and white, patterned by cracks and the smell of tar is collapsed into a single package named “4th Street” and stored away. Coding “economizes on the quantity of *data* to be processed" (Boisot, 1995, 57). The goal of coding is efficiency of both thought and communication. Abstraction performs a similar economizing role through the further lumping of conceptual categories.

While coding is an individual coping mechanism, social codification is also possible. Language is a form of social codification, but it is not the only form of codification used to communicate. Body language, facial expressions, gestures, color, and form are all used to communicate in social contexts. Contexts differ, however, and codification may change with them. A light touch on the arm means very different things in different situations.

Apparent similarity in social codification (i.e. language) may lead to severe misunderstandings if differences in contexts are not recognized. Context refers to general physical, political, economic, social, and cultural structures, as well as individual and familial situatedness within those structures over time and space. What is actually packed into the efficient, economizing package of phrase or gesture depends on the contextual history of the individuals and groups using it, as well as the situation at hand. One who does not share a context with another, or does not recognize a valid difference in contexts, does not have immediate access to the same package. The content is different, though the wrapping looks the same. Can the word "money" possibly mean the same thing to one who's never had it and one who's never been without? Codification always occurs within a context. We can learn the surficial code; it is harder to get at the underlying context.

Because codification occurs in context and economizes data, existing methods of categorization tend to be reinforced, and new information may be overlooked. Creating new categories takes time and energy. Efficient coding

> "tends to give an existing repertoire of complexions a life of its own. With repeated use, it acquires inertia and becomes in consequence hard to modify or replace. New stimuli are then filtered through an already established perceptual structure according to assignment rules set by existing codes. Where stimuli herald the emergence of new and complex phenomena, calling perhaps for a fresh coding effort, they may not even be detected … , let alone responded to" (Boisot, 1995, 47).

In practice, this tendency makes codification potentially dangerous, though necessary. It is more efficient to ignore or transform other perspectives than to create new categories for conflicting information. Ignorance becomes a coping mechanism. It is unintentional; we do not even realize we might be missing something. Contexts are validated through codification, as are codification's specific packages. Shared contexts are less likely as time and distance increase. Differing contexts become harder to recognize and understand and shared social codifications are less likely to have the same content.

Efficiency and Effectiveness

"The first is concerned with economizing on means, the second with achieving ends" (Boisot, 1995, 118)

"In a communication model, the function of coding is to communicate effectively and efficiently" (Boisot, 1995, 42). What does it mean to communicate efficiently and effectively? Is it possible to do both? Boisot implies that it may be a difficult balancing act that involves trade-offs in modern communicative situations.

Shannon and Weaver (1949) identify three types of communication problems: technical; semantic; and pragmatic. Efficient communication deals, in part, with the first problem. How do you get the most transmission bang for your communicative buck? Efficient communication requires the quick, accurate transmission of a message with as little cost as possible. The idea is to pack as much you can into a bundle that does not weigh down the system or lose its parts on the way from source to receiver.

How do you do that? First, just as if you were mailing a package, you make it small, light, compact, and durable, easily bounced from place to place. You eliminate what data appear to be extraneous, lump the rest together, and tie them up with a single word, phrase, or gesture. You code them. Second, you make sure your methods of transmission do not rip, tear, snip, add to, significantly slow, or divert the package you sent. Increased efficiency and higher levels of codification become more important as distance and the number of receivers and transmitters increases.

Does the fact that your package gets to your intended receiver apparently unmolested mean that the communication is effective? No! Shannon and Weaver (1949) and Boisot (1995) closely relate communication's effectiveness to its success in influencing behavior in a manner desired by the sender. "A meaningful message in some way changes an individual's disposition to act" (Boisot, 1995, 107). Effective communication overcomes Shannon and Weaver's pragmatic problem. All effective communication is persuasive. The conceptualization of communication as purely persuasive is called a “dominance model” (McQuail and Windhal, 1981).

Efficiency has little to do with the receiver. It does not require either a shared code or a shared context. Effectiveness, on the other hand, is dependent, to some extent, on both. If the receiver has never seen the gesture or heard a word before, no persuasion will be possible. The communication will have neither relevance nor use to the receiver. There will be no category in which the information fits and it is unlikely that the incoming data will be coded by the receiver. The message may very well be ignored completely, and will obviously be ineffective.

A common code, such as shared language, is the first step in overcoming both semantic and pragmatic problems. The message will at least be recognizable and potentially relevant to the receiver. Boisot (1995) argues that selecting a suitable code addresses most of the semantic problems of communication. I would argue that a code’s suitability depends in large part on context.

A common code does nothing to guarantee a change in the likelihood of behavior. As noted previously, meaning changes with context. A sender can control the code used to package information, and to some extent the method of transmission. A sender has little to no control (other than the selection of an audience) over the coding processes of the receiver. The message may take on a life of its own in other contexts. The message might surficially mean the same thing, but not have the same contextual meaning.

The more highly coded and efficient a message is, the more data it loses and lumps, and the more easily a receiver attaches his or her own associations.

The source of information, particular words, or potential inferences may have symbolic meaning to a receiver unrecognized by the sender. Hovland (1948) has shown that symbols play key roles in a receiver's coding process. In a shared context, symbols and values are more likely to be similar and communication has a better chance of being effective. Behaviors are more predictable. Without immediate access to a shared context, effective communication takes much more effort. A shared context must instead be created physically, mentally, or affectively.

There are many who contest the equation of a communication act's effectiveness with its persuasiveness (F. Johnson, 1991; Ruckelshaus, 1983; Belsten, 1996; Trumbo, 2000; Parker, 2000; Kasemir, 2003). This sort of theory establishes a paradigm of manipulation, where the goal is invariably power over another. It encourages the view of communication as strictly one way and regulatory. By equating meaning with persuasion, communication possibilities are limited and understanding is undervalued. Persuasion continues, however, to be the practical, if not theoretical, model of much risk communication. Flood risk communication, in particular, follows the persuasive model.

Risk Communication

Components and Interpretations

"Just as they must understand the strengths and limitations of risk assessment, communicators must appreciate the wisdom and folly in public attitudes and perceptions" (Slovic, 1986, 184)

By Boisot's definition (1995) of effective communication, most risk communication has failed miserably. People often simply do not do what risk communicators and other authorities want them to. People do not wear their seat belts, do not take precautions against natural hazards, do not test for radon, and they continue to smoke. All of these behaviors are statistically risky and claim numerous lives and millions of dollars every year. Each risk is fairly easily mitigated. Quit smoking and wear your seat belt and you will (probably) live longer. Many of us do neither of these things, but we worry obsessively about nuclear power and plane crashes (Slovic, 1987). Statistically these risks claim fewer lives and cost less money. What's the big deal? Why don't people worry about what they 'should'? Why don't we do what is 'good' for us?!

Finding the answers to these questions involves untangling the threads of risk perception and risk communication. This is a difficult task, as they are two intimately related parts of an evolving whole. Their relationship is neither linear nor inclusive, but mutually affective. It is not possible to address one without also looking at the implications for the other. Let us begin with risk communication.

Risk communication as a field of study is relatively new. This is not to say that no one conveyed risk information prior to the 1980's, but that academic interest in the communication of risk increased at this time. Trumbo (2000) identifies two meanings of "risk communication". Risk communication can refer to a subject of study looking at the situational factors surrounding the creation of, the transmission of, and the response to risk information. It can also be "an instrument used by parties with vested interests to control information" (Trumbo, 2000, 192). The second meaning includes communication from those protecting the public's well being as well as those trying to convince us that they are not harming anyone. This type of risk communication is nothing new, and is essentially persuasive. Risk communication as a subject of study gained recognition (and funding) in the late 70's and early 80's. Since then, a more formal theoretical base has been established. Communication theory was appropriated by those working in risk and vice versa, resulting in a discipline capable of asking unique questions and generating practical responses to pressing real world problems.

From an official's point of view, the problem was "Why doesn't the public do the right thing, even when we give them the necessary information? Why don't they listen to us? What do they think we are, miracle workers? How ignorant!." From the public's perspective, it was "Why don't the officials tell us what we want to know? And why don't they listen to us? What do they think we are, idiots? How arrogant!." Those contributing to risk communication research hoped to reduce losses and conflict by bringing these two groups closer together. The approaches to doing so changed through time.

Powell and Leiss (1997) identify three phases in the development of risk communication. [Gilbert White and those working in the Chicago school during the mid 20th century may take offense to the dates assigned to these phases, as their work in risk perception made the "second stage" of risk communication possible (White, 1945, 1964; Murphy, 1958; Kates and White, 1961).] The first phase, which they date from approximately 1975-1984, focused on comparable risk assessment. Emphasis was put on technical expertise and the identification of physical risk categories. It was believed that all people should view "managing opportunities and dangers on the basis of comparative risk information" as an "inescapable duty" (Powell and Leiss, 1997, 36). Communication was authoritarian, privileging scientists and officials and denigrating a public who thought and talked about risk differently. Neither code nor context was considered and communicators and scientists were assumed to be altruistic and objective (Kasperson and Stallen, 1991).

During the second phase (1985-1994), risk communicators recognized they had an audience and borrowed from marketing. Communicators and officials began feeling out their audiences and attempted to tailor their messages. The key to *effective* communication became *persuasiveness*. Communication was instrumental and one sided, but made an effort to recognize public wants and needs. Altruism continued to be assumed, though total objectivity was questioned. Communicators sought to use shared codes and began to consider the importance of context. Unfortunately, it has been determined that trust in the communicator and message source is imperative for risk communication to be persuasive (Covello et al., 1987; B. Johnson, 1987; Slovic, 1993). Trust was in short supply.

The current phase encourages the building of public trust in governmental organizations and experts. Communication emphasizes social context and attempts to initiate a stakeholder dialogue rather than an official monologue. This phase also focuses on demonstrating an official commitment to good risk communication practices. This is accomplished through consistent trustworthy action in and out of crisis situations. Issues of both coding and context have been brought to the fore in this third stage. There has been a move towards understanding and consensus in risk assessment and communication. Effectiveness has begun to part ways with persuasiveness, though the extent to which this is practical or possible is debatable.

Covello et al. (1986) identify four components of the risk communication process. These include the message source, message design, delivery channel, and target audience. This model closely follows the normative model of general communication. Communication can be either one-way or two-way; Covello et al. (1987) argue that "effective risk communication must be understood as a two-way interactive process that is based on mutual respect and trust"(1987, 9). In theory, either side can be the message source, but their focus is on the source as the scientist or government. Risk communication is primarily seen as transmitting technical or scientific information regarding risk from the experts to the public. Their linear model is described by Kasperson and Stallen (1991) as "the engineering approach." The exchange of non-scientific types of risk information is not addressed. Their model represents the second phase in the development of risk communication.

Krimsky and Plough (1988) identify five slightly different components of risk communication: intention of the communicator; content of the message; nature of the audience; source of the message; and direction of the message. In addition to these components, they add a latitude factor. Each component may be interpreted broadly or narrowly. Covello et al.'s (1987) "engineering" model is linear and narrow. Communication assumes intentionality and a goal, targets an audience, has an expert point source, and flows along designated channels. The broad interpretation takes into account the potential for communicative free-for-alls.

A broad interpretation does not assume a goal and models communication as coming from any source through any channel to any audience. Non-scientific Information may still influence risk perception. A broad interpretation better anticipates the unintended consequences of risk information taking multiple paths through multiple sources to recipients outside a target audience. Each new source and path changes, and potentially removes, the intention of communication. A carefully prepared code may initiate different symbol relations and take on different meanings in unforeseen contexts.

A broad view assumes less control over the result of communication and acknowledges multiple sources and types of risk information. It is essentially contextual. It expands on the narrow model, but does not render it useless. Much research continues to be conducted using the narrow model. Looking beyond the narrow results may give us a more accurate picture of risk communication as a whole, however. We may be able to better recognize uncertainties, not only in the message, but in its path, interpretation, and the response it engenders.

Process and Problems

The process of risk communication might become clearer through illustration. Physician-patient communication has long been used as a model for risk communication (Tonn et al.,1989). Like all risk communication, it incorporates elements of uncertainty and probability not often found in general communication. I will address each component of the risk communication process outlined above. The object is not only to explain the components themselves, but to identify the potential failure of communication at each stage. I will first examine the narrow model and then move to a broader perspective.

Tonn et al. (1989) describe the basic risk communication process as being comprised of four steps. This is a linear model assuming one source, one message, and an intended receiver or set of receivers. First, "the physician develops an internal cognitive judgment of the patient's state-of-being" (Tonn et al.,1989, 215) . This is the risk assessment. A physician's judgment is the result of his or her quantitative physical analysis combined with a contextual perception of risk. Risk perception will be covered in more detail in the following section. The physician is the source of the message as well as its communicator and has a stake in the message and the patient's response in both roles.

In the second step, the physician "translates the internalized feeling into a message that can be communicated to the patient" (215). This is the initial coding process. Relevant components include Krimsky and Plough's (1988) intentionality as well as the content of the message. What is the physician's objective? Is it patient understanding or a particular patient response? What response? Is efficiency or effectiveness emphasized through the coding process? What did the physician choose to include or leave out? It may be that the message intentionally does not reflect the physician's own assessment and perception.

In the third step, the patient "accepts the message and translates it into a form amenable for cognitive processing" (Tonn et al., 1989, 215). This is the second coding, where the patient categorizes the incoming data (the physician's message) into his or her own space saving packages. Prior to this second coding, the physician decided on a delivery channel and delivery direction. This might be a direct one-on-one spoken exchange, or could take written form or that of another medium. Communication might also be directed towards a group. It is at this stage that the audience plays an active role in communication.

Fourth, the patient "internalizes the message into a cognitive form consistent with his or her knowledge about uncertainty and medical contexts" (Tonn et al., 1989, 215). The cognitive form the message takes, and hence its meaning, very much depends on the patient's experience with uncertainty and his or her condition, as well as the patient's knowledge, attitude, and situation. Meaning depends on perception, which is contextual. Context and cognition determine the "nature" of the audience.

Whether effectiveness is gauged by the level of understanding or the adoption of a specific attitude or behavior, communication must take into consideration both coding and context in every step of the process. In this narrow, linear example, it is the physician who judges the success or failure of the communication. A communication is successful if he or she is satisfied with the outcome. A successful risk communication is one in which the audience's perception of risk and uncertainty is functionally similar to that of the source. Regulatory risk communication is often judged the same way.

Where might things go wrong? First, let's focus on the source, which in this case is also the communicator. Is the physician able to code the information and uncertainty he or she wishes to communicate? It may be that the physician has no existing boxes in which to categorize data. How does one then send the package on? What has his or her own contextuality filtered out? What if the incoming data produce conflicting symbols and images within the physician? These types of problems make putting together a message very difficult and prevent communication from being efficient or accurate.

A second problem, one that research has deemed to be of primary importance to risk management, is the issue of trust (Covello et al., 1987; B. Johnson, 1987; Slovic, 1993). No matter how efficiently coded a message is, no matter how much source and audience coding overlap, no matter how contextually tailored a message is to an audience, the communication will not be effective if the source is not trusted. Neither audience perception nor action will come closer to that held or desired by the source. Conflict continues, though risk communication is intended to decrease it. Slovic (1993) has argued that “trust is more fundamental to conflict resolution than risk communication”, although good communication can prevent increased conflict. Once broken, trust is very difficult to regain (Slovic, 1993; Covello et al., 1987). Trust is particularly problematic in the area of technical risk communication and management, but can also come into play in the natural hazards arena. The discrepancy can be explained through the research on risk perception covered below. The level of trust results from the perception of not only the source, but the risk itself.

The next set of problems arise when the message channel is added to the mix. The more physically and temporally removed an audience is from the communication source, the fewer types of codes are available for use (Boisot, 1995). In a one-on-one situation, gestures, expressions, voice inflection, as well as language provide information. In a physician’s pamphlet (or in a flood risk map), not only are data very efficiently packaged, only one type of package is available. The message channel must be appropriate to the message in order for communication to be potentially effective.

A third set of problems involves the combination of audience, message, and source. It may be the physician has used words unknown to the patient. The source is not using a code shared by the target audience. This is, in part, a result of different contexts. It is possible that the physician uses familiar words to convey information for which the patient has no categories. This makes a second coding difficult. It may be that the physician uses analogies that inappropriately substitute familiar concepts for unfamiliar concepts of risk and uncertainty. Research has shown the use of analogy in risk communication to be problematic (Slovic, 1986).

Communication may also break down if the words used by the source are familiar, but mean different things to the receiver. How probable is "possible"? Is a 50 percent chance high risk or low risk? Given the same odds of being overrun by locusts, one person may decide to get out of Dodge, while another chuckles and goes to fetch the bug spray. Symbols associated with the message may also differ, shading its meaning. Hazard imaging has been shown to play a role in coding (Slovic, 1986, Benthin et al., 1995) and may vary between individuals and groups. The above problems are issues of shared context and perception. A source must actively seek to create a shared context to increase the chances of effective communication (in addition to increasing trust levels), whether effectiveness is judged by persuasion or understanding.

What happens when a broad interpretation of risk communication processes is adopted? What might change? How would effectiveness be evaluated? Potential problems increase with the number of sources, channels and audiences. Messages coded for a specific context may find themselves in unfamiliar terrain after a quick game of telephone. It has been noted that messages for a general audience also hit the contextual subgroups (Callaghan, 1987). But it is also the case that messages bound for specific subgroups may be intercepted, in whole or in part, by unintended receivers. It is conceivable, even probable in the case of the 100 year flood, that what is believed to be a message coded for a general audience is, practically speaking, targeted toward a subgroup.

Not all risk communication is official, and not all communication about risk is scientific. Friends and neighbors chat, people watch movies, and many of us eavesdrop. Risk information may be passed along all these channels, both intentionally and unintentionally. As a message weaves its way through different contexts, symbols and meanings change. An efficient package may easily be separated from its meaning in an intended context by time, space, and perception. In a broad model, contextual contact points and message paths might be as important as the "nature" of the intended audience. Efficiency might be more of a liability in a broad model if a coded message is shown to be easily adapted to a variety of specific symbol sets and meanings. These differences may in fact be reinforced through the repeated use of the efficient code. Chaos may reign in the guise of order. The subject has yet to be studied thoroughly.

Mileti et al. (1989) have identified a sequential process and problem set similar to that of the physician-patient example. The "hear-perceive-respond" model is also narrow, but examines communication and response from the receiver's perspective. The coding and contextual components discussed above are examined in terms of understanding, belief, and personalization. All are directly related to perception. In Mileti et al.'s model, risk communication processes can be understood only in light of risk perception. Lave and Lave's (1991) communication analysis is also focused on the receiver. They sought to improve narrow risk communication by creating perceptual models of risk for both experts and laymen and rectifying gaps using appropriate and relevant codes.

Risk Perception

Situational and Cognitive Factors

Tobin and Montz (1997) identify two categories of components that influence perception: situational factors and cognitive factors. Perception in turn affects response. If judging a communication's effectiveness by its demonstrated persuasiveness (i.e. behavior), then these factors must be taken into account. Together, they constitute the context and potential coding of communication. White began the work of recognizing perceptual variables and applying them to response (White, 1945). The components of perception are interactive, but communication has tended to focus on the situational factors as a guide to message construction, presumably because cognitive factors are more difficult to assess and group.

Situational factors include variables of the physical and socio-economic environments. Physical components include the magnitude, frequency, and duration of individual hazard types. Their technical assessment and comparison was the focus of the first stage of risk communication. It has since been shown that the physical event is not a good predictor of response (Tobin and Montz, 1997), though experience influences perception negatively and positively. Experience tends to bound one's knowledge of the event, influencing its imaginability, and thus its categorization and assessment (Slovic et al., 1974).

Using the socio-economic environment to predict perception and response has also been shown to be problematic. Individuals and communities with similar social relations may react differently to "identical" hazards (Clifford, 1956). Socio-economic variables include individual traits, such as age, gender, health, and race. Group and community characteristics like family ties, social support systems and demographic make-up also influence perception, response, and communication. The communication channels available and the potential message paths depend on these characteristics, and in turn, become part of the context. Cultural variables like language, religion, and behavioral norms may also influence the categorization of incoming information by providing an existing coding system and symbol set.

Situational factors alone do not determine response. The individual cannot be ignored, though in cases of extreme marginalization or vulnerability, situational factors may significantly bind cognitive ones. Cognitive factors work alongside situational factors to influence perception and behavior, but the relationship is not fully understood. Tobin and Montz (1997) include psychological and attitudinal variables in the cognitive category. An individual's coding processes and symbologies, locus of control, methods for coping with uncertainty (these are covered in greater detail below), and general outlook all fit under the heading of "cognitive factors". None exist outside of situational factors, however. Situational factors will determine whether or not risk communication is relevant (Slovic, 1986). Cognitive factors will help determine a person's communicative capabilities and needs, as well as control shortcuts to processing information.

Perceptual Trends

While it is difficult to generalize about the specific play of situational and cognitive factors in perception, some general trends have been identified. (Finucane et al., 2000; Daggett, 1987; Slovic et al., 1980, 1979, 1976; Slovic et al., 1974). These trends apply to non-scientists in particular, but expert judgment may also be fallible. Trends include the use of heuristics, the inclusion of qualitative factors in assessment, and an aversion to uncertainty.

Heuristics are mental short-cuts. Like coding, they make mental tasks like processing information more manageable. Also like coding, they can become entrenched and lead to other sorts of difficulties. Two types of heuristics pertinent to risk perception have been identified: availability and affect. Availability has to do with the ease with which something is recalled. Availability was touched on above in terms of imaginability. The more easily a hazard is imagined, the more frequent it is assumed to be (Slovic et al., 1976). Ease of recall is not always an effective measure of frequency or risk. Situational and cognitive factors will influence perception. A recent event, though rare, might be more easily recalled than a more common event more temporally distant. Imaginability is also affected by more than the physical characteristics of the hazard. Risk communication in both the broad and narrow senses will have a significant bearing on availability. (Slovic, 1976, 1986; Kasperson et al., 1988) Targeted information campaigns or media attention may increase the visibility, and thus the perceived frequency, of hazards. Non-targeted, informal risk information will also increase the perception of frequency. I've never come across an aggressive shark, but I'm certainly less likely to go into the water after watching "Jaws".

The affect heuristic describes the knee-jerk like-it-or-don't-like-it reaction to information. Images are also pertinent here, as the "Jaws" example illustrates. Epstein (1994) explains that all of us (even the experts) "apprehend reality in two fundamentally different ways." One is based on reason, the other is not. The relevance to risk perception is that as perceived benefit ("I like it!") increases, the perceived risk decreases. Similarly, as dread increases ("I hate it!"), perceived risk increases. Levels of dread may be based on knowledge of potential consequences, the perceived ability to control the hazard, and the perceived impact on future generations. In general, the more familiar a hazard, the less it is dreaded (Daggett, 1987; Slovic, 1987). Most natural hazards are not dread, while nuclear energy, in any form, is (Slovic, 1987). These biases solidify over time and are difficult to change. They filter subsequent information (Slovic et al., 1979; Slovic et al., 1974).

"Experts" tend to equate risk with fatalities. In addition to dread and the level to which the consequences are known, lay people also often include catastrophic potential and the effect on future generations (Slovic et al., 1980). These are rational assessments. Risk communication that dismisses any of these factors will be deemed irrelevant and condescending. It will be ineffective.

Uncertainty

"We have considerable social science and psychological theory and some evidence that resource users are unwilling or unable to adopt this probabilistic view of the world and are not able to live with uncertainty" (Burton and Kates, 1964, 433)

Perhaps the most problematic trend in risk perception is the public's utter distaste for uncertainty. Science is uncertain. Risk assessment is probabilistic. Official risk communication is probabilistic. But people do not like probabilities; they like facts (Slovic, 1986). Tobin and Montz (1997) identify three models used for coping with uncertainty.

The first two are based in the tradition of "cognitive dissonance" first examined by Festinger in 1947. They are labeled determinate perception and dissonant perception. In the determinate model, people eliminate the randomness of an event. Hazards become both knowable and controllable. Randomness can be eliminated in two ways. First, a pattern can be mentally projected onto a hazard. "Oh, sure, we get a storm like this every six years." Another way to pattern hazards is through the "Gambler's Fallacy", what Slovic calls the "law of averages". "If it happened this year, it can't happen next year." The second method is the technological fix. "We've got a levee – no more flooding." Technological fixes can promote a false sense of security that may increase the potential damage should the "fix" fail, a phenomenon known as "the levee effect" (Tobin, 1995). These myths may become ingrained in the local context through informal (broad) risk communication and influence the categorization (or dismissal) of subsequent risk information.

The second model is that of dissonant perception. This is the model of denial. Denial may be complete, “We don’t have hurricanes in Texas. They only hit Florida”, or partial. Partial denial involves placing the threat in the past or giving it only minor importance. An event might be perceived as a freak occurrence, the result of conditions unlikely to occur again (Slovic, 1987). Minor importance might refer to the perceived magnitude of the event, or to perceived personal impact. “What, me worry?” Dissonant perception poses the same problems as determinate perception to effective risk communication.

The third model is probabilistic. This method accepts the randomness of events, but renounces all action. It takes the determinate method to the other extreme. The hazard becomes completely unknowable and uncontrollable; taking responsibility for one’s fate is no longer necessary or possible. “It’s in God’s hands.” Instead of eliminating uncertainty, this method eliminates the need to wrestle with it. Those utilizing the probabilistic method are unlikely to be capable of coding risk information without significant effort. Persuasion assumes some culpability. Communication is unlikely to be effective, though not all people adopting probabilistic models forgo action.

Kasperson and Stallen (1991) argue that the problem with the normative “engineering” model of risk communication is that “it is heavily oriented towards the product (the understanding of the message) as opposed to an emphasis on the process developing an enduring capability in those potentially at risk which can handle uncertainty” (Kasperson and Stallen, 1991, 4). Uncertainty is not going away, but little research has been done on ways to increase the public's acceptance of uncertainty, rather than the public's understanding of its "proper" quantification. The bigger challenge is perhaps getting the public to understand that those quantifications are uncertain and changing as well, made certain only by social "necessity".

The science upon which we base our policies is full of uncertainty. Knowledge is always produced in context, and always based on the study of a sample. The context may lead to a specific categorization of observation and the sample may be very small. When science is used as the basis of regulatory policy, its inherent uncertainties do not often show. Once extrapolated and canonized, errors and uncertainties compound, but are hidden. Schon (1982) and Brian Wynne (1992) argue that "the policy language of risk…falsely reduces uncertainties to the more comforting illusion of controllable probabilistic processes" (Wynne, 1992, 150). This patterning of risk uncertainty into probability allows risk policy to be made, but uncertainties may be further patterned when policy is communicated to the public.

Policy language is created by politicians, not scientists, and for specific purposes. The goal of policy communication is not simply public understanding, but public compliance. Policy communication is one-way and its effectiveness is measured through persuasion, not understanding. During policy formation, communication may be (should be, if trust, shared context, a shared code, and effective policy are important) dialogic and oriented towards understanding. Once policy is set, communication changes. If a shared code and context has not been built prior to the setting of policy, as is the case with flood policy, communicators can only attempt to tailor the message and method to the targeted audience. If the audience perception has been misjudged or overlooked, effective communication will be impossible. An overly efficient message may also make effective communication difficult.

Wynne argues that, in some sense,

> "scientific uncertainty can be seen to be important, not in itself, supposedly measurable on some objective scale, but as a function of (in relation to) the extent of technological or policy commitment riding on the body of knowledge concerned. As such commitments grow, we can tolerate less uncertainty" (Wynne, 1992).

The wider the variety of situations to which uncertain knowledge is applied, the greater the uncertainty and error it produces. But the bigger a policy's scope, the more important it is to produce absolute benchmarks. The more visible and politically powerful a policy becomes, the more important that it appear free of uncertainty. Politicians, like the public, like "facts". Error and uncertainty are enshrined in a language of absolutes or unchanging probabilities.

The bigger a policy's scope, the further its message must travel. Uncertainty makes a message bulky and inefficient. There are too many buts and addendums tagging along for an uncertain message to travel very far. In order to be efficient, the message needs to drop some baggage. The more certain a message appears, the more efficient it becomes. Thus, as a policy's reach extends, two factors work towards the elimination of uncertainty in risk policy communication: a general aversion to uncertainty and the need for policy's efficient transmission. Uncertainty lets go of its qualifications, and in its “certain” efficiency, it is replicated and ingrained through heuristics and coding mechanisms.

The 100 Year Flood

Historical Management Parameters

The use of the 100 year flood as the focal point of current U.S. flood policy illustrates the difficult marriage of uncertainty and policy described above. It is also a good example of many of the communication challenges already discussed. Before examining the problems embedded in 100 year flood terminology, it is necessary to look at how it came to occupy its current position.

In 1875, a congressional report lamented the lack of a unified flood control program, stating that “ the experience of one hundred and fifty years has utterly failed to create judicious laws or effective organization in the several states themselves, and no systematic cooperation has ever been attempted between them. The latter is no less important than the former, for the river has no respect for State boundaries” (House Doc. No.127, in PWRPC, 1950). This was an early call for streamlining flood management. Prior federal involvement, like the Swamp Land Acts of 1849 and1850, the Flood Control Act of 1917, and the 1927 Rivers and Harbors Act, focused on specific projects or prioritized navigation. Most flood control, however, was left in the hands of individual communities and states.

In spite of the 1875 plea, federal involvement remained spotty, though funding and research increased. It was not until the 1936 Flood Control Act that flood control became the official responsibility of the federal government. The Act, like others preceding and following it, was passed in order to reduce losses caused by flooding. Delegating responsibility for flood control to a single body (the Army Corps of Engineers) created both organization and cooperation between states, though the cooperation was, perhaps, involuntary. Multi-state projects emphasizing flood control as well as navigation became more feasible.

In 1936, flood control meant structural mitigation. Organized federal floodplain management ended with dams and levees. Aside from aid, non-structural mitigation continued to be left to the states. In 1958, only seven states had encroachment provisions of any kind (Murphy, 1958). All enacted encroachment laws following a major event. The extent to which they limited development varied greatly, but none used the hundred year floodplain as a guideline. Pennsylvania and Indiana decided encroachment on the basis of individual projects. Iowa controlled development in the “floodway”, but neglected to define it. New Jersey’s line of encroachment was the flood of record, while Massachusetts used the average spring flood. Washington State considered encroachment individually, and used the channel banks as a guideline. Connecticut was perhaps the strictest, using a level generally five times that of the mean annual flood. The multiplicative factor depended on the river.

Most states did not enforce permit requirements. In his evaluation of state encroachment provisions, Murphy states “It appeared that, lacking firm criteria of channel encroachment, the states tend to establish requirements that are not in major conflict with existing developments nor unduly restrictive to new developments” (Murphy, 1958, 20). These considerations took the form of “reasonableness” when the National Flood Insurance Act was passed in 1968.

The National Flood Insurance Act

In the 1940’s and 1950’s, Gilbert White (1945, 1954), Francis Murphy (1958), the Bureau of the Budget (1952), and others recommended a floodplain management program that went beyond structural mitigation. This was in no small part due to the approximately 7 billion dollars spent on river maintenance and “improvements” from 1936 to 1966 (USWRC, 1971, 1979). Research indicated that, in spite of the outlay for flood control, flood losses were not decreasing (White’s Interview with Reuss, 1993; Kusler, 1982; House Doc. 465, 1966; Holmes, 1961; Renshaw, 1961). In order to stem the outward flow of cash, a combination of zoning and encroachment regulations, building codes, insurance, and financial incentives and disincentives was suggested.

Murphy (1958) identified several requirements for successful non-structural floodplain management. If regulations were to be enforceable, they must be clear and concise, and set with consistent criteria. In other words, they must be coded efficiently. Any program must also have sufficient funding.

> "To insure consistency in channel encroachment and zoning provisions, criteria would have to be established at the federal level…The zoning criteria would concern flood frequency and areas to be subject to regulation, which would both be delineated on a zoning map."(Murphy, 1958, 148).

Though Murphy believed that the state level would be the most appropriate for administering flood regulations, he saw that the states had very different management philosophies. He feared that the resulting differences in criteria would cause inequity. The federal government's financial resources, existing staff, and infrastructure also made it a more suitable choice for establishing and recording criteria. Murphy suggested that the criteria should lie between the 65 and 100 year floods in order to be effective in reducing losses.

Many of the above suggestions were incorporated into the National Flood Insurance Act of 1968. As the 1936 Flood Control Act streamlined structural mitigation, the1968 Act was designed to create a framework for non-structural mitigation. The Act sought to both reduce losses and distribute those incurred. The National Flood Insurance Act followed the Southeast Disaster Act of 1965, a 1966 report on flood insurance commissioned by HUD, and House Document 465, a report entitled *A Unified National Program for Managing Flood Losses*. The report was produced by a task force headed by Gilbert White and presented to the Bureau of the Budget in 1966. The National Flood Insurance Act was based in large part on House Document 465, though White was not entirely satisfied with the management results (Interview with Reuss, 1993). The Act was not a reaction to a specific event, but spurred on by multiple events, the culmination of long years of research and argument regarding the feasibility of federal flood insurance and the move to non-structural mitigation.

Tobin and Montz (1997) identify four possible community responses to hazards and disasters. Communities can modify the event, modify vulnerability, modify the loss burden, or do nothing. The National Flood Insurance Program established in the 1968 Act had three goals: to better indemnify individuals for flood losses through insurance; to reduce flood damages through management and regulation; and to reduce federal expenditures for disaster assistance and flood control (FEMA). These goals emphasize modifying vulnerability and the loss burden while discouraging non-action and placing event modification (structural mitigation) within a broader management framework.

The National Flood Insurance Program is made up of three inter-related components. These include mapping, management, and insurance. Each is designed to function as part of a whole in achieving the Act's goals by encouraging the preferred community responses. Mapping is intended to increase awareness and assist in both floodplain management and the creation of rate maps. Management includes the use of zoning, codes, and permitting in order to decrease vulnerability. Insurance shares the loss burden and is intended to reduce the reliance on federal aid. Insurance availability and rates are based on mapped risk zones and documented management practices. Compliance is encouraged through rate reductions, as well as the withholding of insurance, loans, and (in theory) disaster relief.

The focal point of each of these components is the “100 year floodplain”. This is the concise, consistent criteria that Murphy believed was necessary for the successful administration of a flood management program. While flood maps may include other information, the information most important for administering policy is the designation of the Base Flood Elevation and the Special Flood Hazard Area. Both of these are based on the predicted parameters of a flood with a return period of 100 years.

Permits are required for all development within the Special Flood Hazard Area (SFHA). All new construction must be raised at least 1 foot above designated Base Flood Elevation. The National Flood Insurance Program prohibits any construction within the 100 year floodway that raises the Base Flood Elevation (BFE) 1 foot or more. Insurance is required for all building within the SFHA, but is unavailable to communities not identified as having SFHA’s or those that do not meet or enforce the management requirements above. Levees rated to a 100 year level of protection exempt the land behind them from the SFHA. Both the management and insurance components of the National Flood Insurance Program depend on mapping the100 year flood parameters. Though they are subject to all the uncertainty of surveying and science, these lines are represented as absolute.

The Hundred Year Flood as Benchmark

How did the 100 year return period become the benchmark of U.S. flood policy? There was some precedent in the Tennessee Valley Authority’s use of the “intermediate regional flood” as a structural guideline (White’s

Interview with Reuss, 1993; Goddard, 1961; Kates and White, 1961), but the 1% chance flood was not widely used prior to the National Flood Insurance Act. The intermediate regional flood is now equated with the 100 year flood. When looking at its adoption as the regulatory standard it is necessary to consider reasonableness, efficiency, and the individuals involved.

Murphy emphasized reasonableness in his 1958 report. He was speaking of reasonableness regarding specific communities; in 1968 administrators were looking for a reasonable benchmark for all communities. In order to get the program off the ground, administrators "initially had to have some figure to use" (White's Interview with Reuss, 1993). Murphy's "reasonableness" took into account the predicted and historical parameters of flooding, along with community use and need (Murphy, 1958). In 1968, reasonableness was based on a general cost benefit model. In addition to its association with the TVA, the 1% chance flood was chosen because it "constitutes a reasonable compromise between the need for building restrictions to minimize potential loss of life and property and the economic benefits to be derived from floodplain development" (Krimm, 1998). Reasonableness was not assessed on a contextual basis, but a theoretical one. What passed as reasonable in policy formation was assumed to be reasonable throughout the country. Though suggestions were made by researchers like White, the public was not involved in a policy dialogue. Both Murphy (1958) and White (Interview with Reuss, 1993) felt that different criteria for different situations would be more effective than applying a single criterion to communities with different needs, but other forces were at work.

The National Flood Insurance Program was broad in scope and its functionality depended on producing easily readable maps. There was some pressure to get the program off the ground. In a 1985 interview, Gilbert White recalls the first FIA administrator as “committed to blanketing the country” (Interview with Reuss, 1993, 55). There was no pilot program; George Bernstein dove right in, “making large commitments for surveys, for mapping programs, and for doing this not using the regular federal agencies, but bringing in consulting engineers” (White’s Interview with, in Reuss, 1993, 55). In order to map the nation as quickly as possible, using multiple organizations, efficiently coded policy requirements were imperative. The resulting maps were also to be clear, concise, and consistent, able to travel through time and space without obvious alteration. They, too, needed to be efficiently coded.

The initial goal in adopting the hundred year flood criterion was not effective communication of risk or risk policy, but efficient administration and implementation. The effectiveness of this criterion in encouraging desired behavior, preventing loss, and engendering understanding of risk and policy was not tested. It has yet to be tested thoroughly. Efficiency was prioritized; effectiveness was not. Because efficiency was prioritized, a single criterion was used, chosen because of its perceived “reasonableness”. The efficiency with which the FIA set about “blanketing” the country, combined with the efficient verbal and visual coding of the 100 year floodplain, may very well have led to the institutionalization of the “100 year flood” before its usefulness to risk policy and risk communication was proven.

Uncertainty and the Hundred Year Flood

What is the "hundred year flood" intended to represent? It is intended as a measure of flood risk, though the consequences of such risk are not addressed. Flood risk is defined as "the probability that one or more events will exceed a given flood magnitude within a specified period of years" (USWRC, 1977). For the hundred year flood, this means that an event of a specific size or larger can be expected, *on average*, every hundred years. This does not mean it can not happen multiple times in the same year. The return period is based on statistical analysis of the historical record, or flood frequency curves. Historical data can be augmented by comparisons with similar watersheds and precipitation analysis. The basic formula for obtaining the return period is

$$Tr = n + 1/ m$$

where n equals the number of data entries and m equals the rank of a specific flood magnitude. Probability is simply the reciprocal, so a flood with a one hundred year return period has a 1% chance of occurring in any given year. As with any statistical analysis based on a sample, there is an associated error and a set of confidence limits. These "uncertainties can be decreased only by obtaining more or better data and by using better statistical methods" (USWRC, 1977). They can not be eliminated.

Statistical error is only one potential source of uncertainty in the concept of the 100 year flood. Using an example from the IAWCD, the National Research Council (2000) describes probability distribution as a reflection of "natural variability" and the error bounds as "knowledge uncertainty”. Climate change can be included in natural variability, but the resulting probabilities may be skewed. One must also include mechanical error and operator error in creating the frequency curves. In addition, these curves, and the probabilities based on them, may change as use patterns change in the floodplain and watershed. Maps based on these probabilities may quickly become obsolete (USWRC, 1982). Lines could also conceivably be manipulated by those in power.

In addition to the uncertainties associated with determining probability, flood heights, velocities, and consequences of similarly rated events vary from place to place, introducing another type of uncertainty. Smith has used this type of uncertainty to argue that “it is impossible to set definitions for a designated flood that are universally applicable” (Smith, 2000, 255). His argument echoes those set forth by Murphy and White regarding the suitability of a single criterion. If a risk benchmark is not associated with both temporal and consequential probability, what does it really mean? Is it useful for either policy or communication? These concerns have been raised by the National Research Council (2000) and by Slovic (1986), but the underlying concepts need to be tested.

As the 100 year flood designation moved out of the arena of implementation and into the political and public arenas, it lost its associated uncertainty. Scientists assessing 100 year flood parameters probably shared a code and underlying context. Embedded in the flood parameters is uncertainty resulting from both natural variability and human error. Parameters change with changing conditions and may not include all relevant information. At least some of these uncertainties were internalized by those conducting the studies. Though “experts” tend to privilege defined uncertainty (Wynne, 1992) and be overconfident in their assessments (Slovic et al., 1979), uncertainty is a part of their context. Other people’s contexts and coding systems are not as tolerant of uncertainty.

An efficiently coded message will be filtered differently by politicians and by the general public than by those who originally produced its content. The underlying context and symbol set is different. Uncertainty is likely to be eliminated as the incoming message is recoded into existing categories. The message will be particularly malleable if the code is recognizable and potentially relevant, as is the case with the hundred year flood. The differences in contextual meaning may not be immediately obvious. Thus, as the hundred year flood was quickly institutionalized, its uncertainty morphed into certainty, “rapidly transformed in the community mind to a definition of flood free and flood prone, with areas above the designated flood perceived to be flood free – a misconception often reinforced by flood maps that shade only those portions that are subject to the designated flood” (Smith, 2000, 255). More research is needed to confirm this, but the assertion is plausible. General risk communication research supports this conclusion (Hance et al., 1988). Kates and White (1961) also indicate that map lines, like levees, may produce a false sense of security. Efficient communication, perhaps inadvertently, has succeeded in making effective communication very difficult.

Communication and the Hundred Year Flood

Since the implementation of the National Flood Insurance Program, many (e.g. Wood et al., 1985; NRC, 2000; Smith, 2000; Fordham, 2000) have recommended the adoption of public participation in flood risk analysis and policy making. The National Flood Insurance Act was passed prior to this phase in risk communication. However, public participation in the communication of flood risk continues to lag behind that of some technological risks and associated policies. This may in part be due to the lack of outrage associated with hazards like nuclear power and the consequent differences in perception (Sandman, 1987).

In the beginning, communication of flood policy to the public was a secondary concern and took the "decide, announce, defend" route. Communication is becoming a primary concern, though it continues to assume a narrow, engineering model. Effectiveness is judged on compliance with the NFIP, not on the understanding of its principles. Flood risk communicators now believe that persuasion is contingent upon understanding of the uncertainty concepts originally associated with the hundred year flood (NRC, 1995, 2000). However, it is not clear that a better perception of uncertainty and probability will bring the risk perception of expert and general public closer together or induce a desired response.

In the narrow model of risk communication, flood risk information is assumed to be transferred from experts to a general audience via maps, pamphlets, and policy. The message travels through intended channels. Because of the efficiency of the message and the shared language of experts and public, a shared code was initially assumed. However, in using the hundred year flood as the basis of verbal and visual communication, risk communicators substituted a contextual sub-group (the experts) for the public as the target audience. No research on message appropriateness was done prior to the implementation of the NFIP. Sub-contexts and symbol sets were merged. Potential differences in context were not addressed and by the time risk communicators were concerned with context, new meanings were entrenched.

A narrow model does not take into account informal communication. It cannot explain the compounding of error as a message makes its way through different contexts on unintended routes. It assumes that flood risk information is received only through the channels in which it was initially sent. The assumption of the narrow model of risk communication was perhaps a contributor to the rapid institutionalization of a flawed probability concept. Other paths, other sources, and other contexts were not considered. Future communication of flood risk would be wise to adopt a broad communication model in order to better anticipate perception and behavior, to appropriately tailor a message, and to encourage a dialogue of stake holders (Fordham, 2000). Aspects of the broad model have been encouraged by the National Research Council (1995, 2000), but there is more research to be done. The "ideal" communication recommended in the 2000 report continues to reflect the narrow model outlined by Covello et al (1987).

Government agencies recognize the inadequacy of "the hundred year flood" in communicating flood risk and the danger of reinforcing risk dichotomies (NRC, 1995, 2000; USACE Guidelines). Over half of flood losses occur outside of the Special Flood Hazard Area (Smith, 2000; Faber, 1996) . There has been a move to adopt more effective terminology without forsaking the efficiency necessary to carry out a nationwide program. The focus has been on the verbal, rather than the visual representation of uncertainty concepts. The Army Corps of Engineers has altered its Principles and Guidelines in an attempt to recapture uncertainty; the objective is to use the probability term “1 percent chance flood” instead of using the return period. Publications, however, show that the Guidelines are not always adhered to (USACE, 1994).

In 2000, the National Research Council suggested several messages thought to better convey uncertainty, though the usefulness of the hundred year floodplain as a policy benchmark was upheld. Suggested terminology included the 1 percent chance flood, percent chance of flooding during a 30 year mortgage (essentially a 1 in 4, or 26 percent chance), and an analogy linking the chance of flooding in 50 years to the chance of tossing a coin and coming up with heads (NRC, 2000). Including damage potential with this description of probability is also suggested. Other organizations, like the Lincoln Institute of Land Policy, suggest a similar shift in terminology (Faber, 1996). The TVA uses the 26 percent chance in a 30 year period in its communication (Newton, 1987). Unfortunately, a glance through publications from areas using the 1 percent chance flood to communicate risk indicates that this message may be as ineffective as that of the 100 year flood. After all, there's "a 99 percent chance of it not happening!" (coxsmeadow.homestead.com).

Arkin (1987) has emphasized the importance of carefully testing messages prior to official communication. However, the suggested terms, like the 100 year flood before them, have not yet been tested as to their efficacy in influencing the public understanding of uncertainty concepts. It may be that they reflect the same communicative problems as the 100 year flood. Nor is there much evidence that they will produce similar qualitative perceptions of risk or levels of concern across contexts, even when uncertainty is accepted. The usefulness of an overhaul of verbal coding must also be questioned, since the visual coding of flood risk information may not reflect the desired changes in communication.

Problem Statement

In the creation of United States flood policy, efficient implementation took precedence over effective communication. The efficient coding of "the hundred year flood" and the scope of the National Flood Insurance Program led to a pervasive use of the term in formal and informal risk communication. When officials began consciously communicating flood policy to the public, they assumed a narrow "engineering" model and did not fully anticipate the influence of informal communication or contextual differences in meaning. The effectiveness of the "hundred year flood" as a means to change attitude or motivate behavior was not assessed. Nor was its utility in increasing public understanding of flood risk. Perception of the hundred year flood and the term's efficacy in policy communication has yet to be thoroughly analyzed. New terms have been introduced, but the effectiveness of "the 1 percent chance flood", "26 percent chance in 30 years", and the analogy of the coin flip are also unproven. It may be difficult to replace hundred year flood terminology in risk communication regardless of the usefulness of the new terms. It would, however, make sense to test them before attempting to move forward.

This project will attempt to answer the following questions within the context of the case study area:

1. What is the public perception of the hundred year flood in terms of probability and risk?
2. Is "hundred year flood" terminology effective in communicating flood risk?
3. Is the visual representation of the hundred year flood effective in communicating flood risk?
4. Are the terms introduced as replacements for or augmentations of "the hundred year flood" more effective in communicating flood risk?

Hypotheses

Comparisons of Effectiveness

1. It is hypothesized that the hundred year flood will be perceived by the public to be regular and predictable and considered a moderate to low risk.
2. It is expected that an event described as having a 1% chance of occurring will be perceived more accurately in terms of its random nature, but will be considered a low risk.
3. It is hypothesized that events described as having a 26% chance of occurring in a 30 year period will be perceived as a moderate threat and more uncertain than a hundred year flood.
4. It is further hypothesized that current maps are perceived to illustrate absolute boundaries, failing to convey uncertainty or effectively communicate flood risk.

Situational Relationships to Perception

5. Individuals with personal experience with flooding are predicted to have a better understanding of the uncertainties of the hundred year flood and may exhibit a level of concern more consistent with policy.
6. It is also expected that the perceived risk will increase with age and be higher for women than for men.
7. Accurate perception of uncertainty is expected to increase with education

Chapter Two: Physical and Social Context

Site Selection

Several criteria were used in selecting an appropriate case study area. These included community size, National Flood Insurance Program status, floodplain proportion, and flood experience. Constraints on data collection limited potential sites to single small communities; a small population makes data collection easier and increases the chances that a sample will be representative.

The second criterion was the community's status in the National Flood Insurance Program. A community that participates in the NFIP has a designated Special Flood Hazard Area, a recorded 100 year flood elevation, and available maps. In theory, the community will have been exposed to both flooding and the terms used to describe flood risk. In this project, participation in the Community Rating System (CRS) was not looked upon as desirable for the selected site. The vast majority (approximately 20,000) of flood prone communities are involved in the NFIP, but only 994 have earned CRS points. Communities earn CRS points by exceeding the requirements of the NFIP. Examples of activities rewarded by CRS are education programs, relocation programs and buyouts, storm water planning, structural measures, and warning systems. A community that does not participate in the CRS is perhaps more representative of other most flood plain communities.

The third criterion was floodplain proportion. If the project was to include analysis of perception and behavior both in and out of the floodplain, the community could not be completely contained within the SFHA or the 500 year floodplain. Nor would it make sense to use a community whose residents lived and conducted business almost exclusively outside either floodplain. Flooding needed to be a legitimate public and personal concern.

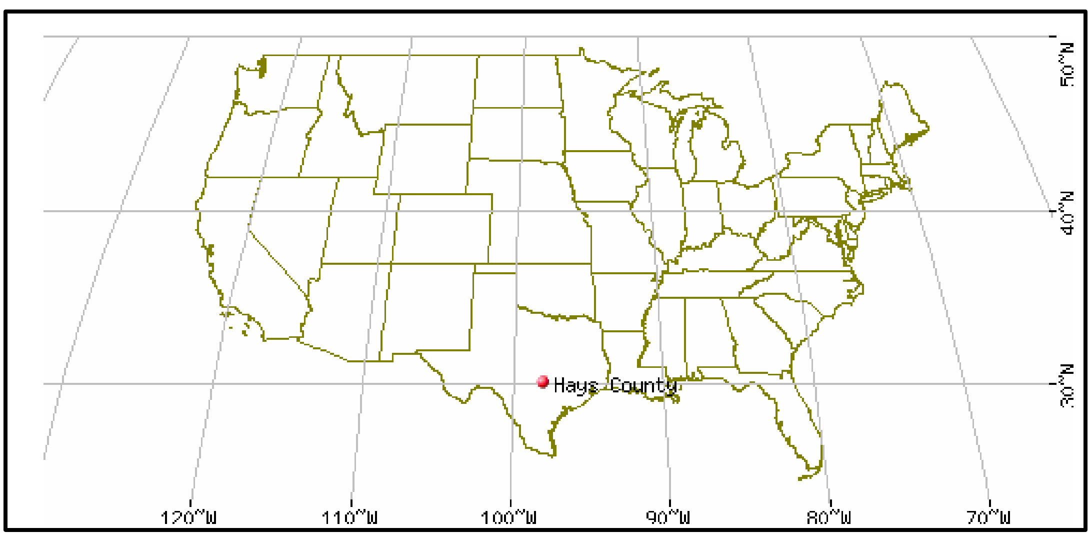
The final criterion was flood experience. For flooding to be a public and personal concern, the community selected needed to have recent experience with floods large and small, including a 100 year flood. This flood should have been discussed in terms of return period in local forums.

The Village of Wimberley, Texas was chosen as the research site. While it serves a portion of the greater Wimberley Valley, the city itself is fairly small, consisting of 2,710 people according to the 2003 Census Bureau estimate. The community currently participates in the National Flood Insurance Program (NFIP) and has since 2002. The city incorporated in 2000. Prior to 2002, the Wimberley area participated in the NFIP through Hays County; the county has been a member of the NFIP since 1993. Neither the city nor the county is involved in the Community Rating System, though some in the community were curious to learn more about it. Wimberley has several neighborhoods both in and out of the floodplain and has experienced a variety of flood events over the last 10 years, some of which were quite large. In addition, the population of Wimberley is growing, and not all the immigrants are from flood prone communities. This quality will aid in analyzing the effects of experience on perception and behavior.

Physical Context

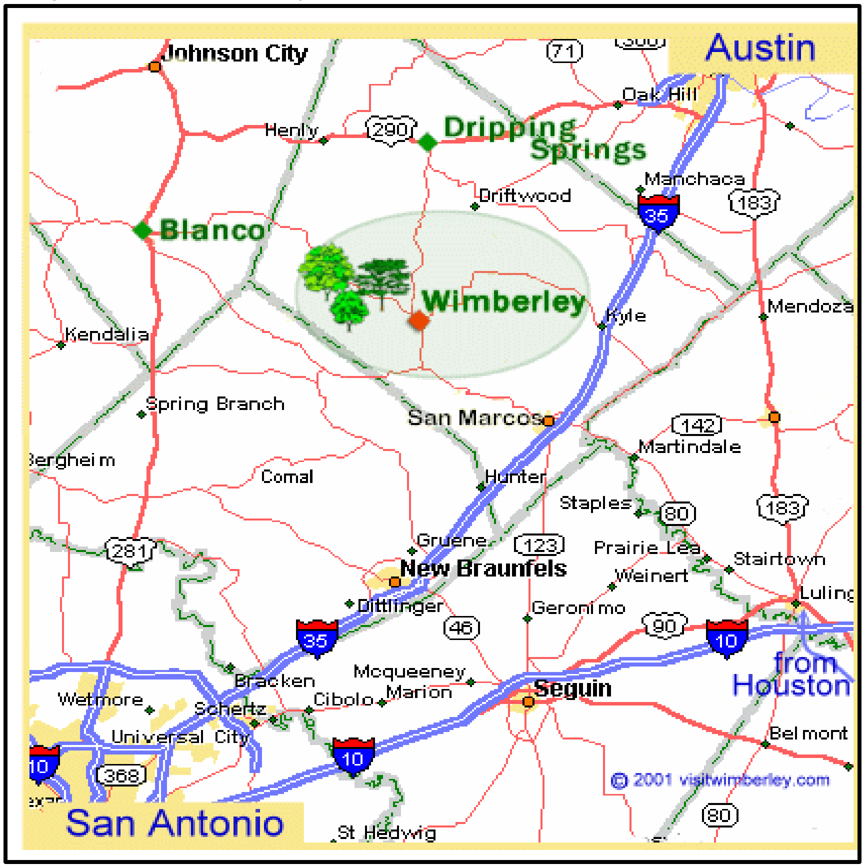
Wimberley is located 30 miles southwest of Austin and 50 miles northeast of San Antonio. It is the largest of several small towns in Hays county, including Dripping Springs, Driftwood, Buda, and Kyle. San Marcos, home of Texas State University, is the county seat as well as the area's population center. San Marcos is 15 miles southeast of Wimberley. Figures 2.1 and 2.2 illustrate the location of Hays County and Wimberley, respectively.

Figure 2.1. Hays County Location



Source: www.geonames.usgs.gov

Figure 2.2. Wimberley Location



Source: www.visitwimberley.com

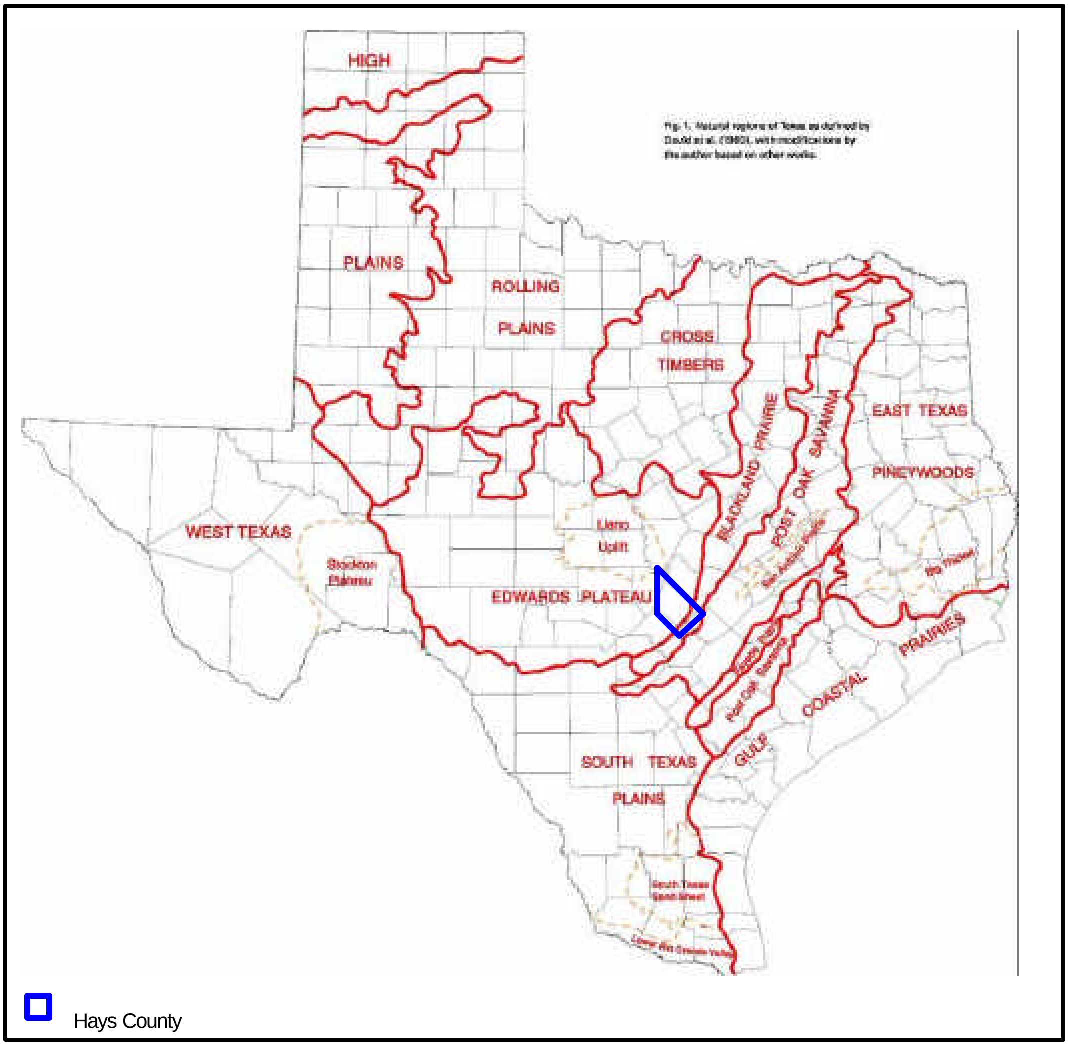
Hill Country

Hays county marks the eastern edge of Texas hill country, a 36,000 square mile area riddled with canyons extending over portions of 25 counties. Hill Country covers parts of two physiographic regions, including the Llano Uplift and the Edwards Plateau. The smaller Uplift is primarily igneous and is punctuated with rounded granitic hills. It contains some of the oldest rocks in Texas. The Edwards Plateau surrounds the Llano Uplift and is chiefly limestone (TPWD, 2004; TSHA, 2002). Several rivers, including the Frio, Medina, Nueces, Llano, Pedernales, Guadalupe, and the Blanco cut through the softer rock of the Hill Country, as do many named and unnamed creeks and streams. The Trinity and Edwards aquifers underlie much of the area, sending springs bubbling to the surface in New Braunfels, Comal, San Marcos, and many other places (TWDB, TSHA, 2002). Plant communities are dominated by live oak - juniper parks and woods, with live oak - mesquite communities more common in the uplift region. Canyons contain other oak species and hardwoods, including black cherry, pecan, hackberry, and Texas mountain laurel (TPWD, 2004; TSHA, 2002). Bald cypress are common along the streams.

Hays County

Hays County straddles the Balcones Escarpment, a fault that marks the divide between the Edwards Plateau and the Blackland Prairie Region. Rangeland is predominant in the northwestern portion of the county, as the thin soils and relief make the land inappropriate for most crops. The southeastern third of the county is situated on the inland sweep of the coastal plains; the dark clay soils are thicker and richer than those of the Plateau (TPWD, 2004; TSHA, 2002). Most native vegetation has been cleared for cropland. Texas's natural regions are included in Figure 2.3; Hays county is colored blue.

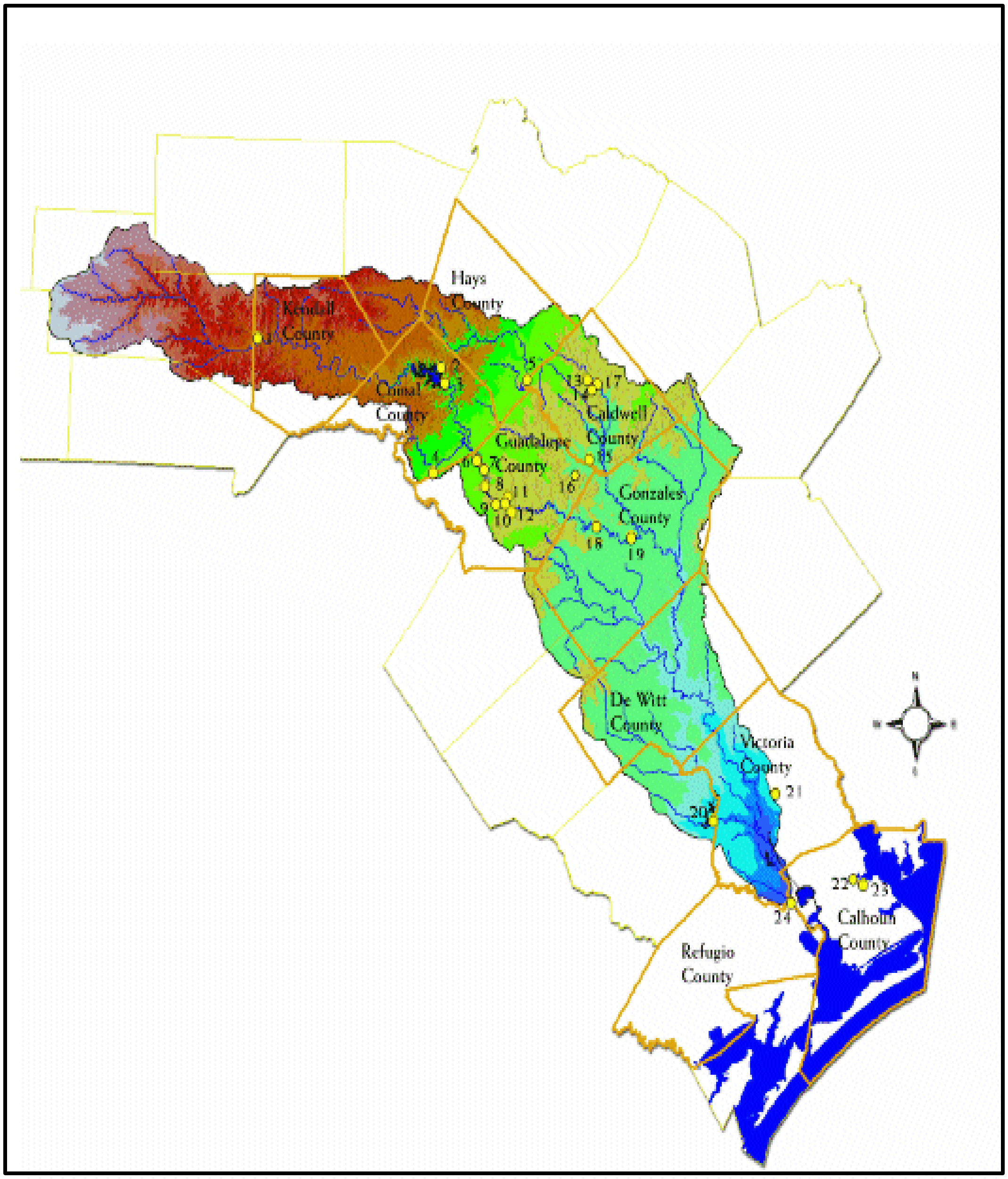
Figure 2.3. Natural Regions of Texas



Source: TPWD, 2004

Water in Hays County runs from northwest to southeast, following the elevation change through the Escarpment. The Blanco and San Marcos Rivers are the major waterways, but there are others that can, and have, caused damage. For the most part, the Blanco flows freely, though Hays County contains some small off channel flood control dams located on private property and paid for by the federal and county governments. These were credited with reducing losses during the 1998 floods (GBRA, 1999). The southern half of Hays County, including Wimberley, lies within the Guadalupe Blanco watershed (see Figure 2.4). The Guadalupe Basin includes ten counties and drains an area of 1,652 square miles. The Blanco feeds the San Marcos River and joins the Guadalupe near Gonzales. This smaller basin drains an area of approximately 355 square miles (USGS). The entire Guadalupe River Basin has been called ‘Flash Flood Alley’ and is one of the three most dangerous regions in the U.S. for flash floods (GBRA, 1999). It is of particular importance in areas such as these to effectively communicate flood risk and encourage appropriate behavior in both individuals and communities.

Figure 2.4. Guadalupe River Basin

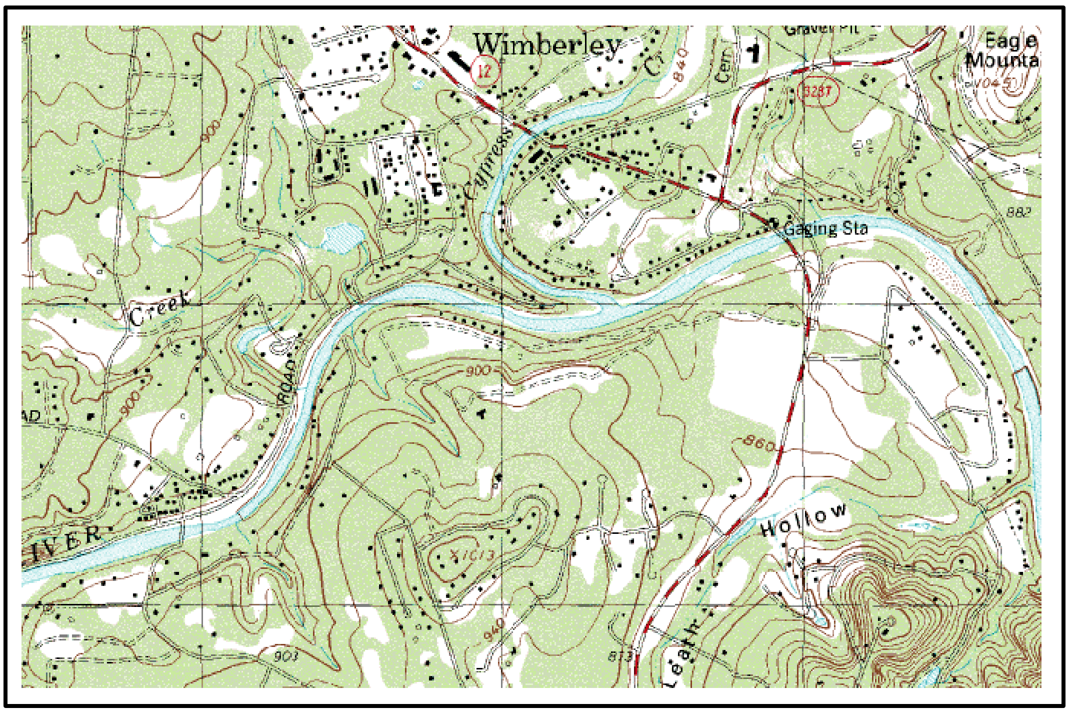


Source: Gaudalupe-Blanco River Trust
Numbers refer to gauging stations.

The Village of Wimberley

The heart of the Village of Wimberley is located at the confluence of Cypress Creek and the Blanco River (see Figure 2.5). Wilson Creek enters the Blanco west of downtown and numerous washes run through neighborhoods. These washes are often not included on flood risk maps, but residents indicated that these washes have caused flooding and damage. Like that of most of Hill Country, Wimberley's bedrock is primarily limestone, and soils are generally thin. Elevations range from 780 to 1260 feet above sea level (TSHA, 2002). Wimberley's topography and geology puts the population at some risk, though open space and vegetative cover are generally abundant, allowing for some infiltration.

Figure 2.5. Central Wimberley Topography and Rivers



Source: www.Topozone.com UTM 14 587076E 3318373N (WGS84/NAD83)

USGS **Wimberley** Quad

Social Context

A Brief History of Wimberley

When Hays County was founded in 1848, Wimberley was a trading post known as Glendale. The population was very small and unsettled. In the early 1850's, William Winters discovered the spot and moved his family onto 200 acres near the confluence of Cypress Creek and the Blanco River. In 1956, he built a limestone house and a mill. The mill was originally used for lumber; a grist mill was added shortly thereafter. The surrounding area came to be called Winter's Mill. When Winters died in 1864, his son-in-law John Crude took over mill operations and repaired flood damage to the mill. Crude's Mill was sold to Pleasant Wimberley in 1874 and the name changed to Wimberley's mill. In 1880, the town applied for recognition from the Post Office and became Wimberley (Allen, 1986; TSHA, 2002; Wimberley History).

Through the course of the community's early years, the power of Cypress Creek was used to produce lumber, grist, flour, sorghum, molasses, shingles, and cotton. In 1912, the Creek could no longer power mill operations. The mill closed in 1925 and was razed in 1934 (Allen, 1986; TSHA, 2002; Wimberley History). It presumably sustained major damage during the 1929 flood and may have been unsalvageable. The original site is currently occupied by a bank; the town square is just across the creek.

Wimberley's economy changed in the post war boom. With improved roads, Wimberley and the rest of hill country became accessible. Austin and San Antonio were growing quickly, and many began to look outside the cities for relief and leisure. In the 1950's and 1960's, Wimberley began to support a growing community of part time residents staying in weekend and summer homes. Tourism also increased as vacation lodging was built (Allen, 1986; TSHA, 2002). The trend has continued; one third of Wimberley's businesses are directly related to tourism (Wimberley Comprehensive Plan, 2002). In the past few decades, more of Wimberley's visitors have decided to stay, contributing to a boom in the population.

Demographics

In 2000, Wimberley's population as a Census Designated Place was 3,797. Its estimated 2000 population as an incorporated city was 2,583. In 2003, the city population was estimated at 2,710. Wimberley is predominantly white (91.2 percent) with the largest minority group being the 6.9 percent who identified themselves as Hispanic of any race. English was not the primary language of 11.3 percent of the residents. In 2000, 41.2 percent of Wimberley's population held a Bachelor's degree or higher, while approximately 11 percent did not have a high school diploma or the equivalent. The median age of the population in 2000 was 45.6 with a median household income of $46,042. In general, Wimberley's population is significantly whiter and older, somewhat better educated, and slightly wealthier than the rest of Hays County or Texas. Comparisons of Census 2000 data are included in Table 2.1.

Table 2.1. Demographic Comparison of Wimberley, Hays County, and Texas Using 2000 Census Data

	Wimberley CDP	Hays County	Texas
Population	3,797	97,589	20,851,820
% White, Non-Hispanic	91.2%	64.5%	52.4%
% Hispanic of Any Race	6.9%	29.6%	32.0%
% English as a Second Language	11.3%	23.1%	31.2%
% with Bachelors or Higher	41.2%	31.3%	23.2%
Median Age	45.6	28.4	32.3
Median Income	$46,042	$45,006	$39,927

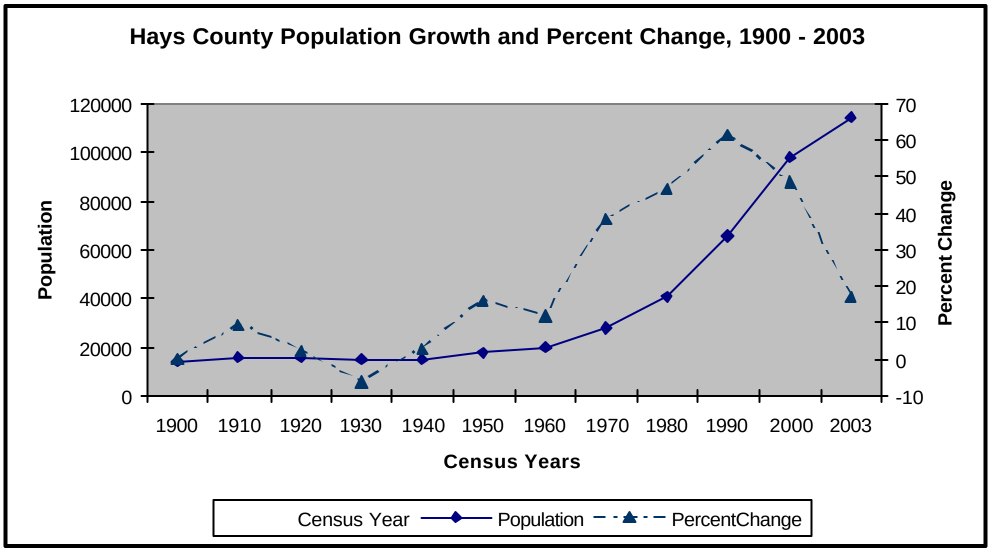
Growth

Current Wimberley residents are concerned about growth, though the slogan atop the local paper and website, "A Nice Place to Visit… a Great Place to Live", appears to encourage it. In 2003, Wimberley was rated one of the top 10 small towns in the country by Travel Holiday Magazine. Many have heeded the call and settled here, including a large number of retirees. Others have also come, and 'locals' are worried about maintaining the bucolic way of life that first brought them to Wimberley. One section of the 2002 Wimberley Comprehensive Plan is devoted to growth management. Another section deals with community character. So far, Wimberley has managed to keep business fairly local, avoid chains, and encourage the arts.

Growth has other potential impacts. Increased development puts more stress on the water supply. More relevant to this study, development reduces infiltration, increases run-off, and potentially puts more people at the mercy of larger floods, even when zoning is enforced. And while the Comprehensive Plan states that, "Particular attention should be given to preparing for periodic major flooding" (Wimberley Comprehensive Plan, 2002), it is not explicitly incorporated into other aspects of planning. References are made to waterfront development, but flood education is not mentioned. From a pre-event perspective, this could be problematic, though flood response has been actively addressed through the fire department and Wimberley EMS as well as CERT (Citizen Emergency Response Team). CERT currently has 20 members and is actively recruiting. Emergency response organizations hold regular flood specific trainings (www.visitwimberley.com/cert).

Another potential problem is the lack of collective memory in the newcomers. Those with experience may have made mental and physical adjustments to frequent flooding unavailable to new residents without targeted education. Growth will continue to be a concern as Austin and San Antonio spread. Historic Census records are unavailable for Wimberley itself, and census tracts have changed significantly. Historical data are available for Hays County, however, and illustrate the growth patterns of the region. Figure 2.6 shows huge growth from 1970 – 2003, with a jump of 61.6 percent from 1980 to 1990. If the growth rate continues as estimated, the percent change will be over 50 percent in 2010.

Figure 2.6. Hays County Population Growth, 1950 – 2003



Source: Census Bureau

Meteorological and Hydrological Context

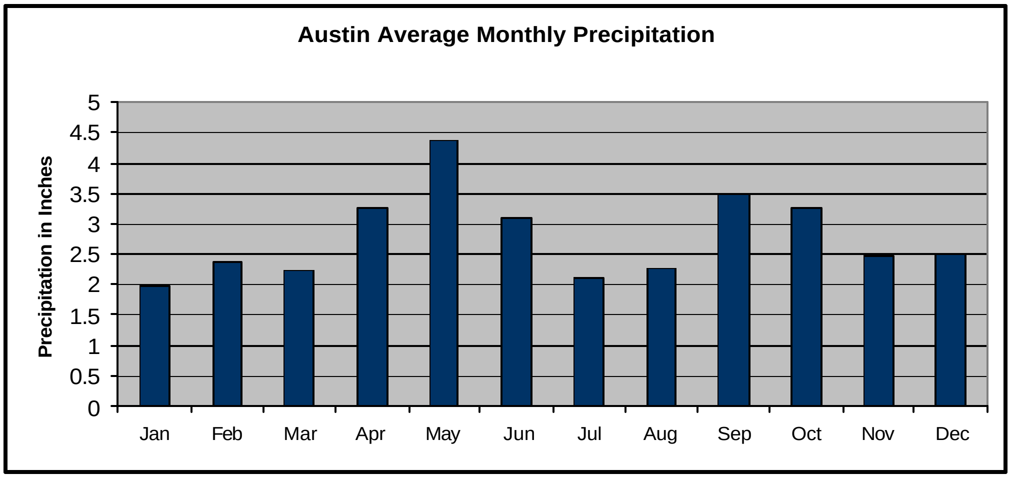
Weather and Climate

Located at 29°59'50" N and 90°80'04" W, Wimberley has rather mild winters and hot summers, bordering humid and semi-arid regions. Wimberley receives a mean 300 days of sunlight per year, with a growing season of approximately 254 days. January is usually the coldest month, averaging 40°F, while July, with an average temperature of 96°F, is the hottest.

Mean yearly precipitation is 33.75 inches, with the majority of rain falling in late spring and fall. Spring rainfall is usually frontal. The bulk of summer and autumnal rainfall is generated through convective thunderstorm activity, though frontal precipitation is also common in later months (NWS, TSHA, 2002). The area is impacted by hurricane related precipitation as well.

These violent rainfall types contribute to the flash flooding for which the Guadalupe Basin is known. Average monthly rainfall is shown in Figure 2.7. Snow is rare. National Weather Service information is for Austin, which has an annual average of 33.42” and a pattern comparable to that of Wimberley.

Figure 2.7. Austin Average Monthly Rainfall



Source: National Weather Service

The City and Its Surface Water

As illustrated in Figure 2.5, Wimberley lies at the confluence of the Blanco River and Cypress Creek. The square, which is the tourist and business center of the village, is bordered on the north and west by Cypress Creek. The Blanco marks its southern edge. Many residences are also located near these two waterways, as well as near Wilson Creek and other creeks and washes. While the majority of the population does live outside the Special Flood Hazard Area, flooding is a very real threat to both personal and public property.

Farm Road 12, one of Wimberley's major thoroughfares, crosses both Cypress Creek and the Blanco River. One of the Blanco's gauge stations is located at the RR 12 bridge. Cypress Creek is not gauged. The bridges are located just to the north and south of downtown. The firehouse is north of the Blanco and west of Cypress Creek, north of both bridges. The firehouse is one of the centers of emergency response for the community and is located outside both the 100 year and 500 year floodplains. However, if either bridge is flooded, responders are cut off from much of their service area. The Cypress Creek bridge has been more problematic and a project is currently under way to bring it up to flood standards (and relieve congestion).

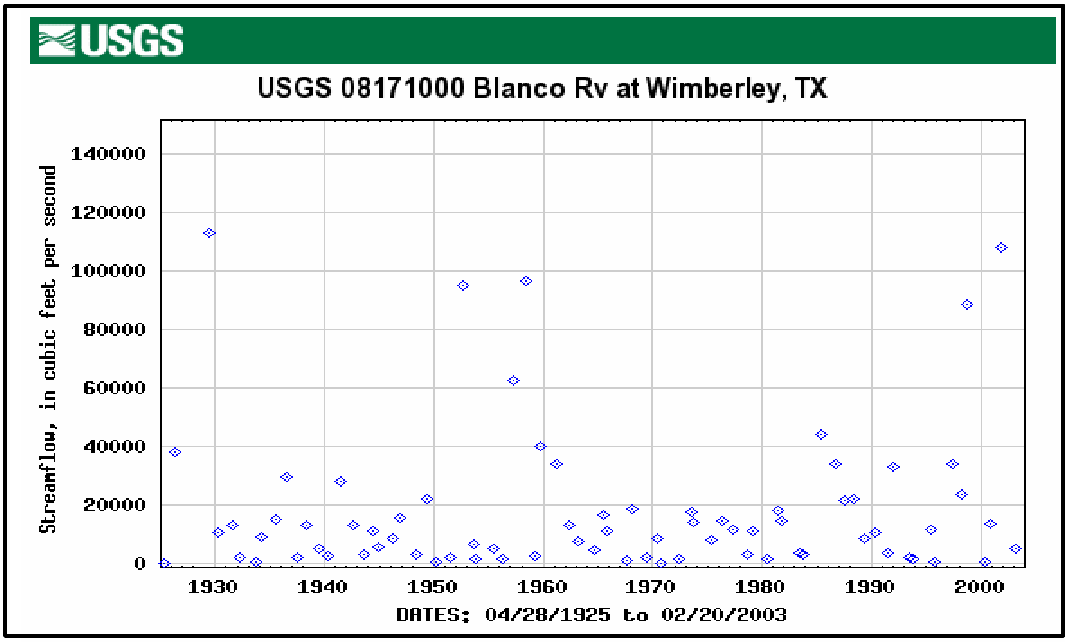
Many neighborhoods also have only one way in and out; during flood events, these neighborhoods are stranded. Luckily, flood waters usually recede relatively quickly, but this is not always the case. The multiple low water crossings are also of concern. An example is shown in Figure 2.7. What is 'safe' for one vehicle is not safe for another and though these crossings are marked 'closed' by local officials when the river stage rises above a few feet, there is a lag between the time the river reaches a dangerous level and the time the crossing is closed. Closings are not always respected. Additionally, the existence of these low water crossings may encourage residents to drive through flowing water, a dangerous practice in an area prone to flash flooding. In Texas, the majority of flood related deaths are caused by driving into floodwaters (www.floodsafety.com).

Flood History

River stages and discharges have been recorded for the Blanco River at Wimberley since 1924. There are no gauges for Cypress Creek; flooding is reported through local estimates and damages. In recent years, Cypress Creek has caused more extensive damage than the Blanco in the Wimberley area, and though its flooding is related to that of the Blanco, it is not dependent upon it. The creek is only 14 miles long, but it might warrant its own monitoring system.

Flood stage for the Blanco at Wimberley's RR 12 bridge is 13 feet. According to the USGS, since 1925, the annual peak of the river has surpassed flood stage on 24 occasions. The number increases if one includes non peak flows in high volume years. Of the 24 floods, 5 were considered to be 'major' by the National Weather Service, having exceeded 26 feet. 17 feet is categorized as moderate. The largest flood of record occurred on May 28th, 1929. USGS records the stage at 31.10 feet with a discharge of 113,000 cfs, 18.10 feet above flood stage. The National Weather Service puts the stage at 33.30 feet, with the same discharge. Regardless of who's right, the 1929 flood is still used as a point of reference by survey respondents who were in Wimberley at the time. Figure 2.8 shows the annual peaks of the Blanco at Wimberley from 1925 – 2003, recorded by the USGS.

Figure 2.8. Annual Peak Discharge of the Blanco at Wimberley, 1925 – 2003



USGS and National Weather Service data are not consistent. Table 2.2 includes the stage and discharge of the top five floods as recorded by the National Weather Service.

Table 2.2. National Weather Service Peak Flows for the Blanco at Wimberley

Rank	Date	Stage in Feet	Discharge in cfs
1	5-28-1929	33.30	113,000
2	11-16-2001	28.89	NR
3	10-17-1998	28.50	116,000
4	7-5-2002	25.71	66,700
5	6-9-1997	20.46	34,100

According to NWS Austin/San Antonio, four of the five highest peaks have occurred in the last seven years. USGS recorded a similar stage for the

2002 flood, but because it occurred in the same water year as the November, 2001 flood, it was not included in their yearly peaks. However, the USGS recorded discharge for the 1998 flood was only 88,500 cfs. Four floods that surpassed the 1997 mark were not included in the NWS top ten, let alone the top five. USGS has both the 1952 flood and the 1958 flood surpassing 30 feet with discharges close to 100,000 cfs. Nevertheless, the four out of five statistic is often quoted by lay people.

The four floods cited by the NWS were large and damaging (though only 2 qualify as major by their standards), but few people aside from the fire chief appeared to remember the impacts of the floods in the 1950's. Collective memory appears to have been replaced through informal and accidental communication. The void is filling itself. In an area where people's lives and livelihoods are at risk, discrepancies of this magnitude are inexcusable. According to Slovic (1993), competing information is a sure was to break the public trust. Trust is essential to effective risk communication (Covello et al., 1987; B. Johnson, 1987).

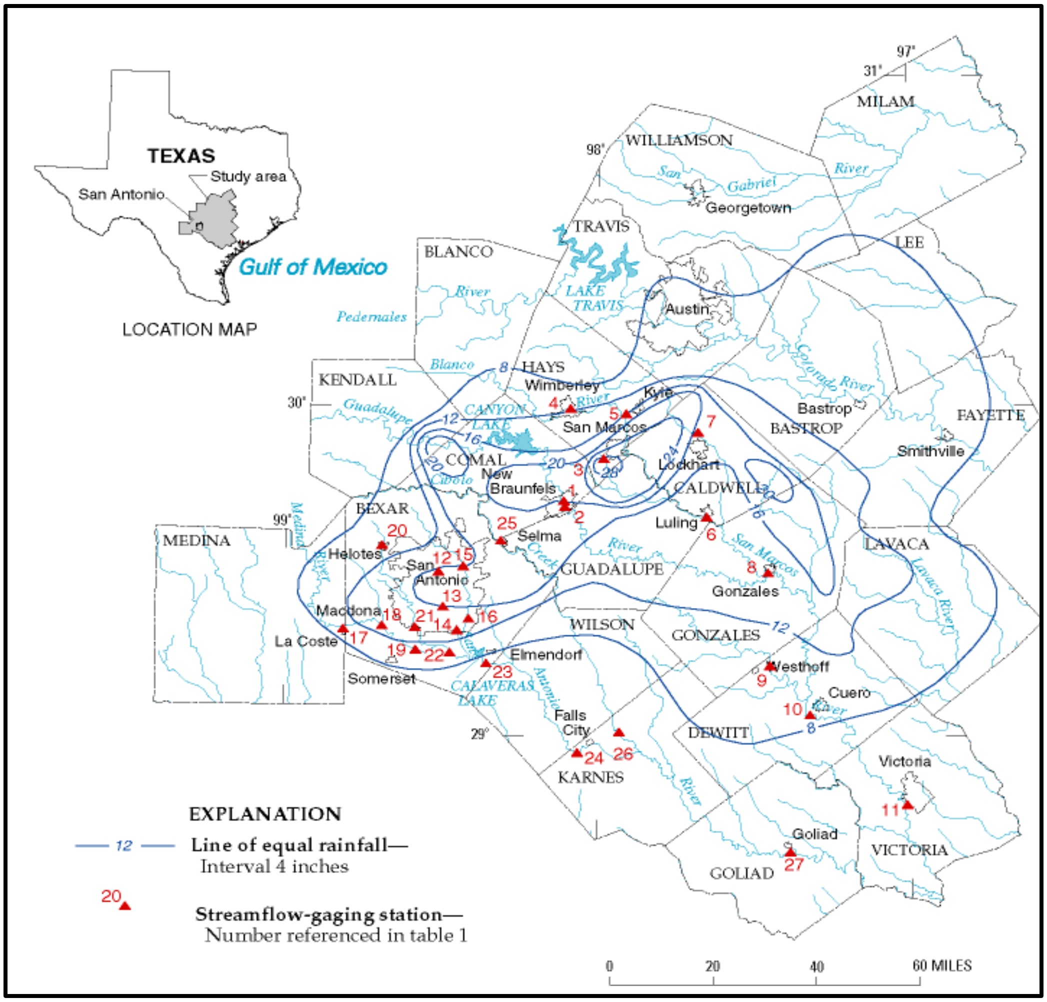
Of the most recent floods in the Wimberley area, the 1998 October flood caused the most extensive damage, though its stage and discharge were surpassed by the 2001 flood. Most of the damage in the greater Wimberley area occurred along Cypress Creek and in Woodcreek, just north of Wimberley. The 2001 flood devastated other areas of the Guadalupe Basin, but got little to no coverage in the local paper, and several survey participants who sustained damage from the Blanco mentioned that it was harder to get assistance than in 1998. Local organizations were not as active. Many who did not live on the Blanco did not realize that the 2001 flood had done any local damage. The 2002 flood got some local coverage, as it happened around the July 4th holiday and produced a 25.71 foot crest, but festivities continued and there was little damage reported. The 1997 flood also caused significant damage in Woodcreek and along Cypress Creek, but Blanco flows were much lower than those of other floods.

The 1998 October Flood

Those living along the Blanco tended to use 2001 as a reference point during the interviews. However, the 1998 flood appeared to be a life marker for the community as whole. The storm was centered in southern Hays County, damage was more widespread, and there was less lead time than for the other storms mentioned. The reference pattern described above, along with individual references to the 1929 and 1958 floods by those who had experienced them, supports the work of Lave and Lave (1991), who found that people focus on the largest, most destructive flood of their own experience, regardless of when it happened.

The storm precipitating the 1998 flood came on quickly. Two hurricanes in the Gulf of Mexico, an upper level trough, and a cold front combined to produce massive amounts of rain in Comal, Hays, and Guadalupe Counties on the 17th and 18th of October, 1998. (GBRA, 1999; Slade and Persky, 1999). USGS estimates Wimberley received over 12 inches of rain in 3 ½ hours. Two day totals for Hays County were believed to top 30 inches. Figure 2.9 illustrates precipitation and gauge locations.

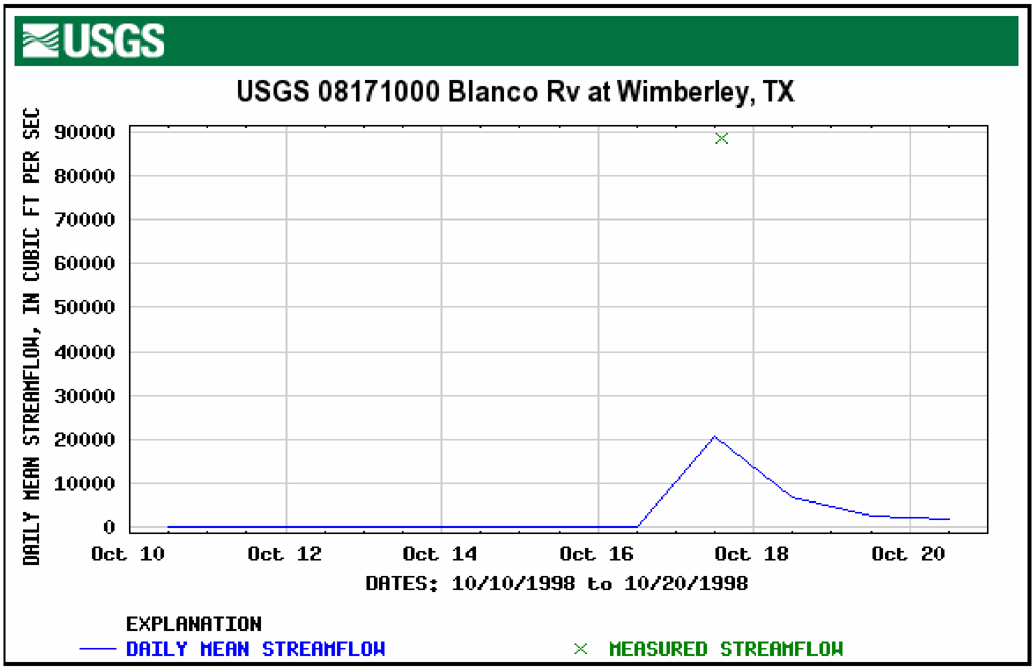
Figure 2.9. Rainfall for Oct. 17th and 18th, 1998



Source: USGS

In the Guadalupe and San Antonio Basins, 13 gauges recorded discharges with a return period equal to or greater than 100 years. Records were broken at 11 stations. Wimberley's discharge of 88,500 cfs was considered a 100 year flood (Slade and Persky, 1999). The storm's hydrograph is included as Figure 2.10. Note that the line is the daily mean, while the "x" is the measured peak. The difference indicates the speed and quantity of the storm water.

Figure 2.10. Hydrograph for the Blanco at Wimberley



Slade and Patton (2002) reported 32 two lives lost and an estimated 500 million dollars in property damage. Floodsafety.com, a collaboration of federal and regional Texas organizations, reported approximately 1.5 billion dollars in total damage. In 1999, the Guadalupe Blanco River Authority recorded 12 basin deaths due to the flood and estimated 11,699 destroyed or damaged structures. Approximate disaster assistance in the basin totaled $117,178,905. In Hays County, 1,040 structures suffered significant damage (GBRA) and Floodsafety.com reported one fatality. In San Marcos, the Warm Springs Hospital was forced to evacuate as 8 feet of water made its way inside.

The Blanco was not reported to have flooded any houses in Wimberley, but the heavy local rains flooded Dry Cypress Creek and Cypress Creek; the

Creeks were further backed up by the Blanco. The fire chief estimated that Cypress Creek rose to 17 feet, covering the RR 12 bridge. On October 31st, the local press reported the possible condemnation of a housing development. It is believed that 22 houses were destroyed and 17 suffered major damage (Allen, 1998). Another 21 sustained minor damage. The Red Cross estimated that 1.9 million dollars in damage had been done to local residences. 22 businesses were reported damaged, though in only two cases was the damage over 40%. Twelve people were rescued from Cypress Creek (Allen, 1998; Bond, 1998).

Because other communities had suffered even more serious damage, FEMA did not arrive in Wimberley until ten days after the flood. Local organizations and large corporations took up the immediate slack, collecting donations and providing food, water, and shelter for displaced and needy residents. The successful local response reinforces Hughey's (2003) findings regarding the importance of close internal ties in small communities. The Wimberley View reported that the Wimberley Intercommunity Network (WIN), a group of 15 churches and other organizations formed after the 1997 floods, dispersed over $20,000. United Airlines flew in a plane of donations the day after the flood and sponsored a fundraiser. WIN also raised another $6,000 dollars in a December benefit for the flood victims. Many other businesses and individuals provided support, though this is not evident in the survey results.

The 1998 flood was officially considered a 100 year flood, though many residents have assigned it a return period they think more appropriate, making a mental adjustment towards regularity. Other large floods have followed and preceded it. Some survey respondents linked the floods to development, but dismissed natural irregularity. The physical location of Wimberley and its rapidly increasing population necessitate making flood management a priority, before and after the inevitable event. Integrated planning and education might help, but the information must be appropriate. Hopefully this project will aid in the assessment.

Chapter Three: Study Design

Introduction

Any attempt to address a problem statement or test hypotheses must start with an appropriate data set. For this project, data were collected using a face-to-face structured questionnaire. Interviews lasted from 12 to 30 minutes.

Oppenheim (1966) identifies 10 stages of successful social survey design. These stages are reflected in the eight components of geographic field work proposed by Lounsbury and Aldrich (1979) and the seven steps of the survey process described by Rodeghier (1996). When combined, these guidelines provide a useful research model. Each of the following aspects of survey research and design are required for the completion of a project:

1. A clear statement of the problem;
2. Formulating the hypotheses;
3. Determining the research area;
4. Reviewing the relevant literature;
5. Selecting the sample;
6. Designing the questionnaire;
7. Collecting the data;
8. Coding and cleaning the data; and
9. Examining, analyzing, and reporting the data.

The first four components were addressed in Chapters One and Two. This Chapter will deal with numbers 5 through 9.

Selecting the Sample and Collecting the Data

A stratified random sample was used in order to most effectively replicate the geographic and socio-economic characteristics of the population. The target population consisted of all adults over 18 living in Wimberley who could complete a questionnaire in English. Subgroups were created geographically, delineated between those in either the 100 year or 500 year floodplain and those outside an official floodplain. Five neighborhoods were chosen as appropriate sampling clusters using the 1998 Flood Insurance Rate Map for Hays County unincorporated areas. Two neighborhoods were located almost entirely within either the 100 or 500 year floodplain, while three were mixed to varying degrees. Two neighborhoods were primarily affected by Cypress and Wilson Creeks, the remainder by the Blanco River. Of the 45 who participated, 26 lived in one of the two designated floodplains.

Within the identified neighborhoods, sampling was random. Up to three main streets were selected in each neighborhood. On each street, the sampling process began with a coin toss to decide on which side of the street to start. On the selected side, every other house was approached. If no one was home, residents of the next house were contacted. Every third house was approached on the opposite side. Interviews were conducted over a two week period from the 28th of July to the 10th of August, 2004 from 11 A.M to 6:30

P.M. Though several interviews were completed on both weekends, the time frame may have contributed to a sample slightly older than the target population (see Section Three of Chapter Four).

Designing the Questionnaire

The questionnaire was used to assess the effectiveness of the four methods most commonly used to convey flood risk. These include the one hundred year flood, the 1 percent chance flood, the 26 percent chance in 30 year flood, and a flood risk map. Survey data were also used to identify alternative methods and explore the relationship of certain situational factors to perception and behavior. The questionnaire consisted of three sections relating to individual flood history and experience, methods of description, and demographic information. The questionnaire is included as Appendix A.

Evaluating Effectiveness

Effectiveness can be measured through the success of a message in bringing behavior and attitude in line with that desired by the communicator. It can also be measured by the level of understanding engendered in the receiver. This project used both methods to evaluate the effectiveness of the descriptive methods listed above.

Allison Godber (2002) has used public policy guidelines to represent the level of risk accepted by local governments. This study used policy standards to represent the behavior and level of concern policy makers wish the public to display. U.S. flood policy has deemed that living in the hundred year floodplain without insurance or other mitigation strategies is an unacceptable risk. Policy views it as an area of high risk and high concern. Expressed levels of concern and the perceived need for protection were used to measure effectiveness as persuasion. Understanding focused on the uncertainty concepts embedded in the four methods of description. Effectiveness as understanding was assessed using the public's perception of uncertainty in each of the verbal and visual codes.

Situational Factors

The first section of the survey was used to gather information on participants' flood experience. Included were questions on both flood frequency and damage. This section also addressed past flood behavior and information issues. The third section was used to collect socio-economic data including education, age, gender, income, and length of residence. These data were used to determine whether or not the sample was representative and to identify perceptual and behavioral patterns.

Validity and Reliability

Face validity and content validity were assessed throughout the development of the questionnaire. Pre-tests were administered to 10 people to improve clarity, content, and flow. In order to increase reliability and validity, the questionnaire consisted primarily of closed questions and made use of Likert, nominal, and ordinal scales. To further increase validity, responses to individual questions were combined using factor analysis to form broader scales of uncertainty, persuasion, and experience. The internal consistency reliability of these scales was evaluated using Cronbach's Alpha. The creation and testing of these new scales is addressed more thoroughly in Chapter Five.

Coding and Analysis

Coding was made less subjective through the use of closed questions. Data analysis was primarily quantitative, using Simstat for Windows to perform standard statistical procedures. Comparisons of effectiveness were made using one-tailed paired t-tests at alpha = 0.05. Variables with somewhat skewed distributions were tested using Wilcoxon sign rank tests. Relationships between situational factors, perception, and behavior were evaluated using independent t-tests, likelihood ratios, and Pearson's product moment correlation coefficients. Though the majority of analysis was quantitative, the face to face format allowed for qualitative analysis as well, adding depth and context to the results.

Chapter Four: Descriptive Analysis

Introduction

As described in the previous Chapter, survey questions were grouped into three main sections. Each section included a varying number of subsections. The results are grouped accordingly and presented in tabular form using numerical and percentage totals. A fourth section consisting of thematically related questions is also presented. Means are used where appropriate. A total of 45 people participated in the survey; four declined.

In the first section of the survey, questions dealt with individuals' personal flood histories. Also included were questions on respondents' familiarity with flood programs and information. The second section consisted of questions regarding people's understanding of flood risk and their subsequent attitudes toward flooding. Three verbal methods and one visual method were used to describe a flood of the same theoretical size. Verbal methods included the '100 year flood', 'a flood with a 1 percent chance of occurring in any year', and 'a flood with a 26 percent chance of occurring in 30 years'. The visual method consisted of a Project Impact flood map readily available on the internet (see Appendix B). The questions in the third section were used to gather basic demographic information. The fourth section includes the results of questions designed to suggest other useful methods of communicating flood risk (see Appendix A).

Section 1: Respondents' Personal Flood History

Flood Experience

Table 4.1 includes the results of questions pertaining to flood experience as measured by frequency. Experience in terms of both frequency and impact has been shown to be a key factor in perception and response (Tobin and Montz, 1997). These questions concerned the number of times a person's home or property, workplace, or community was flooded in his or her lifetime, as well as the number of times his or her current home or property has flooded. All questions were open ended; groupings are for presentation purposes only. Response values of over 50 floods were given for both Lifetime Home and Lifetime Community variables. Individual experience was clustered around low values; community experience had a somewhat more normal distribution. Both the mean and median are given for each variable.

The variables in Table 4.2 examine experience in terms of impact. Participants were given a card listing potential damages and asked to identify those they had experienced at any point in their lives. The table shows the number of affirmative responses for each damage type mentioned by more than 5 percent of the sample. Not surprisingly in an area of frequent flooding and few through roads, 64 percent of those interviewed had experienced disrupted transportation. One person acknowledged structural damage and another the death of a family member or friend. No affirmative responses were recorded for either crop damage or injury. Damages other than those listed below were cited by 7 percent of the respondents and included damage to docks or peripheral decks. One person witnessed a stranger drown. Of the 45 people who participated in the survey, 11 claimed they had never experienced any damage due to flooding.

Table 4.1. Flood Experience

	Number of Times flooded											
	0		1-5		6-10		Over 11		Total		Median	Mean
	#.	%	#	%	#	%	#	%	#	%		
Current Home or Property	26	58%	16	36%	2	4%	1	2%	45	100%	0.00	1.82
Lifetime Home or Property	18	40%	23	51%	3	7%	1	2%	45	100%	1.00	4.22
Lifetime Workplace	38	84%	6	13%	1	2%	0	0%	45	100%	0.00	0.29
Lifetime Community	3	7%	22	49%	12	27%	8	18%	45	100%	4.00	9.96

Table 4.2. Flood Damages

Disrupted Transport.		Floor or Wall Coverings		Furniture		Keepsakes		Contaminated Water		Appliances		Loss of Business		No Damage	
#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
29	64%	14	31%	9	20%	4	9%	3	7%	3	7%	3	7%	11	24%

Flood Related Behavior

The next set of variables focused on behavior. Questions addressed actions taken to reduce flood damage, reduce vulnerability, and share loss. The first question dealt with actions taken to secure personal property or safety during flood events. Participants were given a card listing some possible responses and asked to name those they had employed during a flood event at any time in their life. The percentage of participants naming each response type is listed in Table 4.3. The number who elevated valuables reflects the number of respondents who have experienced flooding at their current residence (see Table 4.1). Similarly, the percentage who have never responded to an event is comparable to the percent whose current property has never been flooded.

Table 4.3. Personal Event Response

Elevated Valuables		Evacuated		Personal Sandbagging		Other (Taped Windows)		No Personal Event Response	
#	%	#	%	#	%	#	%	#	%
16	36%	6	13%	4	9%	1	2%	28	62%

In the next question, participants were asked about community response activities during a specific event. At the time of the 1998 October flood, 64 percent of the survey respondents were living in Wimberley. One person identified himself as part of the 1998 emergency response team. Another identified himself as currently part of the Citizen Emergency Response Team. Again, individuals were given a list and asked to name any and all activities in which they participated.

Of participants citing actions other than those listed on the card, one person helped to process flood insurance claims and provide information in a professional capacity. Others described neighborhood activities. Neighborhood based activities were the most commonly mentioned, though locally organized relief efforts did exist and were publicized in the local paper (Allen, 1998). An article in the October 28th 1998 *Wimberley View* indicated that a scheduled clean up was "sparsely attended" (Bond, 1998). It appears that community activity was fairly limited to those directly affected, the efforts of the Wimberley Intercommunity Network notwithstanding. The majority (69 percent) of respondents took no community action. Activities mentioned by more than one person are included in Table 4.4. Only one person mentioned making a donation; distribution of food and water was not mentioned by any of the participants.

Table 4.4. Community Response, 1998 October Floods

Community Sandbagging		Distribution of Aid		Community Cleanup		Neighborhood Cleanup		Helped Friends Take Action		No Community Action	
#	%	#	%	#	%	#	%	#	%	#	%
2	4%	2	4%	3	7%	5	11%	5	11%	31	69%

The third question of the behavior set focused on general protective measures. Each person was asked whether he or she had raised a house above flood level, raised utilities, or taken other protective measures. Measures receiving multiple affirmative responses are included in Table 4.5. Moving a propane tank, modifying a septic system, and moving higher were each mentioned by one person. Most participants had not taken any protective measures, though 58 percent lived in either the 100 or 500 year floodplain (see Table 4.6).

Table 4.5. General Protective Measures

Raised House		Raised Utilities		Created Diversions		Checked Previous Levels with Neighbors		Purposely Bought or Built outside Floodplain/ Elevation Certificate		No Protective Measures Taken	
#	%	#	%	#	%	#	%	#	%	#	%
4	9%	6	13%	2	4%	2	4%	5	11%	26	58%

The final question related to mitigation dealt with flood insurance. Participants were asked whether or not they had insurance, or if they did not know. Individuals were also asked whether or not they lived in a Special Flood Hazard Area (SFHA). Respondents were again given the Don't Know option. Results are included in Table 4.6.

Table 4.6. Floodplains and Flood In surance

		YES		NO		DON'T KNOW		Total	
		#	%	#	%	#	%	#	%
In SFHA	Insurance	6	40%	4	27%	5	33%	15	100%
	Believe they are in SFHA	8	53%	0	0%	7	47%		
In 500 Year	Insurance	5	45%	5	45%	1	9%	11	100%
	Believe they are in SFHA	1	9%	8	73%	2	18%		
Not in Official Floodplain	Insurance	3	16%	14	74%	2	11%	19	100%
	Believe they are in SFHA	0	0%	12	63%	7	37%		
Total Insurance		14	31%	23	51%	8	18%	45	100%

One third of the participants were previously determined to be living in an SFHA. Another 24 percent lived in the 500 year floodplain. Of those 26 people, only 42 percent claimed to have flood insurance. It is likely that those who answered Don’t Know thought it was included in their home policy or renter’s insurance. Some who answered Yes may have believed the same; FEMA claims that, as of December, 2003, only 9 Wimberley policies were in force. These numbers and the behavioral results of Table 4.5 indicate a potential failure of flood policy and communication. Those in the floodplain appear to be dangerously unprepared for another large flood from the standpoint of policy.

Respondents were also asked to rate their familiarity with the National Flood Insurance Program (NFIP). No explanation of the program was given. Familiarity was rated on a four point scale, 1 being very unfamiliar and 4 being very familiar. Results were not encouraging and are included in Table 4.7. The lack of familiarity with the program may help to explain the apparent lack of preparation indicated above. Lave and Lave (1991) cite the poor marketing of the NFIP as particularly problematic; communication of program goals and benefits needs to be improved.

Table 4.7. NFIP Familiarity

Very Unfamiliar (1)		Somewhat Unfamiliar (2)		Somewhat Familiar (3)		Very Familiar (4)		Total		Mean
#	%	#	%	#	%	#	%	#	%	
25	56%	11	24%	5	11%	4	9%	45	100%	1.73

Information Sources

The fourth set of questions in the Personal Flood History concerned sources of flood information and respondents' subsequent satisfaction. Participants were given a card listing a number of possible sources of information. They were then asked to choose their primary source for information on local flooding. They were also asked to name their primary source of information on flood response options. Sources that were not originally listed, but garnered multiple votes, are included with the rest in table 4.8. Two people did not name a source in either question, saying they did not care about flooding and had not looked for information.

In both cases, TV was the most widely preferred source for information, with Friends and Family second. These findings reinforce the results of a study by Anderson (2001) conducted in San Marcos, Texas. It is imperative that the television media in the area be well informed. Commercials might also be an effective means of communicating options. When the interviews were conducted, FEMA had just begun running an informational advertisement regarding flood insurance; it was mentioned a few times.

Table 4.8. Information Sources

Info Source		TV	Radio	Paper	Friends or Family	Local Gov	Fed or State Gov	Internet	Common Sense/ Experience
On Local Flooding	% Affirmative	64%	4%	4%	11%	2%	0%	4%	0%
	Number Affirmative	29	2	2	5	1	0	2	0
On Response Options	% Affirmative	49%	0%	2%	17%	7%	2%	4%	11%
	Number Affirmative	22	0	1	8	3	1	2	5

The majority of those who cited local government as their primary source of information had a relative working in an emergency or planning related organization. Others exclaimed, “You’ve got to be kidding.” It appears that many do not directly associate the government with flood information. What’s more, they might not trust what information they do get. Disdain seems to run deep; in 2002, a referendum was introduced to disband the village government (Wimberley Comprehensive Plan, 2002). While it did not pass, individuals may find the media more accessible and more trustworthy. Anderson’s work found that only 40 percent of those interviewed recognized the government as a trustworthy source of information, while 85 percent considered television to be trustworthy (Anderson, 2001). If this is the case, the government would be wise to work through the media directly.

Overall satisfaction with available flood information was rated on a five point scale, 1 being very dissatisfied, 3 being neither satisfied nor dissatisfied and 5 being very satisfied. Over two thirds (71 percent) of respondents were either very satisfied or somewhat satisfied with available information. While some may not know what they are missing (as evidenced by behavior, insurance, and NFIP familiarity scores), the overall score does indicate trust in the primary sources mentioned in Table 4.8. These sources should be utilized. Totals for each level are given in Table 4.9.

Table 4.9. Flood Information Satisfaction

Very Dissatisfied (1)		Somewhat Dissatisfied (2)		Neither Satisfied nor Dissatisfied (3)		Somewhat Satisfied (4)		Very Satisfied (5)		Total		Mean
#	%	#	%	#	%	#	%	#	%	#	%	
2	4%	1	2%	10	23%	23	51%	9	20%	45	100%	3.80

Section 2: Comparative Flood Descriptions

Section 2 consisted of five subsections and was the main source of the data used in analysis. The questions in the first four subsections were very similar, if not identical, and were designed to illustrate respondents' perceptions of uncertainty and levels of concern related to flooding. Comparable data were collected using the four methods of description outlined in the introduction: the 100 year flood; a flood with a 1 percent chance of occurring any year; a flood with a 26 percent chance of occurring in 30 years; and an online flood risk map from Project Impact designed by FEMA and the GIS company ESRI. All descriptions refer to a flood of the same theoretical size. The results of these subsections were used to evaluate the relative effectiveness of each term as a means to communicate flood risk. The fifth subsection makes an attempt to identify other potentially effective methods of flood communication through the use of both open and closed questions.

The results of each of the first four subsections are included in Tables 4.10 - 4.21. The first table in each subsection section concerns questions of uncertainty over time and space. The second deals with expressed need for protection of both personal and community interests. The third indicates expressed levels of concern pertaining to personal and community loss. In the first two sets, participants were asked to respond to statements using a four point scale of agreement where 1 equaled Strongly Disagree and 4 equaled Strongly Agree. A Don't Know option was also given. The data on concern levels were gathered using a 6 point scale where 1 equaled Very Unconcerned and 6 equaled Very Concerned. Don't Know was not a given option.

100 Year Flood Results

The first descriptive method used was the 100 year flood. Perception of uncertainty was assessed in four ways. Participants were first asked to respond to the statement, "A 100 year flood will not happen again in my lifetime." The next statement was, "A 100 year flood could happen one or more times in any year." Respondents were then asked the extent to which they agreed that scientists could accurately assess the size of a 100 year flood. The last of the uncertainty statements was, "The size of a 100 year flood will change over time." Results are listed in Table 4.10. Unless otherwise noted, uncertainty statements used in the following three subsections simply substitute the descriptive term.

Perception of protection warranted by the 100 year flood was evaluated on two levels. Respondents were first asked to what extent they agreed that they should protect themselves against the 100 year flood. They were also asked to respond to the statement, "My community should protect itself against the 100 year flood." Results are contained in Table 4.11. Identical statements of protection agreement were used in each of the following three subsections. Only the descriptive terms are different.

Table 4.10. 100 Year Uncertainty

	Strongly Disagree (1)		Somewhat Disagree (2)		Somewhat Agree (3)		Strongly Agree (4)		Don't Know		Total	
	#	%	#	%	#	%	#	%	#	%	#	%
One or More in Year	3	7%	6	13%	17	38%	17	38%	2	4%	45	100%
Not in Lifetime	23	51%	15	33%	4	9%	1	2%	2	4%	45	100%
Size Accurate	17	38%	11	24%	10	22%	1	2%	6	13%	45	100%
Size Change	0	0%	1	2%	17	38%	17	38%	10	22%	45	100%

Table 4.11. 100 Year Protection

	Strongly Disagree (1)		Somewhat Disagree (2)		Somewhat Agree (3)		Strongly Agree (4)		Don't Know		Total	
	#	%	#	%	#	%	#	%	#	%	#	%
Should Protect Self	1	2%	7	16%	17	38%	18	40%	2	4%	45	100%
Community Should Protect Itself	1	2%	2	4%	15	33%	27	60%	0	0%	45	99%

Like warranted protection, concern levels were also related to both personal interests and community interests. Participants were asked to rate their level of concern regarding personal loss due to a 100 year flood. Next, they were asked about their concern regarding community loss due to a 100 year flood. Results are found in Table 4.12. In the next three subsections, the only differences in the questions regarding concern are the terms used to describe the flood.

Table 4.12. 100 Year Concern Levels

	Very Unconcerned (1)		Somewhat Unconcerned (2)		Slightly Unconcerned (3)		Slightly Concerned (4)		Somewhat Concerned (5)		Very Concerned (6)		Total	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Pers. Loss	14	31%	4	9%	6	13%	8	18%	7	16%	6	13%	45	100
Comm. Loss	3	7%	2	4%	2	4%	8	18%	14	31%	16	36%	45	100

1 Percent Chance Results

The second phrase used to describe a flood that policy considers hazardous was “a flood with a 1 percent chance of occurring in any year.” No reference flood or explanation was given to the participants. In the first uncertainty statement read, the timeframe was changed from “lifetime” to “next year”. Responses to the uncertainty statements are found in Table 4.13. Protection and concern statements remained the same. Results are listed in Tables 4.14 and 4.15, respectively. Of particular note is the difference between the distributions of personal concern and community concern. The mean for personal concern was 2.96; that of community concern was 4.31. This appeared to be a consistent trend across the descriptive methods and will be analyzed more thoroughly in the next chapter.

Table 4.13. 1% Chance Uncertainty

	Strongly Disagree		Somewhat Disagree		Somewhat Agree		Strongly Agree		Don't Know		Total	
	#	%	#	%	#	%	#	%	#	%	#	%
One or More in Year	2	4%	3	7%	12	27%	26	58%	2	4%	45	100%
Not Next Year	31	69%	7	16%	3	7%	0	0%	4	9%	45	100%
Size Accurate	18	40%	12	27%	9	20%	0	0%	6	13%	45	100%
Size Change	1	2%	1	2%	16	36%	16	36%	11	24%	45	100%

Table 4.14. 1% Chance Protection

	Strongly Disagree		Somewhat Disagree		Somewhat Agree		Strongly Agree		Don't Know		Total	
	#	%	#	%	#	%	#	%	#	%	#	%
Should Protect Self	5	11%	7	16%	20	44%	12	27%	1	2%	45	100%
Community Should Protect Itself	3	7%	2	4%	14	31%	26	58%	0	0%	45	100%

Table 4.15. 1% Chance Concern Levels

	Very Unconcerned (1)		Somewhat Unconcerned (2)		Slightly Unconcerned (3)		Slightly Concerned (4)		Somewhat Concerned (5)		Very Concerned (6)		Total	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Pers. Loss	16	36%	3	7%	7	16%	8	18%	8	18%	3	7%	45	100
Comm. Loss	4	9%	2	4%	3	7%	12	27%	15	33%	9	20%	45	100

26 Percent Chance Results

The third method used to communicate flood risk was "a flood with a 26 percent chance of occurring in 30 years." It should be noted that 64 percent of the respondents found this method confusing and asked for clarification. When asked, the interviewer described the flood as having an approximately one in four chance of occurring over the course of a standard mortgage. This technique has been used by the TVA and NRC as a means of explaining the phrase. All other statements were framed in the same manner as those concerning the 1 percent chance flood. Results are found in Tables 4.16, 4.17, and 4.18. As in the previous methods, a rather high percentage (in this case, 24 percent) of respondents answered “Don’t Know” to the question regarding change over time. This indicates a lack of awareness of the links between land use and flooding and may warrant a targeted education campaign. Increased understanding might increase public support for non-structural mitigation.

Table 4.16. 26% Chance Uncertainty

	Strongly Disagree		Somewhat Disagree		Somewhat Agree		Strongly Agree		Don’t Know		Total	
	#	%	#	%	#	%	#	%	#	%	#	%
One or More in Year	0	0%	7	16%	17	38%	16	36%	5	11%	45	100
Not Next Year	23	51%	17	38%	3	7%	0	0%	2	4%	45	100
Size Accurate	28	62%	9	20%	4	9%	0	0%	4	9%	45	100
Size Change	1	2%	1	2%	17	38%	15	33%	11	24%	45	100

Table 4.17. 26% Chance Protection

	Strongly Disagree		Somewhat Disagree		Somewhat Agree		Strongly Agree		Don’t Know		Total	
	#	%	#	%	#	%	#	%	#	%	#	%
Should Protect Self	3	7%	5	11%	20	44%	16	36%	1	2%	45	100
Community Should Protect Itself	1	2%	2	4%	16	36%	26	58%	0	0%	45	100

Table 4.18. 26% Chance Concern Levels

	Very Unconcerned (1)		Somewhat Unconcerned (2)		Slightly Unconcerned (3)		Slightly Concerned (4)		Somewhat Concerned (5)		Very Concerned (6)		Total	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Pers. Loss	13	29%	5	11%	6	13%	7	16%	8	18%	6	13%	45	100
Comm. Loss	3	7%	3	7%	5	11%	4	9%	19	42%	11	24%	45	100

Map Results

In the fourth subsection, the communication method was visual. The maps illustrated the boundaries of the official 100 year and 500 year floodplains, but the shaded areas were not described in those terms. Participants were asked only about the depiction of the 100 year floodplain, and told that the area was considered by flood policy to be of high risk. The first two uncertainty statements were the same as above. Those regarding accuracy and change were dropped. Instead, the interviewer indicated a point on the map (consistent in each surveyed neighborhood) outside the “high risk” area and asked how much they agreed with the statement, “If I live here, I am safe from flooding.” This statement addressed map accuracy and the potential for unrepresented change. Results for the uncertainty statements are given in Table 4.19. Assessment methods for protection and concern levels did not change. Results are included in Tables 4.20 and 4.21.

Table 4.19. Map Uncertainty

	Strongly Disagree		Somewhat Disagree		Somewhat Agree		Strongly Agree		Don't Know		Total	
	#	%	#	%	#	%	#	%	#	%	#	%
One or More in Year	0	0%	3	7%	20	44%	17	38%	5	11%	45	100
Not Next Year	31	69%	7	16%	5	11%	0	0%	2	4%	45	100
Safe Outside Shading	14	31%	13	29%	12	27%	4	9%	2	4%	45	100

Table 20. Map Protection

	Strongly Disagree		Somewhat Disagree		Somewhat Agree		Strongly Agree		Don't Know		Total	
	#	%	#	%	#	%	#	%	#	%	#	%
Should Protect Self	6	13%	4	9%	17	38%	16	36%	2	4%	45	100
Community Should Protect Itself	2	4%	3	7%	9	20%	30	67%	1	2%	45	100

Table 21. Map Concern Levels

	Very Unconcerned (1)		Somewhat Unconcerned (2)		Slightly Unconcerned (3)		Slightly Concerned (4)		Somewhat Concerned (5)		Very Concerned (6)		Total	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Pers. Loss	13	29%	4	9%	5	11%	10	22%	5	11%	8	18%	45	100
Comm. Loss	2	4%	3	7%	2	4%	5	11%	15	33%	18	40%	45	100

Section 3: Demographics

The questions of Section 3 were used to collect general demographic information, including gender, race, education levels, income, and age. Participants were also asked for the number of years they had lived at both their current address and in Wimberley. Gender, race, and education levels were assessed using nominal scales. Respondents were asked to indicate their income using an ordinal scale. Information on age and years of residency were gathered using open ended questions.

Of the 45 participants, 23 (51%) were women. This is slightly lower than the 2000 Wimberley CDP Census figure of 54 percent for females over 18. All but two individuals, or 96% of the sample, indicated their race as “white, non-Latino”. The remaining 4% described themselves as “Latino”. Census 2000 percentages were 91 percent white and 7 percent Latino. The Census Bureau also reported that the median adult age for the population was 45.6 years in 2000; the sample median was 52 years. The youngest participant was 19 years old and the oldest was 83. On average, respondents had lived at their current address for 7.96 years, though the minimum was only 0.08 years and the maximum was 30 years. The mean number of years spent in Wimberley was 11.95, with a minimum of 0.08 years and a maximum of 83 years. Medians for both residency variables were lower than the means at 6 years and 9 years, respectively.

The breakdown of education and income levels are included in Tables 4.22 and 4.23. Education categories refer to highest degree or level of education the individual achieved. One individual declined to answer. The income level represents the estimated range of the respondent’s annual household income in 2003. Seven people did not want their income level recorded.

Table 4.22. Education Levels

High School Diploma or GED		Some College		Associate's Degree		Bachelor's Degree		Master's Degree		Professional Degree		PhD		No Data		Total	
#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
8	18%	10	22%	2	4%	17	38%	6	13%	0	0%	1	2%	1	2%	45	100

Table 4.23. Income Levels

Under $20,000		$20,001-35,000		$35,001 – 50,000		$50,001 – 75,000		$75,000 – 100,000		Over $100,000		No Data		Total	
#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
5	11%	12	27%	5	11%	5	11%	4	9%	7	16%	7	16%	45	100

According to the Census Bureau, 41.2 percent of Wimberley's population held a Bachelor's degree or higher in 2000. Of those interviewed, 24, or 53 percent, held the same. When comparing only the percentage of those holding Bachelor's degrees, the sample was approximately 14 points higher than the Census data. Percentages were similar in all other listed categories. However, none of the respondents had less than a high school diploma or the equivalent, while in the overall population, the Census Bureau estimated the rate to be close to 11 percent. Median income for the Wimberley Designated Census Area was $46,042 in 2000. Median income for the sample was between $35,001 and $50,000. This includes the Census median, though the distributions were not equal. Survey participants were slightly better educated and slightly older than Wimberley's general population, but overall, the sample approximates the intended population fairly well.

Identifying Alternatives

Included in Sections 1 and 2 of the survey were questions intended to identify potentially effective (in terms of both understanding and persuasion) methods of flood communication. The results from three sets of questions are presented here.

Specific Flood Levels and Relative Concern

In the first set, descriptions of flood size were given in terms of height relative to residence. Participants were read a series of flood heights ranging from the yard to over one foot in the home and asked to indicate the level of concern associated with each. It should be noted that most residences in Wimberley do not have basements. Respondents used the same concern scale used in the previous subsections. Results are included in Table 4.24.

Table 4.24. Residential Flooding and Concern

	Very Unconcerned (1)		Somewhat Unconcerned (2)		Slightly Unconcerned (3)		Slightly Concerned (4)		Somewhat Concerned (5)		Very Concerned (6)		Total	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Yard	4	9%	2	4%	1	2%	8	18%	14	31%	16	36%	45	100
Outer Walls	2	4%	1	2%	1	2%	3	7%	11	24%	27	60%	45	100
Up to 6 Inches	2	4%	0	0%	0	0%	1	2%	4	9%	38	84%	45	100
6 Inches to 1 Foot	1	2%	0	0%	1	2%	0	0%	1	2%	42	93%	45	100
Over 1 Foot	1	2%	0	0%	1	2%	0	0%	1	2%	42	93%	45	100

There appear to be two breaking points in the levels of concern associated with specific relative heights. The first is the point where water contacts the outside walls of the residence. The number of people answering Very Concerned jumped 24 percentage points. An identical increase was observed when the theoretical flood waters moved inside the residence. These points could potentially be used in flood risk communication to make the threat more concrete.

Methods of Describing Flood Size

In the Personal Flood History section of the questionnaire, respondents were asked to identify the size of the 1998 flood using their own words. Their answers were then coded by type of description. Seven types of description were used by more than one person, including return period, qualitative comparison to other floods, flood stage in feet, reference to some point on an individual's property, the estimated number of homes flooded in the community, discharge in cubic feet per second, and Don't Know. These categories and the number of people that used each are found in Table 4.25.

Numerical answers within the categories varied greatly and are included where applicable. One person used a community landmark and another used rainfall to describe size. One person used two methods to describe the flood. Twenty-nine people (64 percent) identified themselves as living in Wimberley during the time of the 1998 flood. Those who did not were not asked to describe the size of the flood, though three mentioned it. Their answers are noted in the table. Most others who did not live in Wimberley during the 1998 flood mentioned in passing that they did not know its size.

Table 4.25. Methods of Size Identification

	Return Period		Relative to Other Floods		Stage		Home Reference		# of Homes Lost		CFS		Don't Know/ No Data	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
98 Residents	7	16%	5	11%	4	9%	3	7%	3	7%	1	2%	5	11%
1998 Non-Res	0	0%	2	4%	0	0%	0	0%	0	0%	1	2%	13	29%
Descriptive Range	100 to 500 Year		2^{nd} to 1^{st} Largest		25' to 40'		NA		1 to 50		28,000 to 300,000 cfs		NA	

Not surprisingly, return period was one of the two most frequently used methods to describe the flood. It is the method most commonly used by both the media and officials in communication. Seven people also described the flood in terms of its size relative to other floods. This may be somewhat useful, but depends on a single collective memory that newcomers do not have access to, and that may differ among the experienced. Flood stage was the third most frequently used method, and may not be currently utilized to its full potential.

Aspects of Flooding and Concern

In the third question presented in this section, participants were asked to identify the aspect of flooding of most concern to them. Four choices were given, including Level, Frequency, a Combination of Level and Frequency, and Other. Of the four people who picked Other, three stated that they were not concerned about anything. One cited speed. The results are included in Table 4.26.

Table 4.26. Most Concerning Aspect of Flooding

Level		Frequency		Combination		Other		Total	
#	%	#	%	#	%	#	%	#	%
22	49%	0	0%	19	42%	4	9%	45	100%

Approximately half (49 percent) of the people interviewed identified flood level as the most concerning aspect of flooding. Another 42 percent cited a combination of level and frequency. None chose frequency alone. This is a problem. The term most frequently used to describe floods, like the terms introduced to replace it, is wholly focused on frequency. Flood risk communication cannot hope to be effective if it does not address the concerns of those it is intended to reach. The same can be said of flood policy. Frequency methods might be effective if linked to specific heights or damages, as was suggested by the NRC (2000). Used alone, their effectiveness is questionable. A flood stage linked to specific physic al markers may be more effective than current methods in communicating flood risk and inducing appropriate pre-event attitude and behavior. Agreed upon flood levels might also be more useful in creating and enforcing flood policy.

Summary

The data presented in this Chapter provide foundation and direction for further analysis. The sample was shown to represent the intended population moderately well. Those interviewed had a broad range of experience and familiarity with flooding and flood programs. Attitudes toward flooding and flood protection also differed, though responses appeared to be more closely grouped than expected. The final section showed that individuals describe floods in a variety of ways and that current methods of flood risk description may not address public concerns. This issue, like the research questions and hypotheses outlined in Chapter One, requires more in depth analysis and will be examined more thoroughly in the following Chapter.

Chapter Five: Analysis and Discussion

Introduction

This project attempted to answer four questions within the context of the case study area.

5. What is the public perception of the hundred year flood in terms of probability and risk?
6. Is "hundred year flood" terminology effective in communicating flood risk?
7. Is the visual representation of the hundred year flood effective in communicating flood risk?
8. Are the terms introduced as replacements for or augmentations of "the hundred year flood" more effective in communicating flood risk?

The descriptive statistics of the last chapter provided foundation and direction, but substantive answers require more in depth analysis.

In Chapter One, hypotheses were put forth concerning the relative effectiveness of four methods used to describe flood risk. Hypotheses regarding the relationships of certain situational and cognitive factors to aspects of perception were also developed. In addition to assessing the validity of the hypotheses, this chapter looks at the relationships between situational and cognitive factors and the protective behavior exhibited by those living in the floodplain.

Several statistical techniques were used to test hypotheses and examine the data. Comparisons of effectiveness were made using paired *t*-tests for those variables with a relatively normal distribution. Friedman and Wilcoxon sign-rank tests were used to compare variables with skewed distributions. Relationships between situational and cognitive factors and aspects of perception were assessed using Pearson's correlation coefficient, cross tabulation, and independent *t*-tests. In order to increase the validity of the survey results, related variables were combined to form scales; scale validity and reliability were tested using factor analysis and Cronbach's alpha. Specific analyses are explained as they are used.

Comparing Relative Effectiveness

As described in previous chapters, the bulk of the survey was made up of four subsections containing questions intended to measure effectiveness. Each subsection used a different method to describe the same theoretical flood event. Verbal methods included the 100 year flood, a flood with a 1 percent chance of happening in any year, and a flood with a 26 percent chance of occurring in 30 years. Floods were described visually through a flood risk map available online through FEMA's Project Impact. Only two people mentioned the equality of the 100 year and 1 percent chance events. None equated the 26 percent chance event with a flood described by other means.

Chapter One outlined two methods used to assess the effectiveness of communication: understanding and persuasion. In this project, understanding focused on uncertainty concepts associated with flood descriptions. Four questions in each subsection dealt with environmental or human uncertainty. Persuasion was also handled with four questions and was split to reflect levels of concern and the perceived need for protection relative to each description. These questions were combined to form scales of uncertainty, protection, concern, and overall persuasion (a combination of protection and concern).

Scale Creation

Individual questions provide insight into perception, but the larger concepts of uncertainty and risk are more pertinent in the comparison of effectiveness. The data regarding the 100 year flood were used to test the validity and reliability of the new scales. The 100 year flood is the most commonly used method of flood description and respondents answered this subset of questions with more confidence, leaving fewer missing values. Answers of Don't Know were treated as missing values in factor analysis and reliability testing. Factor analysis confirmed the usefulness of grouping the eight questions into the categories of uncertainty, protection, and concern described above and detailed in the previous chapter.

Before testing for reliability using Cronbach's alpha, the negative questions were recoded to reflect a single directional scale. The question regarding the ability of scientists to accurately assess the size of a theoretical flood event was dropped from the final uncertainty scale. In the factor analysis, it had the lowest inter-item correlation of all the uncertainty variables as well as the lowest loading score. Factor results for the uncertainty scale are found in Table 5.1.

Table 5.1. Uncertainty Variable Correlations and Factor Loading for Uncertainty Scale

Variables	Correlations			Uncertainty Loading
	Anytime	Not Again	Accurate	
Anytime	1.000	.6320	.4067	.8912
Not Again	.6320	1.000	.2740	.7537
Accurate*	.4067	.2740	1.000	.5204
Will Change	.5239	.3008	.08510	.7147

Anytime = Event might happen one or more times in a year
Not Again = Event will not happen again in lifetime
Will Change = Size of the event will change over time
Accurate = Scientists can accurately assess the size of the event
*Variable not included in final scale

The adjusted scale contained fewer missing values and the alpha score increased slightly. In addition, the accuracy question had more to do with human error and the uncertainties of science than environmental uncertainty, bringing in issues of trust. This question is useful in exploring perception, but less useful in assessing an understanding of uncertainty. No variables were dropped from the persuasiveness scales.

Cronbach's alpha is essentially a correlation measure and ranges from 0 to 1. Values close to one indicate that the scale produces consistent results and that each item has a strong relationship to the others in the scale. Rodeghier (1996) and Litwin (2003) set the guidelines for reliability at alpha equals approximately 0.70, though Rodeghier indicates that, “this rule of thumb is approximate and should not be routinely applied” (Rodeghier, 1996). Because of the limited number of variables in all the scales and the skewness of the protection scale, alpha was not expected to be extremely high. Cronbach’s alpha for the uncertainty and protection scales were 0.69 and 0.68, respectively. Each scale can be said to be relatively reliable.

Table 5.2. Cronbach’s Alpha for 100 Year Uncertainty, Protection, Persuasion, and Concern Scales

	Cronbach’s Alpha	Valid Cases*
Uncertainty Scale	0.69	33
Protection Scale	0.68	43
Concern Scale	0.46	45
Persuasion Scale	0.55	43

*Don’t Knows eliminated

Cronbach’s alpha for the concern scale was only 0.46. Condensing the response categories did not improve the score. Other descriptive methods had higher reliability ratings for the concern scale. The low alpha could be a result of both the limited number of variables and the large difference between personal concern and concern for the community, which will be discussed in a subsequent section. The alpha of the overall persuasion scale was also affected by this split. When concern variables for each descriptive method were used in an overall scale of concern, Cronbach’s alpha was 0.89. A combined persuasion scale resulted in an alpha of 0.91. It is useful to the analysis to include and compare the subsets.

Creation and Evaluation of Uncertainty and Persuasion Variables

In order to compare the effectiveness of the four methods of description, new variables were formed based on the tested scales. The values of individual variables were added together to create the new scores. The uncertainty scale consisted of three variables with original value ranges of 1 through 4. (Refer to the second section of Chapter Four and Tables 4.10, 4.13, 4.16, and 4.19 for specifics. The accuracy value was dropped and values for "Next" were reversed for consistency. New values lay between 3 and 12. Protection values were also based on a four point scale (see Tables 4.11, 4.14, 4.17, and 4.20) and new values ranged from 2 to 8. Concern variables were based on a six point scale (see Tables 4.12, 4.15, 4.18, 4.21); the new range was from 2 through 12. In each case, the higher the score, the more effective the communication was judged to be from the standpoint of policy.

U.S. flood policy has been based on an event described as the 100 year flood. Policy considers this event to be high risk to both individuals and communities, but does the public view it as such? New terms have been introduced to increase public understanding of uncertainty, but do these terms induce the desired level of concern and protection? In this study, methods of communication were judged to be effective if the observed mean is at least 85 percent of the total possible points. This percentage would indicate that, on average, individuals answered at least one question of each scale in strong agreement with policy and no questions in opposition to policy or with "Don't Know".

As discussed below, there were no significant differences found between the various descriptive methods regarding the number of Don't Know answers. Because of this, Don't Know answers were treated as missing values in direct comparisons. However, when judging the overall effectiveness of a method in contributing to the understanding of uncertainty or in shaping attitudes, Don't Know is not a neutral answer. It indicates that the coding used may not be recognizable. This is especially evident when looking at effectiveness in terms of understanding. When evaluating effectiveness as a percentage of a scale's total possible points, Don't Know answers were assigned a value of zero and included in the calculation of the mean. Hypotheses concerning effectiveness and expected relative scores are outlined in Table 5.3.

Table 5.3. Hypotheses of Effectiveness and Expected Relative Scores

Descriptive Method	Hypotheses	Expected Relative Scores	
		Uncertainty	Persuasion
100 Year Flood	Perceived to Be Regular and Predictable; Moderate Risk	Low	Moderate
1% Chance Flood	Perceived to be Random; Low Risk	High	Low
26% Chance Flood	Perceived to Somewhat Regular, but Unpredictable; Moderate Risk	Moderate	Moderate
Map	Boundaries Absolute, but Timing Somewhat Unpredictable	Moderate to Low, Depending on Location	Moderate to Low, Depending on Location

Comparing Perceptions of Uncertainty

All four uncertainty variables had a fairly normal distribution. Because hypotheses had been made regarding the relative effectiveness of each term, comparisons were made using one-tailed paired t-tests with an alpha of 0.05. Each uncertainty variable was compared to the other three. Table 5.4 includes the differences in paired means, the level of significance of that difference, the actual mean of each variable when Don't Knows are treated as zeroes, and the 95 percent confidence interval for the mean as a percentage of total points possible. Cell values and signs indicate the difference between the means of variables in the first column and those in columns two, three, and four. Tables should be read horizontally.

Table 5.4. Comparisons of Uncertainty Variables

	100 Year Comparison		1% Comparison		26% Comparison		Mean (Don't Knows Treated as Zeroes)**	95% Confidence Interval (Mean as Percentage of Total Points)	
	Dif.	Sig.	Dif.	Sig.	Dif.	Sig.		Low	High
100 Year Uncertainty	NA	NA	-.53*	.040	.03	.45	8.91	67.4%	81.1%
1% Uncertainty	.53	.04	NA	NA	.52	.00	9.20	69.8%	83.5%
26% Uncertainty	-.03	.45	-.52	.00	NA	NA	8.71	66.2%	79.0%
Map Uncertainty	0.00	.50	-.62	.01	-.22	.23	9.16	70.2%	82.4%

* Negative signs indicate that the variable in the corresponding row has a lower mean than the associated column variable. Values indicate the magnitude of the difference.
**Total possible points equals 12

As hypothesized, the 1 percent method of description has the highest overall mean score, but the map comes very close and has the smallest standard deviation when including Don't Knows as zeroes. None of the 95 percent confidence intervals include values totaling 85 percent of the total points possible. However, only the 26 percent method's confidence interval lies entirely below 80 percent of the total points; it is also the only method whose median is 9 rather than 10.

While none are categorically effective, no method can be dismissed as completely ineffective in conveying uncertainty. The higher than expected mean value given the 100 year flood may have quite a bit to do with its familiarity in a developing, flood prone area. Mental adjustments may have been made by turning '100 year' events into regular episodes of a different period. Experience may similarly impact the map score, as many individuals had a concrete idea of past flood parameters and neighborhood topography. The influence of experience and other situational factors on perception will be examined in subsequent sections.

In direct comparisons using paired t-tests, uncertainty scores associated with the 1 percent flood were significantly higher than those of all three of the other descriptive methods. Though the map was suspected to have the lowest comparative uncertainty score, no significant differences were found between the map, the 100 year, or the 26 percent methods.

Comparing Perceptions of Accuracy

The 26% results should be treated carefully. The accuracy question was removed from the uncertainty scale, but best illustrates a qualitative trend observed during the interviews. Participants were uncomfortable with the apparent exactness of both the percentage and the timeframe in the 26% chance in 30 years description. When asked whether they agreed that scientists could accurately assess the size of a flood described in this manner, more than one participant exclaimed, after a derisive snicker, "Who do they think they are, God?". Reactions were immediate and often forceful and appeared to be directly related to the terms used. None of the other methods of description elicited such a strong response. Quantitative analysis confirmed the trend.

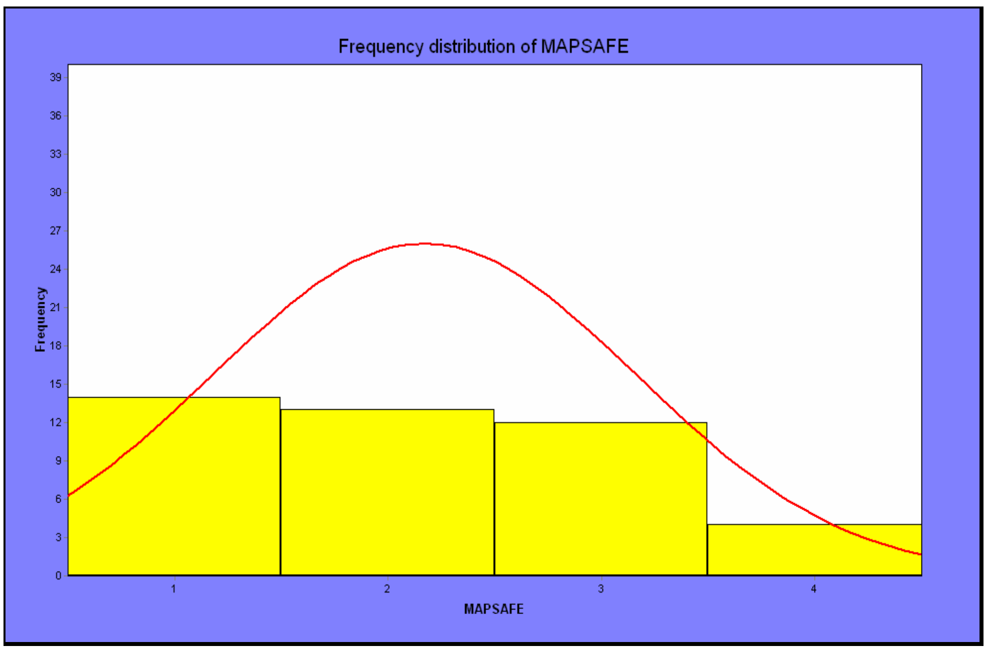
Table 5.5. Comparisons of Perceived Accuracy

	100 Year Comparison		1% Comparison		26% Comparison		Individual Mean**	95% Confidence Interval (Mean as Percentage of Total Points)	
	Dif.	Sig.	Dif.	Sig.	Dif.	Sig.		Low	High
100 Year Accuracy	NA	NA	.08	.13	.47	.00	1.87	39.6%	54.0%
1% Accuracy	-.08	.13	NA	NA	.38	.00	1.77	37.7%	50.8%
26% Accuracy	-.47*	.00	-.39	.00	NA	NA	1.42	30.1%	40.7%
Map Accuracy	.27	.08	.29	.07	.70	.00	2.14	45.9%	61.1%

* Negative signs indicate that the variable in the corresponding row has a lower mean than the associated column variable. Values indicate the magnitude of the difference.
**Total possible points equals 4

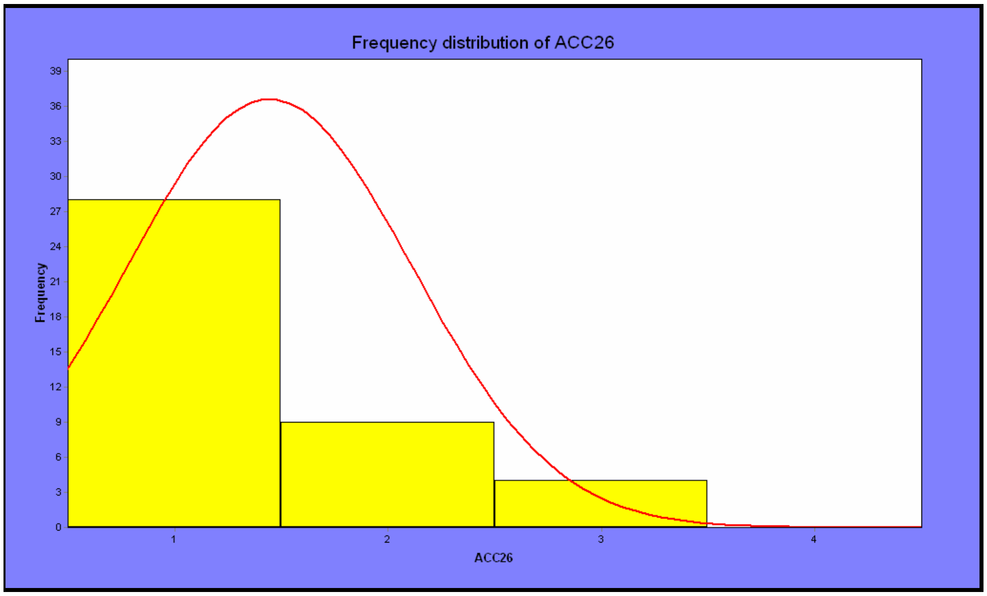
Comparisons were again made through a one-tailed t-test at alpha = 0.05. Neither the variable nor the scale were modified from the original, so the scale ranges from 1 = strongly disagree to 4 = strongly agree. No significant differences were found between the other methods, though the map had the highest overall score and its highest p-value was 0.08. The difference in mean score was up to 5 times as great as the differences between other scores. Differences were all significant at 0.00. The extreme shift in attitude is illustrated in Figures 5.1 and 5.2.

Figure 5.1. Histogram of Map Accuracy Ratings



1=Strongly Disagree, 4=Strongly Agree

Figure 5.2. Histogram of 26% Chance Accuracy Ratings



1=Strongly Disagree, 4=Strongly Agree

While a healthy skepticism of science and probability is useful and indicates a better understanding of uncertainty, its total dismissal is detrimental to both persuasion and understanding. The agreement scores are all low, but the strength of the disagreement associated with 26% terminology and accuracy makes other data gathered using the term suspect. This judgment is reinforced by the confusion score (64 percent asked for clarification) discussed in the last chapter.

During the interviews, it also appeared that the probability terms (1 percent and 26 percent chance) were garnering more answers of "Don't Know" than the map or the 100 year flood description. This was most apparent in the uncertainty section of the survey. Don't Know content was also statistically tested; a method with a comparatively high number of Don't Knows could be considered somewhat ineffective, regardless of other test results. It may indicate a potential coding problem in addition to a comprehension problem.

New variables were created by converting all Don't Know values to 1 and all others to 0. Don't Know values for each descriptive method were combined, then compared. The map had the fewest Don't Know responses and the lowest score, which in this case is a positive thing. When compared to both the 1 percent method and the 26 percent method, the resulting p-value was 0.055. No other differences were significant at alpha equals 0.05 or 0.10. While this could be considered a boost for the case of the map, there was more of a relationship between individual questions and answers of Don't Know. Out of 65 total Don't Knows, 50 occurred in the questions about accuracy and change. These concepts of uncertainty, particularly that of change over time, should perhaps be targeted through education.

Comparing Attitudes Toward Protection

The protection variables as a whole did not clearly demonstrate either a normal or skewed distribution; all were generally concentrated around high values, but differed in the patterns of their lower values. Because of the ambiguity of the variables' distributions as a whole, both non parametric tests and t-tests were used to detect tends. Possible values ranged from 2 to 8, with higher values more desirable from the perspective of policy.

Initially, a Friedman test was used. Differences were not found to be significant at alpha equals 0.05, though the p-value was 0.071. Wilcoxon tests found significant differences in protection scores between the 1 percent method and the 100 year flood (1 percent lower, p = 0.02) and 1 percent and 26 percent (1 percent lower, p = 0.02). The 1 percent score was lower than the map score at a significance of 0.07. No other differences were significant. The results of the non parametric tests were reinforced through the results of the paired t-tests, included in Table 5.6. Means and confidence intervals are also listed.

Table 5.6. Comparison of Protection Variables

	100 Year Comparison		1% Comparison		26% Comparison		Individual Mean (Don't Knows Treated as Zeroes)**	95% Confidence Interval (Mean as Percentage of Total Points)	
	Dif.	Sig.	Dif.	Sig.	Dif.	Sig.		Low	High
100 Year Protection	NA	NA	.49	.01	.12	.26	6.58	76.6%	87.9%
1% Protection	-.49*	.01	NA	NA	-.34	.02	6.22	71.7%	83.9%
26% Protection	-.12	.26	.34	.02	NA	NA	6.53	76.4%	87.0%
Map Protection	-.26	.13	.28	.11	.07	.37	6.31	71.6%	86.2%

* Negative signs indicate that the variable in the corresponding row has a lower mean than the associated column variable. Values indicate the magnitude of the difference.
**Total possible points equals 8

The combination of results may help confirm that the 1 percent description is less effective than the other terms in inducing protective behavior or appropriate levels of concern, as was hypothesized. This method was the only one whose confidence interval did not include the 85 percent mark. It was close, however, and both the median and the mode were 7. The mode for the 26 percent method was only 6. Though the 1 percent method appears relatively less effective, the results are inconclusive. The expressed desire to protect oneself and community against flooding may not be related to the terms used to describe risk.

Comparing Concern

Concern variables showed a normal distribution, so the one-tailed paired t-test was used with an alpha of 0.05. Results are included in Table 5.7. Cell signs and values again refer to the variables in the first column.

Table 5.7. Comparisons of Concern Variables

	100 Year Comparison		1% Comparison		26% Comparison		Individual Mean (No Don't Knows Recorded)**	95% Confidence Interval (Mean as Percentage of Total Points)	
	Dif.	Sig.	Dif.	Sig.	Dif.	Sig.		Low	High
100 Year Concern	NA	NA	.60	.03	.18	.23	7.87	58.9%	72.2%
1% Concern	-.60*	.03	NA	NA	-.42	.06	7.27	54.2%	67.0%
26% Concern	-.18	.23	.42	.06	NA	NA	7.69	57.0%	71.1%
Map Concern	.27	.16	.87	.00	.44	.02	8.13	60.8%	74.7%

* Negative signs indicate that the variable in the corresponding row has a lower mean than the associated column variable. Values indicate the magnitude of the difference.
**Total possible points equals 12

Though the map was significantly more effective than either of the probabilities, it was not shown to be better than the 100 year flood in raising concern. This may again be attributable to public familiarity with 100 year flood terminology and the aforementioned confusion caused by probabilities. Maps may serve as an effective jolt to those on the fringes of the Special

Flood Hazard Area who have not sought out a lot of information and have not been required to get insurance. Several respondents (especially those near the 100 year flood plain) remarked that they did not realize they were so close to danger. None of the percentage ranges are encouraging, however, and the 1 percent description is shown to be the least effective in motivating attitude. Its paired mean concern score was significantly lower than those of both the map and the 100 year flood and only slightly above significant in relation to the 26 percent description.

Comparing Persuasion

As an overall measure of persuasion, a scale including the two protection variables (personal and community) and the two measures of concern (also personal and community) was found to have a Cronbach's alpha of greater than .67 for three out of the four methods of description. The highest was 0.73, the lowest 0.55, with an average of 0.66. Based on these numbers, the scale was judged to be fairly reliable and was used to compare the overall effectiveness of each method, as judged by persuasion.

The original protection variables were based on a four point scale; concern variables ranged from one to six. In order to give protection and concern equal weighting in the new scale, protection scores were multiplied by 1.5 before combination. Overall persuasion scores ranged from 6 to 24. Distribution was normal and comparisons were made using one-tailed paired t-tests at alpha = 0.05. Results are included in Table 5.8.

Table 5.8. Comparisons of Overall Persuasion Scores

	100 Year Comparison		1% Comparison		26% Comparison		Individual Mean (Don't Know Treated as Zeroes)**	95% Confidence Interval (Mean as Percentage of Total Points)	
	Dif.	Sig.	Dif.	Sig.	Dif.	Sig.		Low	High
100 Year Persuasion	NA	NA	1.36	.01	.24	.27	17.73	69.1%	78.6%
1% Persuasion	-1.36*	.01	NA	NA	-.99	.01	16.60	63.7%	74.6%
26% Persuasion	-.24	.27	.99	.01	NA	NA	17.49	67.5%	78.3%
Map Persuasion	-.15	.37	1.37	.01	.27	.26	17.60	67.2%	79.5%

* Negative signs indicate that the variable in the corresponding row has a lower mean than the associated column variable. Values indicate the magnitude of the difference.
**Total possible points equals 24

Persuasion scores for the 1 percent method were found to be significantly lower than each of the other three. The null hypothesis of equality could not be rejected in the remaining comparisons. Overall scores are moderate, but the 100 year description, 26 percent chance method, and map can be said to be equally effective in this context. However, the 26 percent chance results should be eyed warily in light of the issues mentioned above.

Comparing Overall Scores

Comparisons of the descriptive methods' overall scores were not found to be useful. Scales including all uncertainty and persuasion variables had Cronbach's alphas ranging from 0.42 for the 100 year to 0.66 for the map. These scores indicate that an overall scale is not reliable and may point to a problem in linking understanding and persuasion. T-tests showed no significant differences between the methods of description. Those that had relatively high scores in uncertainty had low scores in persuasion, and vice versa. This appears to be a fundamental problem in communicating flood risk. Managers and policy makers may have to decide whether understanding or persuasion is most important.

Comparing Attitudes Towards Individuals and Community

Another trend identified qualitatively during the interviews was the disparity between expressed attitudes towards personal loss and responsibility and community loss and responsibility. In order to address this issue quantitatively, all four descriptive scores for personal protection were combined. Scores were also combined for personal concern, community protection, and community concern variables. Cronbach scores were all over 0.81, with a high of 0.94. Each new scale can be said to be reliable.

Both community scores were somewhat skewed, but personal scores had a normal distribution. Comparisons were made using one-tailed t-tests at alpha = 0.05. The range of possible protection scores was from 4 to 16. Concern scores ranged from 4 to 24. Results are included in Tables 5.9 and 5.10.

Table 5.9. Comparison of Personal and Community Protection Variables

	Personal Protection		Mean (Total Points Equals 16)	95% Confidence Interval (Mean as a Percentage of Total Points)	
	Dif.	Sig.		Low	High
Personal Protection	NA	NA	12.17	69.9%	82.2%
Community Protection	1.74	.00	13.93	82.3%	91.8%

Table 5.10. Comparison of Personal and Community Concern

	Personal Concern		Mean (Total Points Equals 24)	95% Confidence Interval (Mean as a Percentage of Total Points)	
	Dif.	Sig.		Low	High
Personal Concern	NA	NA	12.67	44.5%	61.0%
Community Concern	5.62	.00	18.29	69.5%	82.9%

In both cases, community means were significantly higher than personal means. Part of the difference can be attributed to the responses of people with limited flood experience living in areas of minimal risk. But even those in areas considered at high risk for flooding tended to worry about their neighbors more than themselves. This might indicate another possible tack for emergency managers and planners. A focus on community impacts and benefits might create the concern and support necessary for non structural mitigation projects. However, it might also represent a transference of perceived responsibility the individual to the community, or, as was explained in Chapter One, a dissonant perception of personal risk.

The attitudes expressed may not translate into community action or support for community protection projects. Survey results concerning activities during severe flooding showed that, while neighborhood activities were somewhat common in affected areas, city-wide participation was minimal (see Table 4.4). Likewise, though protection scores were relatively high, actions taken to protect personal property by those considered at risk (100 and 500 year flood plain) were not widespread (see Tables 4.5 and 4.6). Only 11 out of the 26 individuals considered at risk claimed to have insurance. Only 5 of the 15 in the 100 year floodplain have taken other mitigative measures. The disparity between community and personal scores may also cause friction when community projects require what might be considered unnecessary personal adjustment.

Comparing Specific and Abstract Descriptions

In addition to rating their levels of personal and community concern in response to abstract descriptions of risk, participants were also asked to respond to specific descriptions. Flood levels were given relative to individuals' residences and ranged from the "yard" to "over 1 foot" in the house (see Table 4.24). Only personal concern was evaluated.

During the interviews, participants appeared more involved and concern scores seemed higher when discussing specifics. Personal concern scores for each of the abstract descriptions and for the lowest specific level given (yard) are included in Table 5.11. One-tailed paired t-tests were used to compare the means and detect significant differences. Results are found in Table 5.12. Because the abstract methods refer to a flood inundating the SFHA, only those living in the Special Flood Hazard Area were used in the comparison.

Table 5.11. Specific and Abstract Levels of Concern*

	Yard	100 Year	1% Chance	26% Chance	Map
Mean Personal Concern	4.53	3.87	2.67	3.60	3.80

*Total possible points equals 6

Table 5.12. Comparisons of Personal Concern*

	100 Year		1% Chance		26% Chance		Map	
	Diff.	Sig.	Diff.	Sig.	Diff.	Sig.	Diff.	Sig.
Yard	.67	.10	1.87	.01	.93	.03	.73	.05

*Total possible points equals 6

The mean level of concern was shown to be higher for the specific reference than for any of the other methods of flood description. Differences between the yard score and the 1 percent chance, the 26 percent chance, and the map were significant at alpha = 0.05. Only the difference between the 100 year method and the yard was not. These results reinforce the potential usefulness of concrete reference points in communication. It might be that specific references are more effective in motivating desired attitude and behavior than abstract descriptions of flood risk.

Testing Hypotheses of Perception

In addition to comparing the effectiveness of various methods of communicating flood risk, this project sought to examine the effects of some situational factors on perception. It was hypothesized that the understanding of uncertainty increased with education and flood experience. It was expected that perceived risk (illustrated through persuasion variables) would increase with age and would be higher for women than for men. Lastly, it was expected that those living in the floodplain would have higher uncertainty and persuasion scores than those who do not.

The first three hypotheses were tested using Pearson's product moment to detect positive correlations. Education data were collected nominally, but were treated as a progressive 8 point scale in this test, 1 being the completion of 12th grade or lower without receiving a high school diploma or the equivalent, and 8 being the completion of a Ph.D. Experience was assessed through both frequency and impact. The frequency scale combined the number of times the individual's current property has flooded with the number of times in their lifetime their property has flooded. This scale was found to be reliable and had a Cronbach's alpha of 0.69. Flooding of businesses and the community were not shown to be reliable measures. The damage scale was limited to positive responses concerning damage to structures, floor or wall coverings, appliances, furniture, or keepsakes, and contaminated drinking water. Cronbach's alpha was 0.73 for this scale, showing it to be reliable as well. The original data on age was not altered.

Don't Knows were treated as zeroes in correlation assessments in order to retain the number of cases and to make sure those who might answer Don't Know most frequently were not left out. Including the Don't Knows may assist in targeting education and improving communication. Correlation coefficients for these situational factors and uncertainty and persuasion scores are found in Table 5.13. Combined uncertainty, protection, concern, and persuasion scales were all found to be reliable.

Table 5.13. Correlations with Uncertainty and Persuasion Scores

	Uncertainty		Protection		Concern		Persuasion	
	Corr.	Sig.	Corr.	Sig.	Corr.	Sig.	Corr.	Sig.
Education	.32	.02	-.057	.36	-.24	.06	-.12	.22
Experience (Frequency)	-.04	.39	-.16	.15	-.14	.19	-.17	.13
Experience (Damage)	.16	.14	.03	.43	.14	.18	.10	.25
Age	-.17	.13	-.23	.07	-.14	.17	-.21	.08

Tests showed that only one of the hypothesized relationships existed in this sample. Education was shown to have a moderate positive correlation with the understanding of uncertainty concepts. However, a slight negative correlation between education and levels of concern was found to be just less than significant at alpha = 0.05. This may have to do with education's relation to income and an increased ability to take action.

The final two hypotheses were tested using independent one-tailed t-tests with an alpha of 0.05. Gender comparisons used "female" as the primary variable. Results are found in Table 5.14. Gender differences were significant in both levels of concern and overall persuasion scores (a combination of protection and concern). This result confirms the hypothesis that perceived risk is higher in women than men. Significant differences were also found between male and female uncertainty scores. Females in this sample had a lower understanding of uncertainty than did the males. This may be due to the difference in education levels between the men and women who participated in the survey. Independent t-tests found the women to have a mean education score 1.15 points lower than that of the men (p = 0.01).

Table 5.14. Gender Comparisons

	Uncertainty		Protection		Concern		Persuasion	
	Dif.	Sig.	Dif.	Sig.	Dif.	Sig.	Dif.	Sig.
Difference Between Female and Male Means	-4.40*	.05	.99	.28	6.58	.01	8.07	.04

*Negative sign indicates that female mean score is lower than male mean score

No significant differences were found in the attitudes of those living in the SFHA and those living in the 500 year floodplain. These categories were combined and then tested against the attitudes of non-floodplain dwellers. No significant differences were observed in either uncertainty or persuasion variables. This may, in part, be due to the rather common attitude of those living near the river that flooding is part of river life. As one man said, "It's only water". Is this an example of dis sonant perception, or an understanding and acceptance of the uncertainty of the chosen location? Many of those in the floodplain who have insurance feel they have done what they can to protect themselves and do not need to worry about personal loss. This might also partially explain the split between personal and community concern scores.

Attitude and Behavior in the Floodplain

While the participation and support of the entire community are necessary to enact mitigation, one of the goals of flood policy is to encourage mitigative behavior in those living in the floodplain. In order to adjust methods of communication and look for areas of possible improvement in policy, it is necessary to look at situational factors that might be correlated with desired action as well as attitude.

Twenty-six of the forty-five people interviewed lived in either the 100 year or 500 year floodplain (see Table 4.6). Those in the 100 year are considered more at risk and policy targets their behavior more specifically than those living in the 500 year floodplain. I used cross tabulations to look at potential differences in the purchase of insurance and other pro-active behaviors (see Table 4.5) between the two populations. No significant differences were found in the likelihood of either group purchasing insurance. Those in the 500 year floodplain were shown to be significantly more likely ($p = 0.04$) to take other precautionary actions. However, it should be noted that many cited settling outside the 100 year flood plain as a precautionary action.

Since there was no apparent difference in the purchasing of insurance between the two designated floodplains, broader associations were sought. Only 11 of the 26 claimed to have insurance. Pearson's product moment was used to test he correlation between insurance and education, income, age, flood experience, and the number of years in Wimberley. It was expected to be positive in each case. Coefficients and significance for each variable are found in Table 5.15. No correlations were found between these situational factors and protective behaviors other than the purchase of insurance. Nor was any correlation apparent between experience (frequency or damage) and the purchase of insurance. All results in this section are based on a fairly small sample, however, and may not reflect relationships extant in the population.

Table 5.15. Situational Factors and Insurance Purchase in the Floodplain

	Insurance Purchase	
	Corr.	Sig.
Age	.79	.00
Income	.54	.01
Education	.59	.00
Years in Wimberley	.43	.03

As predicted, all four situational factors were found to be positively correlated with floodplain residents' purchase of insurance. All were significant at the 0.05 level. The correlation between age and insurance was particularly strong, perhaps pointing to the influences of life experiences not quantified in the variables used in this project. Age had additional positive correlations to education (0.57, p = .00) and income (0.37, p = .05). Education and income were also positively correlated (0.36, p = .06), though not significantly so at the .05 level. In the floodplain cases, the number of years spent in Wimberley was not associated with any other variable. However, when all cases were used, length of residence had a significant correlation to damage (.28, p = .03). In light of this, the number of years in Wimberley might be viewed as another measure of experience. The relationship of age, income, education, and insurance might point to the importance of a perceived ability to pay for insurance, while the years spent in Wimberley might instill in people a perceived need to pay in order to prevent loss.

What kind of relationships do expressed attitudes have with mitigative behavior in the floodplain? In order to explore this question, overall uncertainty, protection, and concern variables were set against the purchase of insurance as well as other protective behavior. Pearson's product moment was used to test the correlations. Results are included in Table 5.16. Significant correlations of situational factors followed the patterns of the full data set outlined in Table 5.13.

Table 5.16. Floodplain Attitude and Behavior

	Purchase of Insurance		Other Mitigative Behavior	
	Corr.	Sig.	Corr.	Sig.
Uncertainty	.02	.47	.36	.03
Concern	-.41	.04	-.06	.39
Protection	.20	.19	-.40	.03

Three relationships were found to be significant. Two were negative and moderately strong. The hypothesized relationship between insurance and concern mentioned in the above section is borne out quantitatively here. Respondents already had or did not have insurance when asked about concern. Any explanation of correlation must reflect that temporal aspect. While tempting, it does not make sense to hypothesize that, because people are concerned, they have insurance. The quantitative correlation may be coincidental, but many in the floodplain said they were not concerned about loss *because* they had insurance. In fact, when compared using an independent t-test, the mean concern score of those with insurance was 8.4 points lower than those without (p = .04). This relationship may prove to be a hurdle to those in the community attempting to implement additional mitigation measures. A similar phenomenon might also be at work in the negative correlation between protection and behavior, though no significant difference was found when tested.

Uncertainty scores had a moderate (0.36) positive correlation to other mitigative behavior, though no correlation to insurance purchase. Uncertainty was also positively correlated to both education and income. The behavioral correlation to uncertainty may indicate individuals with an understanding of risk, knowledge of protective measurements available (or required), and the means to implement them.

Summary

Some of the hypotheses put forth in Chapter One regarding the relative effectiveness of the four descriptive methods were supported by statistical analysis. Others were discounted. As predicted, the 1 percent method was found to be significantly more effective in conveying uncertainty than any of the other three. It was also shown to be the least effective method in motivating attitudes of protection and concern. The map performed better than expected in terms of both understanding and persuasion and was significantly more effective than either of the probabilities at inducing desired levels of concern. The 100 year flood was also shown to be more effective than predicted in conveying uncertainty, though this may be due to the mental adjustment of an experienced community rather than a real understanding of the term.

The 26 percent method was comparatively less effective than expected in conveying uncertainty. More importantly, qualitative and quantitative analysis pointed to underlying problems in using the 26 percent chance to describe flood risk. The extreme shift in attitude illustrated by the accuracy question and the 64 percent confusion rate described in Chapter Four indicate an inherent weakness in the method. These problems may be due, in part, to inappropriate coding.

Hypotheses regarding the relationships of situational and cognitive factors to perception were only partially supported by analysis. As expected, education and uncertainty scores were positively correlated. Women were found to have higher concern and persuasion scores than men. Predictions of positive correlations between age, experience, location and perception were not borne out in the results. These factors were found to be more closely related to behavior (see Table 5.13 for correlations to insurance purchase).

An important trend concerning the effectiveness of descriptive methods was identified through analysis. Uncertainty and persuasion appear to be irreconcilable in the current methods used to convey flood risk. This split is evident in the low Cronbach scores of the combined scales, the varied performance of the 1 percent chance method in different arenas, the lack of differentiation when overall scores were compared, and the opposite signs of correlations between education and uncertainty and education and concern. When tested directly, the negative correlation between uncertainty and certain persuasion variables is clear and significant. Results for the entire data set and for the floodplain subset are included in Table 5.17. This disparity is more pronounced in the floodplain subset and may be one of the most difficult hurdles for policy makers and risk communicators to overcome.

Table 5.17. Correlations Between Uncertainty and Persuasion

	Protection		Concern		Persuasion	
	Corr.	Sig.	Corr.	Sig.	Corr.	Sig.
Uncertainty (All)	.11	.24	-.30	.02	-.14	.19
Uncertainty (Floodplain)	-.31	.06	-.43	.01	-.43	.02

The negative relationship between uncertainty and persuasion variables is only one of the trends identified through analysis. Chapter Five built on qualitative observation and the results presented in Chapter Four, statistically examining relationships between descriptive methods of flood risk, situational factors, perception, and behavior. General trends believed to have the greatest potential impact on effective communication are laid out in Chapter Six.

Chapter Six: Conclusions

Hypotheses

The project's research hypotheses were addressed in Chapter Five. Only one of the hypotheses concerning the four methods of description was validated; the 1 percent chance method was found to be the most effective in conveying uncertainty and the least effective in motivating attitude. Both the map and the 100 year method produced better than expected uncertainty scores. The uncertainty score for the 26 percent method was worse than expected.

Five situational factors were predicted to have positive relationships with uncertainty and persuasion variables. Only two exhibited the expected correlations. Uncertainty scores increased with education levels and women were found to have higher concern and persuasion scores than men. Age, experience, and location were found to be related to the purchase of insurance, but had no significant correlation to uncertainty or persuasion variables. A more sensitive approach to location and a different evaluation of experience might alter these results, however.

Hypothesis testing provided a starting point for analysis, but the descriptive results presented in Chapter Four suggested other directions and raised new questions. By examining these possibilities, unexpected patterns in the data were revealed, producing more meaningful results. These new directions provided a broader perspective and a deeper understanding of the data, allowing it to be applied in a wider arena.

Implications for Flood Risk Communication

Four potentially important trends concerning the effective communication of flood risk and flood policy were identified using quantitative and qualitative analysis.

- First, effectiveness judged through understanding and effectiveness judged by persuasion appear to be at odds using current methods of description. Unless communication changes, a choice may have to be made. Persuasion and the 'engineering model' will likely prevail. The results of this project contradict the claim of the NRC (1995, 2000) that persuasion is dependent upon an understanding of uncertainty. More contextual research is necessary to clarify the relationship.

- Second, the description of a flood with a 26 percent chance of occurring in 30 years induced confusion, vehemence, and dismissal in the sample group. Further use of this term should be reconsidered in light of this reaction.

- Third, a significant difference was found in effectiveness as persuasion when related to individuals and the community. While this expressed difference might be capitalized on, it is more likely to be a hurdle to community mitigation projects.

- Lastly, survey participants were more concerned about flood levels than flood frequency and were more effectively persuaded when concrete references were used. These results reinforce recommendations by the NRC (1995, 2000) and Smith (2000) to include damage estimates and may point the way towards more effective communication.

Just as this project built on previous research regarding flood risk communication, the identification of these four trends may provide a base upon which other research can continue to build. The split between understanding and persuasion appears to be of particular concern, though it may be the result of a one size fits all flood policy and subsequent evaluation. Regardless, the relationship between the two must be better understood if flood plain management of any scale is to be effective.

Implications for Wimberley

Flood management in Wimberley appears to have focused on emergency response rather than pre-event planning or education. These aspects of preparation will become more important as the populations of both the village and the valley grow. The collective memory may fade with proportional experience. Newcomers might not have access to the mental and physical adjustments employed by the community in the past. A common context must be created.

One of the biggest potential difficulties facing floodplain managers focusing on pre-event context will be the apparent distrust of Wimberley residents. This hurdle may be as specific to Wimberley as the 2002 referendum proposing a dissolution of the village government. However, Anderson's (2000) work indicates the problem may be more widespread. Without trust, risk communication will not be effective.

In developing the Comprehensive Plan of 2002, the local government mailed surveys to every voter in greater Wimberley. Hays County used an internet survey in order to incorporate public input into the Hays County Mitigation Plan (www.co.hays.tx.us). These surveys set a precedent of broad, multidimensional communication that could potentially build trust. If good, consistent information is made available, this method could also be used to build locally effective flood policy. In the meantime, the burden of risk communication will likely fall to the media and local organizations. Managers may want to target these public contacts.

Generalization and Future Directions

The results of this project reinforced previous findings. Situational factors like education and gender were found to be related to perception (see

Tables 5.11 and 5.12); other situational factors were indirectly related through behavior (see Table 5.13). The effects of experience might be seen in the fairly consistent (and high) uncertainty scores (see Table 5.4). Response patterns clearly showed the importance of both the media and trust in risk communication. Results also supported those advocating attaching concrete references to abstract methods of communication.

Previous research concerning the relationship of understanding and persuasion was not supported, however. Nor were those touting the 26 percent chance description as an effective method of communicating flood risk. The sample was small, though, and Wimberley, like all places, is unique. No sweeping generalizations should be made based on this (or any) study. It is a supporting player.

While generalization is difficult, future research in communities large and small, experienced and non-experienced, may help identify components relevant to effective communication and contextually effective codes. The use of multivariate analysis adjusted for contextual relationships might assist in this search. Further research assessing the effectiveness of flood risk communication could result in new, democratic methods of description and help close the gap between understanding and persuasion. If effectiveness is valued over efficiency, loss and s uffering due to flooding might be reduced.

The role of flood policy itself cannot be ignored, however. In this project, and in general assessments of effectiveness, all individuals and communities were judged against a single perceptual and behavioral standard. The questions Murphy (1958) and White (Interview with Reuss,

1991) raised, and that Smith (2000) and others continue to raise regarding the effectiveness of a uniform flood policy, are still relevant. In order to truly assess the effectiveness of flood risk communication, it might also be necessary to look at the contextual effectiveness of ‘efficient’ flood policy.

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APPENDICES

Appendix A: Questionnaire

Efficient and Effective?
The Hundred Year Flood in the Communication and Perception of Flood Risk

Conducted by Heather Bell
University of South Florida

Faculty Advisor:
Dr. Graham Tobin

Introductory Statement

Hello, my name is Heather Bell. I'm a graduate student at the University of South Florida and I'm conducting a survey on people's attitudes toward flooding. I'd like to ask you some questions about your experience with flooding and how you feel about the likelihood of future floods. All of your answers are completely confidential; they will only be used for statistical purposes. The study is not funded by any company or corporation, and I am NOT trying to sell you anything. You may stop the interview at any time, but your participation will not only help me finish my thesis, it might also influence the way people talk about flooding and flood policy. The survey takes about 25 minutes to complete. Do you have any questions? May I continue?

If you have any questions or would like more information, please contact Dr. Graham Tobin at the University of South Florida at 813-974-4808. He can also be reached through e-mail at gtobin@cas.usf.edu.

Appendix A (Continued)

SURVEY NUMBER: ***FZONE:***

FIRST I'D LIKE TO ASK YOU SOME GENERAL QUESTIONS ABOUT YOUR EXPERIENCE WITH FLOODING.

Personal Flood History

1. Have you ever been flooded?

YES (1)	
NO (0)	

If no, skip to question 4.

2. How many times has your current home been flooded?

3. In your lifetime, how many times has your home or property been flooded?

4. ***In your*** lifetime, has your workplace been flooded? ***If no, mark 0.*** How many times?

5. In your lifetime, how many times has a community you have lived in experienced flooding?

If all above answers are 0, skip to question 12.

NOW I'D LIKE TO ASK YOU SOME MORE SPECIFIC QUESTIONS ABOUT DAMAGES AND WHAT YOU DID DURING FLOODING.

Give interviewee damages card

ON THIS CARD IS A LIST OF POSSIBLE DAMAGES DUE TO FLOODING.

6. What kinds of damages have you personally experienced?

Structural Damage to Residence	YES (1)
	NO (0)
Damage to Floor or Wall Coverings	1
	0
Damage to Furniture	1
	0
Damage to Appliances	1
	0
Damage to Keepsakes	1
	0
Contaminated Drinking Water	1
	0
Damage to Crops	1
	0
Disrupted Transportation	1
	0
Loss of Business	1
	0
Injury	1
	0
Death of Family Member or Friend	1
	0
Other (Please Describe)	1
	0

7. During a flood, have you ever taken any of the following measures?

Moved Valuables to Higher Elevation	YES (1)
	NO (0)
Sandbagged Doorways or Entrances	1
	0
Evacuated Your Property	1
	0
Other (Please Describe)	1
	0

WE'VE TALKED ABOUT YOUR EXPERIENCE WITH FLOODING IN GENERAL. NOW I'D LIKE TO TALK TO YOU ABOUT A SPECIFIC EVENT.

8. Did you live in Wimberley during the 1998 October flood?

YES (1)
NO (0)

If no, skip to question 12.

9. During the 1998 flood, were you a part of the Emergency Response Team?

YES (1)
NO (0)

Give interviewee activity card

10. Please indicate which, if any, of the activities listed on the card you took part in during the 1998 flood.

Sandbagging	YES (1)
	NO (0)
Search and Rescue	1
	0
Distributing Food and Water	1
	0
Distributing Aid	1
	0
Donating	1
	0
Community Clean-Up	1
	0
Other (Please Describe)	1
	0

11. To the best of your knowledge, what size was the 1998 flo od?

DK (555)

Begin questions here after skips.

I'D NOW LIKE TO ASK YOU ABOUT ANY MEASURES YOU'VE TAKEN AGAINST FLOODING IN GENERAL. I'D ALSO LIKE TO ASK ABOUT YOUR FAMILIARITY WITH FLOOD INFORMATION AND PROGRAMS.

12. In your lifetime, what measures have you personally taken against flooding?

Raised House Above Flood Level	YES (1)
	NO (0)
Raised Utilities Above Flood Level	1
	0
Other (Please describe)	1
	0

13. Do you have flood insurance?

YES (1)
NO (0)

14. Do you currently live in a Special Flood Hazard Area?

YES (1)
NO (0)
DK (555)

15. How familiar are you with the National Flood Insurance Program?

Very Unfamiliar (1)
Somewhat Unfamiliar (2)
Somewhat Familiar (3) Very Familiar (4)

HERE'S A CARD LISTING SOME POSSIBLE SOURCES OF FLOOD INFORMATION. PLEASE USE IT TO ANSWER THE NEXT TWO QUESTIONS.

16. What is your **primary** source for information about local flooding characteristics?

TV or Radio	YES (1)
	NO (0)
Newspapers	1
	0
Friends or Family	1
	0
Local Gov't	1
	0
State or National Gov't	1
	0
Other (Please Describe)	1
	0

17. What is your **primary** source for information about flood response options?

TV or Radio	YES (1)
	NO (0)
Newspapers	1
	0
Friends or Family	1
	0
Local Gov't	1
	0
State or National Gov't	1
	0
Other (Please Describe)	1
	0

Give interviewee card with satisfaction scale.

18. Using this scale, how would you rate your overall satisfaction with available flood information?

Very Dissatisfied (1)
Somewhat Dissatisfied (2)
Neither Satisfied nor Unsatisfied (3)
Somewhat Satisfied (4)
Very Satisfied (5)

THANK YOU. THE NEXT THREE SETS OF QUESTIONS HAVE TO DO WITH FLOODS DESCRIBED IN TERMS OF FREQUENCY OR PROBABILITY. HERE ARE TWO CARDS WITH THE SCALES YOU'LL USE TO ANSWER THEM. THE FIRST DEALS WITH AGREEMENT. THE SECOND DEALS WITH CONCERN.

Give interviewee agreement and concern cards.

The One Hundred Year Flood

19. The size of a flood is often described in terms of a time period. For example, we can describe a flood as being a 50 year flood, 100 year flood, or a 500 year flood. The following questions have to do with a 100 year flood, like the flood of 1998. Please indicate your level of agreement with the following statements using the categories listed on the agreement card.

Appendix A (Continued)

A flood of the same size as the 100 yr flood could happen one or more times in any yr	Strongly Disagree (1)	Disagree (2)	Agree (3)	Strongly Agree (4)	Don't Know (555)
A flood of the same size as the 100 yr flood will not happen again in my lifetime	1	2	3	4	555
Scientists can accurately assess the size of a 100 year flood	1	2	3	4	555
The size of the 100 year flood will change over time	1	2	3	4	555
I should protect myself against the 100 year flood	1	2	3	4	555
My community should protect itself against the 100 year flood	1	2	3	4	555

THE NEXT QUESTION DEALS WITH YOUR CONCERN ABOUT LOSSES DUE TO FLOODING

20. Please indicate the level to which you are concerned about each of the following using the categories listed on the concern card.

Personal loss due to a 100 year flood	Very Unconc (1)	Somewhat Unconc (2)	Slightly Unconc (3)	Slightly Conc (4)	Somewhat Conc. (5)	Very Conc (6)
Community loss due to a100 year flood	1	2	3	4	5	6

THE NEXT SET OF QUESTIONS IS SIMILAR TO THE LAST. THE SIZE OF A FLOOD CAN ALSO BE DESCRIBED IN TERMS OF ITS PROBABILITY. THIS SET OF QUESTIONS CONCERNS A FLOOD WITH A 1% CHANCE OF OCCURRING IN ANY YEAR. YOU WILL USE

THE SAME SCALES AS YOU DID FOR THE LAST SET OF QUESTIONS.

A Flood with a 1% Chance of Occurring in Any Year

21. Please indicate the level to which you agree with each of the following statements.

A 1% chance flood could happen one or more times in any year	Strongly Disagree (1)	Disagree (2)	Agree (3)	Strongly Agree (4)	Don't Know (555)
If our community experiences a 1% chance flood this year, we will be safe from one next year	1	2	3	4	555
Scientists can accurately assess the size of a flood with a 1% chance of occurring in any year	1	2	3	4	555
The size of a 1% chance flood will change over time	1	2	3	4	555
I should protect myself against a flood with a 1% chance of occurring in any year	1	2	3	4	555
My community should protect itself from a 1% chance flood	1	2	3	4	555

THE NEXT QUESTION AGAIN DEALS WITH CONCERN ABOUT LOSSES

22. Please indicate the level to which you are concerned about each of the following.

Personal loss due to a 1% chance flood	Very Unconc (1)	Somewhat Unconc (2)	Slightly Unconc (3)	Slightly Conc (4)	Somewhat Conc. (5)	Very Conc (6)
Community loss due to a 1% chance flood	1	2	3	4	5	6

THE NEXT SET OF QUESTIONS WILL USE THE SAME SCALES. THE QUESTIONS ARE SIMIL AR TO THOSE IN THE LAST SECTIONS. THIS TIME THE STATEMENTS DEAL WITH A FLOOD THAT HAS A 26% CHANCE OF OCCURRING IN A 30 YEAR PERIOD

A Flood with a 26% Chance of Occurring in 30 Years

23. Please indicate the level to which you agree with each of the following statements.

A flood with a 26% chance of occurring in 30 years could happen one or more times in any year	Strongly Disagree (1)	Disagree (2)	Agree (3)	Strongly Agree (4)	Don't Know (555)
If a 26% chance flood happens this year, we will be safe from one next year	1	2	3	4	555
Scientists can accurately assess the size of a 26% chance flood	1	2	3	4	555
The size of a flood with a 26% chance of occurring in 30 years will change over time	1	2	3	4	555
I should protect myself against a flood with a 26% chance of occurring in 30 years	1	2	3	4	555
My community should protect itself against a 26% chance flood	1	2	3	4	555

LIKE THE LAST TWO SECTIONS, THIS SECTION ALSO INCLUDES QUESTIONS ON LOSSES AND LEVELS OF CONCERN.

24. Please indicate the level to which you are concerned about each of the following.

Personal loss due to a flood with a 26% chance of occurring in 30 years	Very Unconc (1)	Somewhat Unconc (2)	Slightly Unconc (3)	Slightly Conc (4)	Somewhat Conc (5)	Very Conc (6)
Community loss due to a 26% chance flood	1	2	3	4	5	6

NEXT WE'RE GOING TO USE A MAP.

Give interviewee flood map

THIS IS A FLOOD HAZARD MAP. I'LL GIVE YOU A CHANCE TO LOOK AT IT AND THEN ASK YOU A FEW QUESTIONS ABOUT IT

25. The darkly shaded area represents the extent of a flood that flood policy considers hazardous. Using the categories on the agreement card, please indicate the level to which you agree with each of the following statements.

The outlined flood could happen one or more times in any year	Strongly Disagree (1)	Disagree (2)	Agree (3)	Strongly Agree (4)	Don't Know (555)
If a flood of the size outlined happens this year, it will not happen next year.	1	2	3	4	555
If I live here (show point outside all shading), I am safe from flooding.	1	2	3	4	555
I should protect myself against the flood outlined on the map	1	2	3	4	555
My community should protect itself against the flood outlined on the map.	1	2	3	4	555

THE NEXT QUESTION AGAIN CONCERNS LOSSES

26. Please indicate the level to which you are concerned about each of the following.

Personal loss due to the flood outlined on the map	Very Unconc (1)	Somewhat Unconc (2)	Slightly Unconc (3)	Slightly Conc (4)	Somewhat Conc (5)	Very Conc (6)
Community loss due to the flood outlined on the map	1	2	3	4	5	6

WE'VE TALKED ABOUT FLOODS IN TERMS OF FREQUENCY AND PROBABILITY. IN THE NEXT SET OF QUESTIONS, WE WILL FOCUS ON FLOOD LEVELS. WE WILL AGAIN USE THE SCALE OF CONCERN.

Flood Levels

27. I'm going to read off a list of flood levels relative to your residence. Please indicate the level of personal concern you would associate with each level.

Yard or Outside Walls	Very Unconc (1)	Somewhat Unconc (2)	Slightly Unconc (3)	Slightly Conc (4)	Somewhat Conc (5)	Very Conc (6)
1 to 6 inches	1	2	3	4	5	6
6 inches to 1 foot	1	2	3	4	5	6
1 foot to 3 feet	1	2	3	4	5	6

THE NEXT QUESTION DEALS WITH YOUR GENERAL CONCERNS ABOUT FLOODING.

28. What concerns you the most about flooding?

The Level of Possible Flooding	YES (1)
	NO (0)
The Frequency of Flooding of Any Level	1
	0
A Combination of Level and Frequency	1
	0

WE'RE ALMOST DONE. THE LAST QUESTIONS ARE SIMPLY USED TO GATHER SOME INFORMATION ABOUT THE GROUP OF PEOPLE BEING INTERVIEWED. AGAIN, ALL THE INFORMATION IS CONFIDENTIAL

Personal Information

29. Gender

Female	YES (1)
	NO (0)
Male	1
	0

Give interviewee race card

30. Which of those listed on this card best describes your race or ethnicity?

African American	YES (1)
	NO (0)
Asian	1
	0
Latino	1
	0
Native American	1
	0
White, non Latino	1
	0
Other Race (Please Describe)	1
	0

31. How long have you lived at your current address as of August 1st, 2004?

32. How long have you lived in Wimberley as of August 1st, 2004?

Give interviewee schooling card

33. Which of the educational levels listed on this card best describes the **highest** level of school or highest degree you have **completed**?

12th grade or less	YES (1)
	NO (0)
High School graduate or equivalent	1
	0
Some college	1
	0
Associate degree (academic or occupational)	1
	0
Bachelor's degree	1
	0
Master's degree	1
	0
Professional school degree	1
	0
Doctorate	1
	0

Give interviewee income card

34. Using this card, please indicate which category best describes your **household** income in 2003?

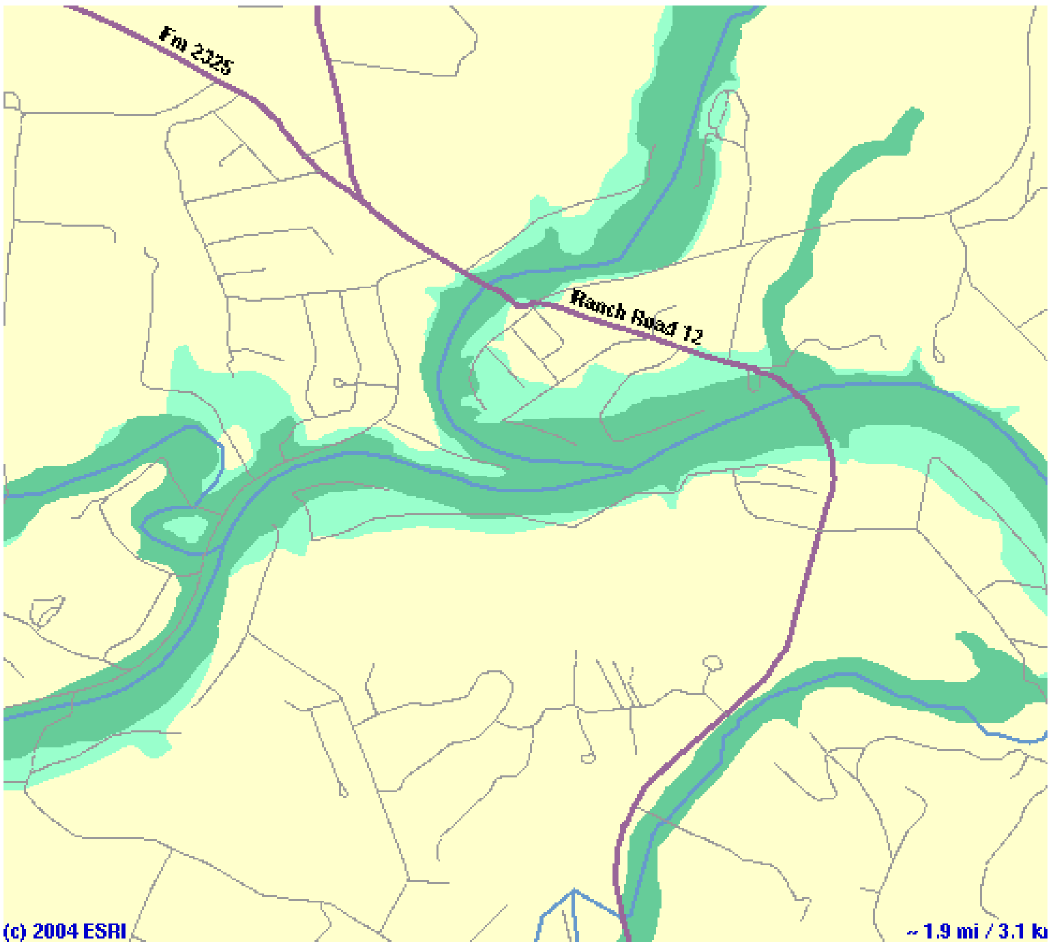
Under $20,000	YES (1)
	NO (0)
$20,001 – 35,000	1
	0
$35,001 – 50,000	1
	0
$50,001 – 75,000	1
	0
$75,001 – 100,000	1
	0
Over $100,000	1
	0

35. Lastly, what is your age as of your most recent birthday? ______

THAT COMPLETES THE SURVEY. THANK YOU SO MUCH FOR PARTICIPATING.

Don't forget the survey cards.

Flood Hazard Map



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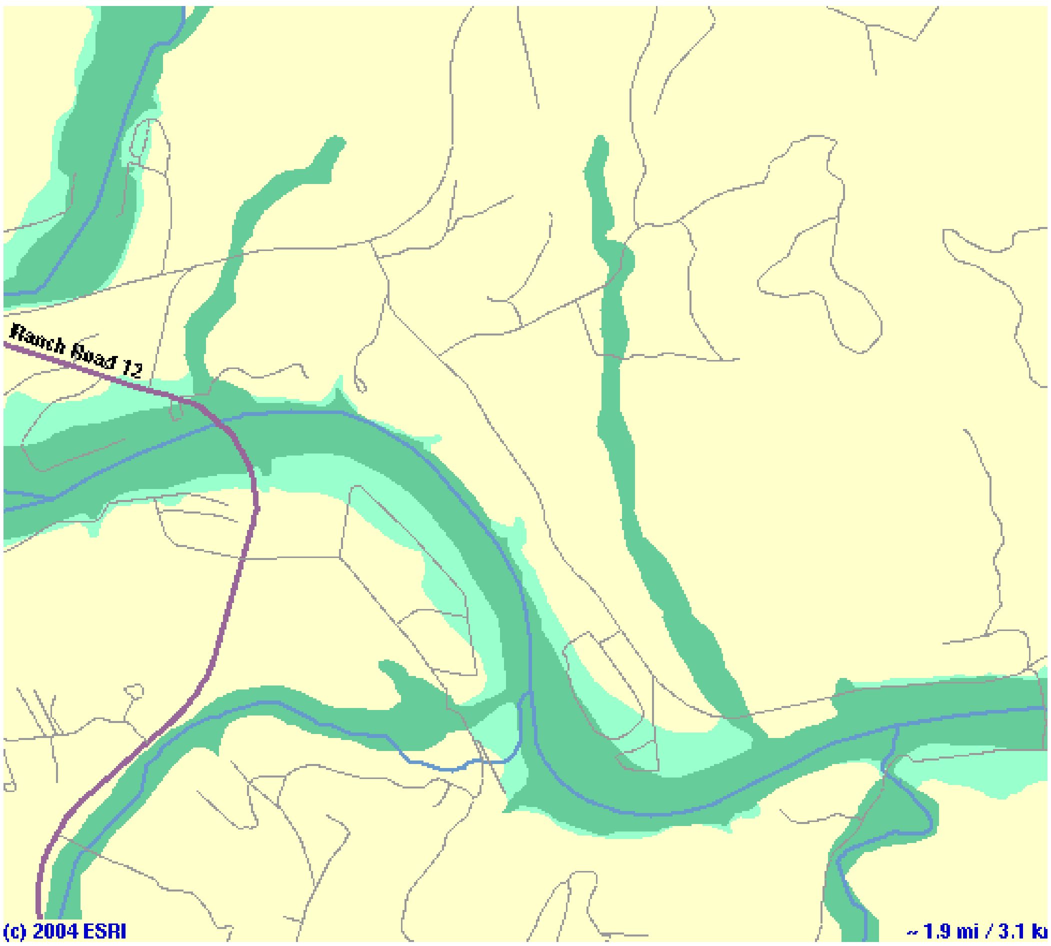
ESRI/FEMA Project Impact
Hazard Information and Awareness Site
http://www.esri.com/hazards

Flood Hazard Map



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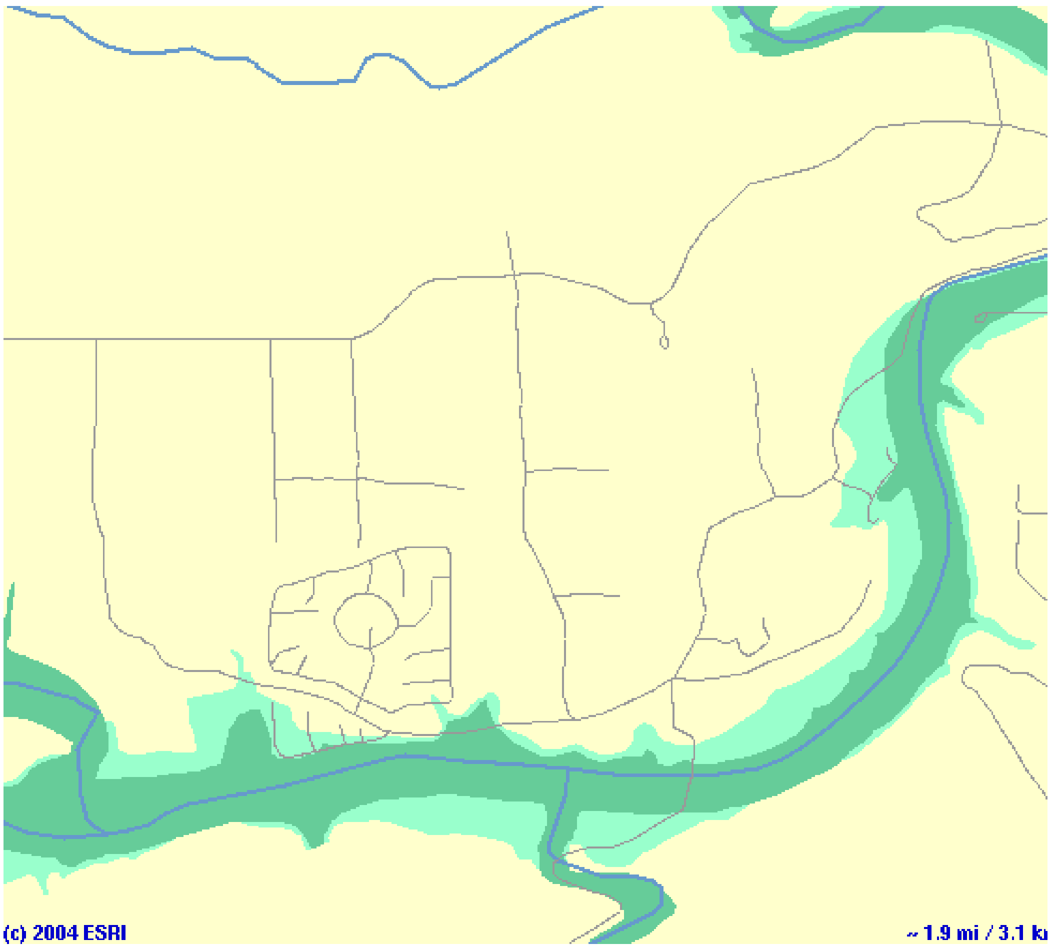
ESRI/FEMA Project Impact
Hazard Information and Awareness Site
http://www.esri.com/hazards

Flood Hazard Map



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ESRI/FEMA Project Impact
Hazard Information and Awareness Site
http://www.esri.com/hazards