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Understanding Decision Making by Communities and Individuals Related to Flood Risk

Appendix C

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Understanding Decision Making by Communities and Individuals that Affects Flood Risk

1 Introduction

The argument for "risk informed and cost responsible" decision-making as the federal flood risk management (FRM) objective, as well as the increasing federal agency commitment to flood risk communication, both rest on the assumption that communities (i.e., local governments) and individuals (i.e., private landowners and renters, which include households and businesses) are the key decision-makers with respect to floodplain land use and implementing flood risk reduction and management actions. Therefore, the design of federal and state policies and programs to support and influence those choices requires an understanding of how such choices are made, including the decision-making processes, the factors that influence decisions, and decision-makers' capabilities to understand and manage flood risk. To advance that understanding, this appendix describes the complex system of influences faced by local governments[1] when making regulatory, tax, and spending decisions; the influences faced by businesses when making decisions on land development and use; and the influences faced by households when choosing to occupy properties in the floodplain and invest in any risk reduction measures. Only by understanding these decisions can federal flood risk information programs be improved and changes in the sharing of decision costs be proposed and evaluated.[2]

2 The Decisions

Beginning with vacant land (which includes lands employed in agricultural uses in this simplified framework), the possible decisions for a landowner are: do not develop, develop and sell, develop and occupy, or develop and lease. Of course, many floodplain lands already have development. In those places, the decisions of a business or household include whether to occupy the site "as is" or further develop the site, with or without accompanying actions to reduce flood risk exposure (e.g., remove all or part of a structure, building elevation) and vulnerability (e.g., flood proofing, move back-up generators

[1] In this appendix, the term "local government" is used to describe government authorities at the sub-state level, which includes special purpose governments such as levee districts.

[2] One way to confirm the descriptions is to see how well the characterizations fit with real cases. The contractor report "Case Illustrations of Nonfederal Flood Risk Management Decision Making" (Woolley, 2013) includes three case studies of local FRM capabilities and commitments that serve that purpose: Chesterfield, Missouri; Denver, Colorado; and Broome County, New York. In addition, media accounts of flood risk reduction and management challenges faced by localities throughout the nation were also tracked and considered in developing the text for this appendix.

to a higher elevation or build an escape hatch in the roof) or to increase resiliency (e.g., purchase insurance).

These business and household decisions are made within the context of and influenced by the decisions of local governments. Local governments can choose to regulate (that is constrain) the use of privately owned lands both within and outside the "base" floodplain, which is defined as lands subject to a 1% or greater chance of flooding in any given year. [3] They can choose to finance (e.g., sell bonds) and fund (e.g., through taxes and fees) community flood hazard reduction infrastructure, exposure reduction projects, and vulnerability reduction measures such as emergency evacuation plans. Local governments can also locate public facilities (parks to government buildings) as well as permit or otherwise affect local investments in roads, railways, utility lines and other forms of infrastructure that can influence the development and use of floodplain lands.

Local government allowance of development in floodplain areas does not imply that the development will necessarily occur; similarly, local government investment in a community hazard reduction project does not inevitably yield expanded development. The decisions on development location and form are made by the owners of undeveloped land within the parameters established by local government decisions relating to flood risk management. The level of perceived residual flood risk is only one of many decision influences faced by these decision agents when they decide whether to leave land vacant, whether to invest in residential or business development and, if development does occur, whether to implement risk reduction and management measures.

[3] The National Flood Insurance Program (NFIP) uses the base floodplain concept to determine the lands in NFIP participating communities that are subject to program rules relating to minimum floodplain management standards and insurance purchase requirements. In the vocabulary for this report contained in Appendix A, however, the term floodplain is defined as any land area that is susceptible to floods, which includes but is not limited to lands subject to a 1% or greater chance of flooding in any given year. This means there are locations in the floodplain where flooding has a 1% or greater chance of occurring in any year as well locations where flooding has less than 1% chance of annual occurrence. Local government land use regulations may be silent on what activities can be located in these different areas of the floodplain. However, for many areas of the nation, as a result of the NFIP and increasing awareness of flood risk, local government land use regulation may direct that locations in the base floodplain only have uses such as agriculture and park land. Locating housing or economic activity in other areas of the floodplain may be allowed, perhaps conditional on adopting risk reduction and management measures. Also, local governments may choose to invest in flood hazard reduction projects to make certain areas of the floodplain are less likely to flood in the hope of protecting existing assets and perhaps attracting new development.

3 General Decision Influences

Floodplain land use and risk reduction and management decision-making is influenced by the decision makers' perceptions of decision benefits and costs, including risk costs, which can in turn be influenced by many factors. Two general decision influences are reviewed briefly below—path dependency and risk perceptions and attitudes.

3.1 Path Dependency

Local government decision-making on floodplain land use is highly constrained by physical topography. In some communities, the best available land for community expansion may have some flood risk, even if the likelihood of flooding is remote. Some localities are characterized by long stretches of frontage along major rivers. Communities also face different types of flood risks, such as slow and easily predicted rates of rise in a river due to rainfall or upstream snowmelt versus flash floods. Communities along large rivers often have community hazard reduction projects (upstream storage, levees, and channelization) already in place.

Decisions by communities and individuals that affect flood risk rarely begin from a blank slate. Past hazard reduction project investments and land settlement choices may constrain or otherwise influence possible subsequent choices. In fact, historic land settlement in the U.S. often was in floodplains in order to realize the benefits of fertile soils, access to water transportation, and opportunities to be near the recreation and aesthetic amenities provided by proximity to bodies of water. And such settlements have often implemented flood hazard reduction projects for protection. Thus, older urban communities often have many houses and businesses in place behind existing levees and floodwalls and so cannot readily reduce residual risk through measures to reduce exposure. And almost every community has small streams with relatively small drainage areas where flooding may result from rapid changes in the hydrograph during intense storm events; such storm water flooding is especially prevalent in rapidly urbanizing areas.

People and assets are already located in many areas subject to flood risk, but the available measures for dealing with that flood risk by the community and individuals may be limited. For example, moving structures and utilities on a large scale can be costly and is typically judged to be impractical or undesirable by the community and residents themselves. Individuals who own properties that experience flood damage (especially if flooding has been recent) will realize lower property values that in turn reduce their ability to sell and move to other locations; thus, rebuilding in place is often judged

to be the best available option. In such cases, adjustments to flood risk might be the construction or improvement of a levee, some flood proofing, and enhanced purchase of insurance.[4]

The important point is that the national policy debate over the federal role in flood risk management often is conducted as if all lands are vacant or as if existing development is easily reversed. Such reasoning is a distraction from the reality that FRM options are place-specific.

3.2 Perceptions of and Attitudes Relating to Flood Risk

Individuals make choices relating to floodplain location and use as well as whether to implement flood risk reduction and management measures based in part on how they perceive the likelihood and consequences of flooding. Research in the behavioral sciences, beginning in the 1970s but accelerating more recently, has explored the ways in which individuals understand risk and act on that understanding. This literature helps to clarify the purpose of risk communication and ways to make such communication more effective, and is briefly reviewed below in order to demonstrate some of the insights it can offer for explaining decision-making and for the design of policy and programs to advance RICR. This introduction to the literature is organized into two sections—systems of thinking and risk attitudes.

3.2.1 Systems of Thinking

The behavioral science literature describes two mental systems by which individuals receive, interpret, and then act on risk information. One is referred to as "system 1 thinking" which describes "intuitive" choice-making that employs decision heuristics, or mental short cuts. Individuals also have the capacity to employ "system 2 thinking," which allows for more complex choice-making involving system perspectives and statistical inference.

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[4] If a decision to construct or improve a levee is made, that decision could influence future flood risk reduction and management actions. Those future actions may be in response to changes in the economic value of the land located in the floodplain, changes in the population settled in the floodplain, or changes in the hydrology that have altered the flood hazard. The Chesterfield, MO and Broome County, NY cases reviewed later in this appendix exhibited characteristics of such path dependency (see: Woolley, 2013). The upgraded levee built in Chesterfield, Missouri was a culmination of a path that started modestly with an agricultural levee to protect farmland. Eventually, the levee was upgraded after some development had occurred, and then there was more development, which justified another levee upgrade. More development followed, spurring the last levee upgrade that will likely attract even more economic development. It is virtually impossible to separate historical decisions to improve hazard reduction infrastructure from development that occurred on the floodplain and to say which came first or which prompted the other. The two are comingled in a complementary arrangement that is also reflected in other areas around the country. In the Broome County case, economic development and infrastructure progressed together for many decades, but since the 1990s economic improvement has lagged, creating an entirely different path. Consequently, the communities in Broome County now have diminished FRM capabilities.

The literature on system 1 thinking (heuristics) is vast and has its own language. Attachment B provides a brief summary of some of that literature, with commentary relating each particular heuristic identified as potentially relevant for flood risk understanding. For example, some individuals have been found to think a threat is more likely when example experiences come readily to mind, such as soon after an event has occurred. This is termed the "Availability Heuristic." On the other hand, it has also been found that after an event occurs, some individuals often believe the likelihood of another similar event occurring has declined, a finding referred to as the "Gambler's Fallacy." For example, many people appear to believe that two 100-year flood events cannot occur in the same area within a few years' time. Thus, the Availability and the Gambler's Fallacy heuristics may work in opposite directions. Some individuals also have been found to be optimistic and myopic in evaluating low-probability risks, often dismissing such risks all together.

Also of note is that how information is presented can alter the perception of and attitudes toward the risk, a phenomenon known as "framing." For example, an individual could think that an event characterized as a 100-year flood is less of a concern than if that same event is characterized as having a 26% chance of occurring during the life of a 30 year mortgage, even though both characterizations depict the same risk.

System 2 thinking, by contrast, might be understood as how technical experts with professional responsibilities in FRM would (ideally) come to understand the frequency and consequences of flooding. These experts will use best available technologies for securing data, analyzing those data, and then using modern modeling and GIS tools to transform that data into information. In fact, innovation in risk communication programs often is associated with a two-step process of expert determination of the risk and then the packaging of the information to communicate the results.[5] With respect to flood risk communication, the implied goal is to align how individuals understand risk with the understanding of "experts" who are acknowledged as having the credentials and skills needed to understand the likelihood and consequences of flooding.

Most flood risk communication programs presume that individuals will employ system 2 thinking in making decisions when provided with flood risk information. However, system 1 thinking often will be employed when people are provided with information on flood risks and available risk reduction and management opportunities. Indeed, expecting people to employ system 2 thinking may be unrealistic, since they would need to invest time in converting complex information into an understanding of the

[5] Technical experts face the challenges of incorporating analytical and epistemic uncertainty into building their understanding of risk. The challenge of uncertainty makes risk communication especially difficult where recipients of risk information (individuals, legislators, judges, government agency staff, etc.) want "bright line" answers to questions about the likelihood and consequences of flooding.

risk, making an assessment of how different actions will reduce and manage that risk, and finally assessing the relative benefits and costs of the actions they might take.

This is not to suggest that some people always employ system 1 and that others always employ system 2. The reality is that, at one time or another, the same person may use different systems of thinking, even about the same problem. This explains why it is easier to get people to think analytically about a flood immediately after the event. Faced with this reality, risk communication as well as public engagement programs must accommodate both system 1 and system 2 thinking. The likelihood of success in the design and execution of risk communication and public participation programs will be increased when the possibility of both system 1 and 2 thinking is recognized as depending on the intended audience and the situation.

3.2.2 Risk Attitudes

Attitudes toward flood risk can vary significantly across individuals and, as a result, different people may make different decisions in the face of the same risk. More specifically, some individuals can be risk averse, some risk takers, and others risk neutral. Also, the same individual may have different risk attitudes for different types of risks. Risk attitudes have been shown to be affected by whether or not individuals feel they have control over the risk, whether they accepted it voluntarily, and whether it has the potential to be catastrophic (Slovic, 1987).

4 Decision Making Contexts

Generally speaking, the decision by a household or business on whether to remain in or newly locate in a floodplain will be based on a consideration of their perception of the benefits of that location weighed against the costs, including risk costs (i.e., the expected adverse consequences of flooding) and the costs of available risk reduction and management actions they could take. In turn, these decisions may be influenced by federal policy and programs and by local government regulatory and spending decisions -- decisions that also may be influenced by federal policy and programs.[6] The ways in which these benefits and cost manifest themselves can vary across and within different communities through time. In addition, the expectations for benefits and costs will be based on the different decision makers' understanding of the flood risk and the weighing will be affected by path dependency and their differing attitudes toward that risk, as outlined above. Below, some of the complex set of factors that interact to

[6] The location, flood risk reduction, and residual risk management choices of businesses and households are intertwined and influence one another. Some may make the choice of where to locate in consideration of the risk reduction actions they would adopt at a given location. Others may choose a location and then sequentially decide whether or not to adopt various reduction and risk management measures.

influence the decisions of local governments, households, and businesses that affect flood risk are briefly outlined.

4.1 Local Government Decisions

The emphasis on RICR in this report and the Corps' commitment to shared responsibility, anticipate that non-federal governments will become fully engaged in all aspects of flood risk management. To do so will require adequate staff in local governments dedicated to FRM, with advanced FRM skills. These skills will assure an understanding of flood risk and the ability to communicate, in partnership with federal agencies, that understanding to communities and individuals. In addition, RICR and shared responsibility require non-federal capacity to invest in programs and projects that reduce hazard, exposure and vulnerability, either on their own or as a cost share partner to Corps and FEMA programs.

Because FRM responsibilities reside in 50 state governments and several territories and also in tens of thousands of local governments and special sub-state special purpose districts, it is possible only to make the most general observations about the flood risk management capabilities and commitments of non-federal levels of government. That said, since the 1960s there have been significant advances in the FRM capabilities of local governments, often advanced by state FRM programs. (Attachment A describes in the most general terms state and local government FRM capabilities.) Differences in capabilities can, in part, explain differences in how local governments consider flood risk in decision-making. The discussion in the rest of this section assumes some minimal and consistent level of state and local government capability in order to explore other influences on local decision-making.

Local government decisions[7] that affect flood risk vary from creating land regulations administered by a department of the local government to implementing a local flood hazard reduction project with significant tax implications for every resident of the community. These local government decisions are sometimes the outcome of a public debate that is finalized through a referendum. At other times local decisions emerge from internal deliberations within the governmental bureaucracy that may need approval from locally elected representatives. Each decision is a result of who participates, the roles of the participants, and the rules by which a decision is made. The participants and the decision processes vary across and within communities.

A frequent assertion is that those who believe they are most affected by any decision will be the most vocal in expressing their views and in attempting to influence decision authorities; the contemporary language refers to these entities as "stakeholders." For any given decision, interested stakeholders may

[7] Local government decision authorities are defined here as entities that have the legally-sanctioned authority to impose local regulations, levy local taxes and fees, and make local spending decisions. State law will in part determine the reach of local authorities and responsibilities.

include neighborhood coalitions, labor groups, business and real estate interests, construction contractors, environmental groups, and other bureaus of government, among others.

Each stakeholder advocates to decision authorities for policies, programs, tax and spending decisions that will serve their objectives. At times their advocacy may be for self-serving decisions and at other times the decisions advanced may be argued to be good for the community as a whole. Indeed, the argument typically made is that decisions which benefit a particular stakeholder also benefit the community at large. As one example, a land developer may argue that its proposal for a zoning change in some part of the floodplain will allow the construction of residential and commercial facilities that will spin off jobs and affordable housing. Meanwhile, other stakeholders may advocate for a bike path or park in lieu of development in that same area, and will argue that this use of the land will add to the community's quality of life.

However, local decision authorities are not a blank slate upon which the preferences of the most influential stakeholders are written. Rather, these authorities are expected to advance the general welfare of the citizens; as a general matter, most will interpret that as securing a favorable business climate to increase jobs and incomes and tax revenues needed to support desired levels of public services within a local government budget. This imperative plays out in particular ways with regard to flood risk management.

The fiscal and economic circumstances of a community are almost always a significant determinant of the local government response to flood risk. Localities with robust economies, growing populations and tax bases, and professional planning staff often take their own initiative to reduce and manage flood risk to levels acceptable to the community. Moreover, this relationship is self-reinforcing, as acceptable levels of flood risk in turn create a favorable business climate and further improvements in the local tax base. On the other hand, less affluent communities, especially those with declining tax bases and significant low-income populations, are generally unable to take flood risk reduction measures on their own, even with some outside support, and are also often reluctant to have flood risk reduction or management requirements imposed on them and their residents (e.g., mandatory purchase of flood insurance).

Without regard to their particular fiscal and economic situations, local decision authorities with entrepreneurial spirit always seek to take advantage of intergovernmental funding sources, often leveraging multiple sources to promote local development strategies and pay for local services (such as when they seek funds to build a levee that can create usable land for new businesses or when they secure funds for removal of blighted and flood-prone properties along a river in order to create water access and open space amenities). These efforts illustrate the reality that local government decision-making is embedded in a federal system where local authorities are granted land use and taxing authority by the state governments and where federal policies and programs can become critical consideration in decision making.

To be sure, local government decisions on floodplain land use regulations and community hazard reduction also are influenced by stakeholder groups and community officials' perceptions of and attitudes toward flood likelihoods and potential consequences. But these are not the only considerations in any decision—tradeoffs and budget constraints are always relevant.

4.2 Business Decisions

Whether a business is a small proprietorship or a storefront for a large corporate enterprise it will base its decisions on the profitability, measured in different ways, of a location choice. Location characteristics that can influence profitability include distance to suppliers, customer expectations related to distance to population and transport access, goodwill based on longevity at the location, as well as proximity to competition or complementary businesses and skilled employees. Some of the variables that can influence profitability may be associated with flood risk at the property. They include proximity to water bodies (perhaps sought for transporting products) or the topography of the site. Joint consideration of these influences will yield expectations for profitability measured as return on investment, payback period in relation to expected time at that location, positive cash flow or other possible measures.

The location decision of some business is intertwined with—and can be influenced by—the flood risk reduction and management options available to it. The location may be deemed profitable if the payback period on any investment is relatively short (a short time period reduces the likelihood of flooding in any year) either because the property will be sold or because the cash flow is significant in the initial years after the investment. If a business feels that it could take risk reducing actions at a cost less than the returns for that location choice, it may be more likely to locate in a flood-prone area. A business may find a floodplain location profitable if it believes that the cash returns will be adequate to pay for risk management through flood insurance.

These calculations depend on perceptions of the flood risk, which can vary across different businesses. Large corporations considering making investments in flood-prone areas may have the ability to carefully assess available data to determine flood risk (i.e., employ system 2 thinking). Smaller companies, especially proprietor-owned small businesses, may need to rely upon publicly available information and may employ the same decision heuristics that households often use to interpret that information (i.e., employ system 1 thinking). Or a small business may look to other, larger businesses that have located in the area and make inferences about flood risk based on the investment decisions of those other businesses.

Similarly, attitudes toward flood risk can vary across businesses. Risk attitudes may differ according to previous experience with the risk, whether the risk could be catastrophic (e.g. whether the business could be 10 feet under water or only experience shallow flooding from inadequate drainage), as well as the size and level of business diversification. For example, a large company with many locations around

the country may be less concerned about having one location in a flood-prone area than a small business whose total assets and operations are in one location.

4.3 Household Decisions

Among the principal considerations that can affect a household's choice to newly locate in or remain in the floodplain are location amenities and disamenities that influence the "net benefits" they receive from that location.[8] These amenities and disamenities can be divided into neighborhood location characteristics and attributes of the specific property. Characteristics of the neighborhood include factors such as the crime rate and property tax rate, while those of the specific location include such things such as how far the property is from the individual's place of work, how far it is from public transit, size and layout of the structure and lot, and the proximity to water-related amenities such as beaches, trails and parks. Of course, when deciding where to locate or whether to remain in a location, households also face a household budget limit.

Some of the amenities will be directly associated with the flood risk at the property. These include such attributes as views and recreational opportunities associated with proximity to a water body. Hence, a household may need to weigh the immediate and readily understood advantages of a property with the uncertain prospects of suffering the unfamiliar adverse consequences of flooding (e.g., property replacement and repair, inconvenience, post flood trauma). [9]

These household decisions will depend on their perceptions of and attitudes toward flood risk; of note here is that federal programs can affect risk perceptions. FEMA NFIP flood insurance rate maps, insurance purchase requirements, and premium levels may serve as risk signals to a household. Expectations for a new or upgraded Corps hazard reduction projects, or Corps or FEMA assessments of a levee and its maintenance may alter household perceptions of the adverse consequences should a flood occur, as might expectations for different types and levels of disaster assistance.

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[8] The term net benefits is used here, but the decision is based on the subjective judgment made by the household about the effect on its well-being from the location choice. The wisdom of the choice made by some household is defined by that household and not by an outside observer.

[9] Household refers to a renter or an owner-occupant, although flood damages experienced by a renter are limited to the contents of a residence.

5 Implications for Advancing RICR

Chapter 3 of this report argues for a federal policy goal to promote risk informed and cost responsible decision-making by communities (i.e., local governments) and individuals (i.e., households and businesses). In order to advance that goal, it will be necessary to evaluate the extent to which federal risk communication efforts improve these decision-makers' understanding of flood risk, and also evaluate how the distribution of cost responsibility resulting from federal flood risk management programs may affect the decisions that are made. Considerations toward those ends are briefly outlined below.

5.1 Risk Communication: Purpose and Methods

Flood risk communication programs are advocated in order to influence the choice behavior of communities and individuals. The belief is that enhanced flood risk communication will improve understanding of risk that will, in turn, motivate change in the choices made. However, risk communication enhancements will introduce new information into an existing and already complex choice-setting that includes financial and physical constraints on choice-making, differing perceptions of benefits and risk costs of alternatives, and varying attitudes toward risk taking. At the same time, every choice made is path dependent. Thus, building an effective communication program requires understanding not only how recipients interpret information, but also the context in which they make choices.

Increased understanding of flood risk by communities and individuals may change their flood risk management choices. For example, one old survey of homeowners in ten cities found that 40% of property owners who reported that they were aware they were located in a floodplain area carried insurance, but only 13% of property owners who were unaware did so (Bollens et al., 1988). This finding suggests that knowledge of flood risk may affect choice behavior for some individuals, although the complexity of their decision frameworks makes it clear that improved understanding of flood risk will not necessarily change the choices made by everyone.

In seeking to increase the public's understanding of flood risk, risk communicators often assume that system 2 thinking by decision agents will prevail. But this may be unrealistic, because as noted earlier, system 2 thinking requires converting information on a risk into an understanding of the risk, an assessment of how different measures will reduce that risk, and finally an assessment of the relative benefits and costs of undertaking each measure. With limited time and attention and the myriad of other determinants of choices, individuals may never make this type of investment of analytical time. Flood risk simply may not rise up to the level where system 2 thinking will be triggered, except perhaps right after a flood or for people who have a keen intellectual interest in the subject.

Nonetheless, a risk communication program could be designed to encourage system 2 thinking about the likelihoods and consequences of flooding so that individuals' understanding more closely mimics that of flood risk assessment experts. To secure that result may require engaging residents, community leaders and technical flood risk assessment experts in an extended stakeholder process with sufficient time to foster system 2 thinking. There may be reason to believe that system 2 thinking will yield a more complete and more permanent understanding of the phenomena of interest, in this case flood risk, and so that effort may be worthwhile. However, as noted, some people may be unwilling to commit to such a learning process when there are multiple issues competing for their time and attention.

Indeed, flood risk reduction and management decision-making must be in anticipation of events that are remote in time and infrequently experienced and so may not be "worth thinking about" for an average individual. So it is reasonable to assume that in many instances individuals will employ system 1 thinking; as such, heuristics will have an influence on decision-making. Therefore, the design of risk communication policies and programs as well as programs that shift cost responsibility with the expressed intent of affecting the choices made must take decision heuristics into account in order to be effective.

Assuming that system 1 thinking will often prevail, the question for risk communication becomes how to make effective use of decision heuristics. The literature on heuristics makes clear that the manner in which risk data and information are presented can affect the recipients' understanding of the risk. Of note is an argument by Thaler and Sunstein (2008) that there is no neutral way to offer a choice or present information. If it is the case that the provision of risk information can never be "neutral," because of the presence of decision heuristics, then risk communication will inevitably slant the understanding of flood risk, and the decisions that follow, in a particular direction.

This reality leads to a need to explicitly consider alternative purposes and methods for risk communication program design. One purpose of communicating flood risk is to simply increase the understanding of that risk by communities and individuals. However, that improved understanding assures that the decisions made are better informed, but does not assure that the decisions will be different than they would have been made in the absence of the risk communication effort. Thus, if the purpose is only to inform, then the observed decisions (e.g., whether or not to buy a flood insurance policy) cannot be used to measure the success of the risk communication program. Alternatively, the goal may be to "nudge" communities and individuals toward a particular decision (e.g., to purchase flood insurance or to implement community building codes and zoning restrictions in floodplain areas outside the base floodplain). In this case, the behavior that results is the measure of success, and whether the risk is actually understood in the same way as experts is of secondary concern.

Risk communication can be designed to harness decision heuristics if the intent is to promote preferred choices. [10] For example, the Availability Heuristic could be used to develop flood risk communication efforts that consistently remind people of past flood events as a way to motivate people to adopt risk reduction measures and/or carry flood insurance.

As another example, a well-recognized problem in flood risk communication is the public's misunderstanding of the term "100-year flood" (Gamblers Fallacy). To avoid that misunderstanding, the thought has been to instead emphasize the concept of the 1% annual chance flood. However, individuals may determine 1% to be so small a likelihood that they will ignore or dismiss the risk ("truncation"). Recognizing this, risk communicators have considered "framing" this flood probability as having a 26% chance of a occurring during the life of a 30-year mortgage. When flood risk is presented as a 30-year risk as opposed to an annual risk, individuals perceive a higher threat (Keller et al., 2006). This has been found for other risks as well, such as risks from earthquakes and failing to wear a seatbelt, and suggests that framing could offset the tendency of people to ignore or dismiss low-probability risks (Kunreuther et al., 2002). Whether this re-framing is harnessing heuristics to better communicate information or nudging them toward taking the risk more seriously can be debated.

As a final example, Kuran and Sunstein (1999) link the Availability Heuristic with Cascade Behavior and develop the notion of "availability entrepreneurs"—individuals who work to trigger cascades "by fixing people's attention on specific problems, interpreting phenomena in particular ways, and attempting to raise the salience of certain information." Clearly this falls in the category of using knowledge of decision heuristics to nudge decisions in a particular direction.

5.2 Risk Communication: Construction of the Risk Message

Mileti (2003) outlines some "immutable laws" of educating the public about hazards that include being clear (e.g., use of graphics and not words to display information), making the message consistent, repeating the message through various sources, and stating what should be done to respond to the risk. Add to this list the need for a trusted messenger and the need to target the message to the right decision makers. Each is discussed in turn below.

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[10] Thaler and Sunstein (2008) develop the concept of "libertarian paternalism," in which individuals retain freedom to make choices, but are "nudged" in one direction or another by the way a choice or choice information is presented. Thaler and Sunstein refer to those people who present others with choices as "choice architects," and suggest that choice architects should design choice contexts so that people make choices that improve their lives; that is, choice architects can nudge people in beneficial directions. The paternalistic aspect is the assumption that choice architects know what is best for people.

First, the message must be concise, credible in its logic, and clearly communicated using graphics and images. Several initiatives in the Corps, FEMA, NOAA, and other agencies have begun to employ GIS technology and databases to create visual images (static and dynamic) of the areas inundated for different flood events. This technology may be a major step forward if it can be linked to particular concise and credible messages; however, to just show a computer simulation of what might happen with a flood may have limited effect on risk understanding or on motivating changes in choices.

As another example, FEMA is encouraging a program of marking heights of historic flood events on buildings. Building marking needs to be accompanied by two additional kinds of information related to the date of the historic flood events. Credibility demands acknowledging that hazard reduction measures may have been put in place since the marked floods occurred, as well as the predicted effectiveness of those measures. And any presentation should describe how often other floods of different scales have taken place, and the heights associated with those floods as a readily appreciated indicator of the likelihood of the most extreme flood events. Both of these kinds of information are generally understood in the social network of the community, and failure to acknowledge this information can undermine credibility of a building marking program. Also, the literature suggests that consequences and not likelihoods may be the way that risk understanding is formed. Thus, a building marking program could be combined with a GIS visualization to show the current potential for adverse consequences if there was a repeat of historic flood heights.

Second, information from authoritative sources needs to be consistent over time and across sources. A lack of consistency has been the hallmark of recent federal agency levee inspections and assessments in recent years leading to community distrust of the results. Some effort is now underway to align the outputs of Corps inspections of levee O&M with information required for NFIP levee accreditation by FEMA. However, the fact that these agencies will use the inspection results for different purposes also needs to be understood or the credibility of the inspections themselves will be questioned. More generally, federal agencies (e.g., Corps, NOAA, FEMA, and USGS) are currently independently developing risk assessment and communication programs, often using their own terms to describe the same concepts. A common vocabulary and a common risk communication platform are needed.

Third, some literature on encouraging disaster preparedness suggests that individuals do not necessarily respond and take action based on information about a risk, but rather are more likely to act if they are told what actions they should take. From one perspective, generally approaching risk communication by telling people what to do as opposed to giving them information might be viewed as manipulating individuals toward a particular decision, when individuals should have the opportunity to choose freely. At best, it may be seen as “libertarian paternalism,” with the goal nudging people toward “better” choices (Thaler and Sustein, 2008). However, whether it is an appropriate role of government to “nudge” toward particular choices, as opposed to enhancing understanding for better informed choice making, is a matter of intense debate about the role of government policy design in areas as diverse as limiting beverage container sizes to the design of retirement plans. One line of argument, as discussed

above, suggests that it is not possible to provide purely “neutral” information and that all information programs will nudge decisions intentionally or unintentionally toward particular decisions. On the other hand, some of the literature suggests that if people believe a public program wants to influence them toward a particular choice, they may respond in contradictory ways and lose trust in the messenger.

Fourth, there must be a trusted messenger. Individuals can receive information on flood risk from three types of sources: 1) official sources, including NFIP flood insurance rate maps, government websites and published documents, statements by elected officials, and lenders, 2) their social network, including family, friends, and colleagues, and; 3) their own personal experiences and observations. Individuals may not trust these sources equally and may discount information provided by certain sources. The literature shows that the level of trust that individuals place on the source of information on flood risk plays a role in how individuals perceive and act on risks.

Some impressions to avoid when garnering trust can be described. First, the risk communicator should understand that the message might be interpreted by the listener as self-serving and hence not trustworthy. For example, FEMA efforts to better describe the area of the base floodplain may be (and have been) interpreted as the agency trying to increase the number of policies it sells to cover its fiscal deficit. Likewise, the Corps effort to describe the limits of aging Corps-built levees and encourage local efforts to reduce community exposure and vulnerability to flooding has been described by some stakeholders as an effort to absolve itself of a perceived responsibility for the adequacy of the levee. Thus, there may need to be a different messenger, but with the same message.

As another example, studies have found that individuals do not want to regret their decisions (Camerer and Kunreuther, 1989) and consider ways to avoid regret when making decisions. Also, individuals have been shown to consider multiple dimensions of a hazard and often put added importance on avoiding “dreaded” threats (Slovic, 1987). Fear has been shown to amplify perceptions of risk, while anger lowers perceptions (Slovic and Peters, 2006). Sometimes emotions can completely dominate an individual’s risk analysis. When making decisions under uncertainty—particularly with respect to emotionally-charged risks—individuals sometimes neglect the probability of a threat occurring and focus entirely on the consequences (Sunstein, 2002). Such emotional responses may influence decisions with respect to flood risk; for example, it has been found that when individuals are shown images of flood damage, it increases their perceptions of the risk (Keller et al., 2006). Thus, risk communication efforts that highlight the adverse consequences of flooding might make people more likely to adopt risk reduction and management actions.

Finally, it must be recognized that people who may have the same understanding of flood likelihood and consequences that experts have may make different location and risk mitigation decision than the experts would make for themselves. Individuals do not base their decisions solely on their understanding of flood probability and potential consequences (an expected value decision rule), but

rather combine such understanding with their beliefs, experiences, preferences, and other factors to produce a binary assessment for decision-making—either worry about the risk or do not worry.

5.3 Complexity and the Design of Policy Reforms

As with risk communication, it is treated as axiomatic that changes in the rules governing cost responsibility will change the choices made. However, once again the complexity of the choice setting makes it difficult to predict the effect of any policy intervention to change cost responsibility.

There has been little rigorous empirical work evaluating the decision-making processes of communities and individuals that affect flood risk. Nonetheless the published literature, government reports, and the public debate over federal FRM policy often include assertions about risk understanding and unexamined arguments about how federal policies and programs create incentives for more intensive floodplain development (location and use) as well as disincentives for floodplain occupants to adopt risk reduction and residual risk management actions.[11] A sample of such assertions includes:

- Community leaders, households, and businesses are not able to understand flood risk as well as federal agency experts when they make location and use as well as risk reduction and risk management decisions. In particular, these entities are incapable of understanding the chance of realizing low probability events.

- Federal post-flood disaster aid to individual households and business is extremely generous and that generosity is anticipated by households and businesses when choosing to locate assets in flood-prone areas; with this assumption as a foundation, it is concluded that disaster aid can encourage development in flood-prone areas.

- Because NFIP policy does not require the purchase of flood insurance for structures located beyond the base floodplain, communities and property owners located outside that area mistakenly believe that they are safe from all flooding. For example, the National Committee on Levee Safety asserts that the 1% annual chance flood event has become a de facto national safety standard, which has had the effect of convincing communities that they are “safe” if they have hazard protection against the 1% annual chance flood or if they are located outside the base floodplain.

However, consider the following:

[11] Often these assertions are based on a failure to appreciate the details of the specific programs. The need to clarify program purposes and capabilities is discussed elsewhere.

- Communities and individuals may understand and knowingly accept a risk of flooding because other factors, such as location of jobs and family, offset the expected costs of flooding.[12] Furthermore, attitudes toward flood risk and thus views on acceptable risk can vary. As a practical matter, simply observing a choice made by a floodplain occupant does not allow for isolating the direction and magnitude of the multiple influences of any single federal program on that choice.

- Federal disaster aid to households and businesses is not as generous as is often asserted. In addition, expected flood damages in any year may be relatively minor when compared to the benefits and other costs of any given location decision. A reasonable hypothesis is that disaster aid, even if fully understood, would not affect location decisions but might affect decisions on whether to purchase insurance (Kousky and Shabman, 2012).

- While it is true that local decisions on the level of hazard reduction to pursue may be targeted to avoid the NFIP mandatory insurance purchase requirement, it is not necessarily the case that people think they are safe when they have hazard protection against the 1% annual chance flood—that is a leap of logic that does not necessarily conform to all empirical evidence. The psychology literature can be interpreted to suggest that flood stage elevation for the 1% annual chance flood event may be an anchor that communities and individuals use for understanding flood risk. One hypothesis that would follow is that the 1% annual chance event becomes a reference for concluding that benefits of development in areas unaffected by that event outweigh the possible flood damage costs, especially in small watersheds and drainage areas. This hypothesis is supported by case examples of flood risk reduction and management decision-making. For example, non-federal entities in some locations along major rivers are building hazard mitigation projects to control flood stages associated with the 0.2 % annual chance event (see Chesterfield, MO example in Attachment A). In places where there is both the risk of "big river flooding" and small stream flooding, the 1% standard applies on smaller streams where flooding from less frequent events would not be catastrophic, but not on larger rivers (see Denver, CO example in Attachment A). In California, the 1% annual chance flood is not the governing state standard for levees; rather, the less frequent 0.5% annual chance event is the minimum level of protection to be provided by hazard reduction infrastructure.

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[12] Gilbert White once wrote that, "We cannot assume people to be uniformly well-informed, rational optimizers, nor can we dismiss them cavalierly as stupid, pigheaded, or knaves" (White, 1966).

- Sometimes assertions about federal program influences on choice behavior are based on correlation analyses without an underlying causal model; for example, a correlation showing increased development behind a levee after the levee is built is assumed to be a result of the levee building itself.

The purpose of this appendix is to increase understanding of the complexity of the choice setting in order to move toward a clearer explanation of choices that may have been observed. However, explanation may not necessarily create a model suitable for predicting the effects on choices of a future policy intervention. The salient point is not that prediction is difficult; rather, that careful thought needs to be put into policy design and evaluation, and simplistic correlations must be avoided. And most importantly, there is much variation across and within situations, so recognizing the specific circumstances of a place must be part of any program design.

However, even an enhanced understanding of flood risk by decision agents or redistribution of decision costs may not assure that a policy change will always yield the desired result. Realistically, a policy intervention may or may not affect choices. And even if there is increased understanding of flood risk, the choices made may move toward more and not less risk-taking. Similarly, a policy to subsidize flood proofing of buildings may or may not increase investment in flood proofing. In a complex decision setting, the realized effect of policy and program changes may be a mix of results: no change in choice, a change in choice in unexpected ways, or a change in an intended direction.

6 Attachment A: Non-federal Flood Risk Management Capabilities

Flood risk management (FRM) responsibilities reside in 50 state and several territorial governments and also in tens of thousands of local governments and special sub-state special purpose districts. Clearly, it is possible only to make the most general observations about the FRM capabilities and commitments of these non-federal governments, even while recognizing that non-federal capability and commitment is always changing. That said, since the 1960s there have been significant advances in capabilities (staff dedicated to FRM, skill levels and investment of non-federal funds) of state and sub-state governments to reduce and manage flood risk in their respective jurisdictions, particularly motivated by implementation of the National Flood Insurance Program in 1968.

With that caveat in mind this appendix provides a perspective on non-federal government FRM capabilities and commitments, informed by drawing from a contractor report on three case illustrations (Woolley, 2013), by a review of publications of the Association of State Floodplain Managers (ASFPM) and the Federal Emergency Management Agency (FEMA), and by the authors' impressions based on reading hundreds of news articles relating to FRM challenges faced by different localities around the country during the course of this study.

6.1 Local Case Illustrations

The capability to manage flood risk varies greatly among the tens of thousands of municipal governments in the United States. In an effort to gain an understanding of local FRM capabilities, case studies of local FRM capabilities and challenges in the Denver, Colorado metropolitan area, Chesterfield, Missouri, and Broome County, New York (and a nearby area) were conducted as a contribution to this study (Woolley, 2013). These cases provide useful contrasts in terms of population levels, topography, economic situations, FRM sophistication, and the nature of flood risk and FRM issues faced. Very brief synopses of the case studies follow below.

6.1.1 Urban Drainage and Flood Control District (Denver Metropolitan Area)

The Urban Drainage and Flood Control District (UDFCD) is a large multi-jurisdictional, sub-state entity encompassing communities in the Denver, Colorado metropolitan area. In 1969, community leaders petitioned the state to create the flood control district after the area experienced severe flooding along the South Platte River in 1965 and then again in 1966 that was followed by the construction of large dams (the dams reduced flood hazards along the main river channel, but not on smaller tributaries).

The UDFCD represents a local FRM entity that is well-funded (having the power to levy an ad valorem tax to generate revenue), that is empowered by the state of Colorado to regulate floodplain development, and that has a long history of implementing the full spectrum of hazard, exposure, and vulnerability reduction actions and promoting actions for managing residual risk.

UDFCD activities represent a nationally acknowledged model of “Good Practices” for flood risk management. UDFCD activities are organized for budgetary purposes in the following program areas: Floodplain Management; Information Services and Flood Warning; Design, Construction and Maintenance, and; Master Planning. The UDFCD has built local hazard reduction projects on its own and in partnership with the Corps, regulated land use within the base floodplain in accordance with NFIP rules, issued state-of-the-art drainage design manuals, installed and now operates flood warning systems, provided an organizational structure and network to communicate flood risk to the public, encouraged permanent floodplain evacuation through land acquisition, and promoted the preservation of natural and beneficial floodplain functions through project design and advocacy.

This locality demonstrates the capacity of local government to implement a combination of FRM policies when well-funded and given appropriate authority by the state. In many respects, the UDFCD experiences can be understood as a response to the evolution of the NFIP and a reflection of the NFIP’s influence on local approaches to FRM.

6.1.2 Monarch Chesterfield Levee District (Missouri)

The Monarch Chesterfield Levee District (MCLD) was formed in 1947 to coordinate flood protection for farmlands in a fertile area of floodplain known as the "Valley." By 1993, when the Valley was inundated by the Great Midwest Flood, the existing MCLD-built agricultural levee had been upgraded to a 100-year level of protection (LOP) by the MCLD and had been accredited by FEMA for NFIP purposes. At that time there was some development behind the levee, though much of the levee-protected land remained open space. After the flood severely damaged the levee, local communities were faced with a choice to: 1) rebuild the levee to its pre-flood LOP; 2) not rebuild the levee and instead acquire real estate and allow the floodplain to return to a more natural state, or; 3) rebuild the levee to a higher LOP to protect against a 500-year flood along the Missouri River, and adopt other FRM measures focused on the 1% annual chance flood event in tributary areas. Option 3 was chosen and federal authorization for a Corps feasibility study and then a project, were secured.

The option was chosen by a community that was well informed of the flood risk and the MCLD and stakeholders followed all legal and regulatory requirements in making that choice in an open and transparent process of public debate and decision-making. Under the auspices of the Corps planning process, an environmental impact study and a hydrologic assessment of effects on flood heights elsewhere were completed. A CWA Section 404 permit was secured and levee construction was fully paid for with funds raised by the local community through a value increment tax.

This case illustrates the relationship between community economic development goals and flood risk and the choice of FRM strategy. The FRM decision process in this case illustrates risk informed and cost responsible decision making. This case also illustrates the interaction of a local community with the Corps planning and design process and illustrates how the minimum levee accreditation standards in the NFIP program do not always govern community decisions on what levee LOP to pursue along major rivers.

6.1.3 Broome County Municipalities (New York)

In 2006, several communities located in Broome County, New York, including the city of Binghamton and the towns of Vestal and Johnson City, had Corps-built and NFIP-accredited levees that had been in place for many years. When that year's historic flood occurred, estimated at that time by the USGS and other authorities to be between a 200-year and 500-year event (depending on location), the levees and floodwalls held in spite of some overtopping, and properties behind the levees were not damaged. However, unprotected towns in the county, such as Conklin, experienced significant property damages.

Subsequently, FEMA officials informed the communities that according to its own hazard analysis, most of the levees would be overtopped by the 1% annual chance (or 100 year) flood event and so would be de-accredited on the area's NFIP flood maps, meaning that the maps would consider the levees as

providing no level of protection. The prospect of levee de-accreditation by FEMA meant that many county homeowners would be required to buy flood insurance in this economically-distressed area. Local officials were confused by the apparent inconsistency between how the levees performed during the July 2006 flood and the FEMA findings. Then in 2011 the area experienced a flood that was more widespread and that had greater flood peaks than the 2006 flood event. The levees in some locations were overtopped, although none breached, and property damages in the area were extremely high.

This case illustrates the effect on local communities of FEMA's map modernization initiative. It offers insight into what the Corps and FEMA can do to help local governments understand flood risk, the processes for certifying and accrediting levees under the NFIP, and the need to clarify the relationships among the many different federal levee initiatives and risk assessment now underway. Meanwhile, as these New York communities are in economic decline, they do not have the financial capability to upgrade their levees or take other measures to reduce flood risk, highlighting the problem of "affordability" for FRM that likely exists in many localities throughout the country.

6.2 Observations on Non-federal FRM Capabilities

The emphasis on RICR in this report and the Corps' commitment to shared responsibility requires that non-federal levels of government have adequate staff with advanced skills dedicated to FRM. These skills will be needed to assure an understanding of flood risk and to communicate, in partnership with federal agencies, that understanding to community households and businesses. In addition there must be non-federal financial capacity to invest in programs and projects that reduce hazard, exposure and vulnerability, either on their own or as a cost share partner to Corps and FEMA programs. Some general observations on the FRM capabilities and budgets of state and sub-state levels of government follow below.

6.2.1 The Role of State Governments

State governments can and often do provide local governments with the authority to regulate land uses in their jurisdictions. In the case of the UDFCD, the state of Colorado went further to provide the UDFCD with multi-jurisdictional floodplain regulatory authority as well as the power to levy ad valorem taxes to fund hazard reduction projects and other risk reduction measures. Recent state legislation extended those authorities to localities statewide. In Missouri, a state grant of authority was required for the locality to establish a tax increment funding district in the area protected by the Monarch-Chesterfield levee. However, very few states take a very active role in FRM. One exception is California, which in recent years has initiated an aggressive state program, called FloodSAFE, that focuses on raising awareness of flood risk and that has established new standards of acceptable flood risk for communities located behind levees.

While state FRM offices vary greatly in budget, personnel, and authority, they generally are relatively small in size when compared to other state government functions and activities. Both FEMA's state 5-year plans and survey data gathered by the Association of State Floodplain Managers (ASFPM) indicate that two-thirds of all states had less than five full time equivalent employees committed to floodplain and flood risk management activities, 25% had one or less, and only seven states had more than ten.

Most states act largely as intermediaries between federal and local government decision-makers and each surveyed state has a state coordinating entity for the NFIP. These state agencies provide information to local governments on how to join the NFIP and provide resources to help them qualify for participation (e.g., by providing model floodplain ordinances). They also provide information and support for state requirements that may take precedence over FEMA requirements. These policy initiatives are implemented through designated state offices that are heavily funded by FEMA. The 2010 survey conducted by ASFPM estimated that 60% of state offices received at least 75% of their funding from FEMA's Community Assistance Program – State Support Services Element —that provides funding to states to provide technical assistance to communities enrolled in the NFIP, and to evaluate community performance in implementing NFIP floodplain management requirements.

The ASFPM survey also found that 85% of states had either maintained stable funding for state floodplain management activities or experienced a decrease in funding between 2003 and 2010. In the case of New York's Department of Environmental Conservation (discovered through the Broome County case study) there has been a dramatic loss in personnel recently and this has adversely affected the state's ability to perform its liaison responsibilities between FEMA and the localities it serves.

6.2.2 Growth in FRM expertise at Sub-state Levels of Government

The reality is that states generally delegate the key floodplain management authorities to local governments and flood control (levee) special purpose districts often to meet the requirements of the NFIP or to act as cost share partners for Corps projects; the latter becoming an especially important responsibility since the WRDA of 1986 that raised non-federal (which is most often local government) cost share requirements for flood hazard reduction project planning and implementation. One result has been a growing number of floodplain management and flood risk management professionals, mostly employed outside of state government, since the 1960s. Much of this increase has been fostered by programs of the ASFPM, which was formed in 1982, and programs of the National Association of Flood and Stormwater Management Associations (NAFSMA), which was established in 1978. Both have been instrumental in advancing professional floodplain management expertise at the local level.

The ASFPM has affiliated organizations in nearly every state, and publishes numerous informational and research oriented documents that are available on their website. The ASFPM began a Certified Floodplain Managers Program (CFM) in 1995 and started testing for such certification in 1999. According to the ASFPM website, "The program recognizes continuing education and professional development

that enhance the performance of local, state, federal and private-sector floodplain managers." By 2011, 8,125 individuals had passed the CFM exam, and there are now certified floodplain managers throughout the nation. Topic areas of the exam include: national floodplain management issues, floodplain mapping, NFIP regulatory standards and administrative procedures, flood insurance coverage and rating, flood hazard disaster assistance procedures and funding sources, the natural and beneficial functions of wetlands, and multi-objective planning.

Members of both NAFSMA and ASFPM were encountered throughout the research for the case studies and their relationships demonstrate the networking of FPM professionals. In New York, for example, the Chief of Floodplain Management in the state Department of Environmental Conservation is an ASFPM member, a CFM, and a NFIP State Coordinator. In many cases, local experiences in FRM are linked to and driven by the personalities and experiences of local floodplain managers and community leaders. This has been the case with the UDFCD, where the UDFCD Manager of the Floodplain Management Program has been in his job for over 30 years, and is presently is on the Board of Directors of NAFSMA and Chairman of their Floodplain Management Committee.

In fact, professional networking among local government experts was evident in all three case studies. Aside from the involvement of locally-based, certified floodplain managers, many non-professionals demonstrated a willingness and ability to research FRM issues on their own. As one example, the Broome County case showed that small town officials faced with important issues and minimal staff quickly investigated options through contact with Corps and/or FEMA personnel or through Internet searches. In Broome County, a County Flood Task Force was established in 2006 and reconvened when communities were informed by FEMA about their new flood maps in 2010, and then again after the 2011 flood. The meetings acted as clearing houses for information and forums to discuss important issues. And in the Chesterfield case, the legal counsel to the Monarch Chesterfield Levee District is associated with 30 other levee districts throughout the Midwest and consults on legal and related issues such as the appropriate level of protection provided by levees in the region. There were many references to consultation and communication about flood risk and floodplain management issues among multiple communities throughout the St Louis area.

6.2.3 Regulatory Programs of Sub-State Levels of Government

Beginning in 1973, community enrollment in the NFIP increased steadily to nearly 17,000 communities by 1979. This was followed by a period of slow growth in the number of communities participating in the program, and today there are approximately 20,000 communities enrolled. This means that these communities have had to implement floodplain management regulations for the base floodplain. The three cases each illustrate the effect of this NFIP requirement on local floodplain management.

For example, the UDFCD established zoning and drainage-way regulations prior to and in anticipation of the NFIP policies on floodplains including designation of Special Flood Hazard Zones reflecting the base

floodplain. Recent flood hazard reduction projects constructed by the UDFCD were designed to protect against the 1% annual chance flood event (base flood), and the economic justification for the project included the residents' financial savings from otherwise mandatory flood insurance premiums that would no longer need to be paid.

Although the Monarch Chesterfield Levee District chose to raise the levees along the Missouri to protect against the 0.2% annual chance (or 500 year) flood, all internal drainage engineering works and land use regulations were designed at the base flood level following plans made in the 1980s. There appears to be a greater willingness to invest in higher levels of protection along major rivers when the risk of catastrophic loss is high. Local Missouri officials throughout the region refer to 0.2% annual chance protection along the Missouri and Mississippi Rivers as the "industry standard."

Both Chesterfield and UDFCD regulate land uses to the minimum level consistent with FEMA rules for smaller watersheds where the risk of catastrophic loss is significantly less likely. However, along the areas adjoining the base floodplain, development is not restricted. Moreover, in spite of efforts to educate the public about residual risks from floods of lower probabilities in areas outside the base floodplain, residents in these areas were reported by officials in each case study to discount the possibility of flooding.

The Community Rating System (CRS) of the NFIP also has had an effect on local FRM programs by offering reduced premiums to individuals whose communities take special risk reduction actions. Incentives are built into the CRS point system for actions that improve public information such as outreach, hazard disclosure, mapping, providing flood data, and for substantive efforts to reduce exposure through land acquisition and preserving open space and mandating higher regulatory standards. The CRS was instituted in 1990 and growth of participating communities in that program was rapid in the first decade, reaching 920 in 2000. The average insurance rate reduction for participating CRS communities in 1990 was 8.55%, and 85% of participating communities were in the two lowest of nine possible rate reduction levels. Increases in participation levels have slowed since 1990, and there are about 1,100 participating communities but with a deepening in the level of participation, as evidenced by the average rate reduction which has reached 11.85%. Data show that more than two-thirds of all NFIP policies are written for properties in communities enrolled in the CRS program.

The three case study localities are consistent with national averages in terms of CRS enrollment. Denver is a CRS participating community and realizes NFIP premium discounts of 5-10%. Chesterfield does not participate in the CRS; and in Broome County only Johnson City participates. When Broome County officials were informed that many residents would be required to buy flood insurance after the new flood insurance rate maps went into effect, they immediately investigated participation in the CRS program for the remaining communities in the county; however, when the new maps were put on hold by FEMA, these actions were terminated.

6.3 Non-federal FRM Budgets

Many communities undertake hazard reduction projects on their own, securing the necessary funding and design engineering expertise, and then contracting to the private sector for construction. Two of the three case studies included communities that were willing to take on this responsibility. And the Broome County case study uncovered a nearby local effort to implement a stop-gap hazard reduction project. In all three cases, the areas that would benefit from the projects were fully contained within the political jurisdiction that was paying for the work. Many states have mitigation grant programs to help localities meet the cost share requirements of FEMA programs. And some states and localities have new funding initiatives specifically for flood risk reduction and management, as in California and King County Washington.

Of the case studies, the largest local hazard reduction project was in Chesterfield, where the 11-mile levee was upgraded to protect against the 0.2% annual chance flood at a cost in excess of $58 million. Although the project was eventually authorized by Congress, work was started by the community without assurance that federal money to implement the project or to reimburse local costs in excess of the local cost share would become available.

The UDFCD has spent over $432 million on the construction of different types of hazard reduction projects over the last forty years in the Denver metropolitan area. Much has been directed toward multipurpose dams along the South Platte River. One recent project in the Globeville area was completed by the UDFCD in 2008 at a total cost of approximately $25 million, and it included elements of land acquisition, habitat creation, recreation, and 7,300 linear feet of levees constructed to the 1% annual chance level of protection. Although UDFCD officials have positive, long standing relationships with the Corps for both large-scale, upstream flood hazard reservoir projects and CWA 404 permitting, they did not attempt to secure a federal authorization for this project, because of concerns about lengthy delays associated with Corps planning, total project costs, federal appropriations uncertainties, and preferences for local engineering and design.

Another example of a community undertaking stop-gap hazard reduction on its own was discovered as part of the Broome County case study. Athens, PA is situated west of Broome and downstream along the Susquehanna River. It was severely flooded by the 2011 flood. This very small and historic town has a long history of flooding, given it precarious location along a narrow strip of land between the Susquehanna and Chemung Rivers. The 2011 flood caused extensive damage to the downtown area and resulted in a high degree of frustration that motivated local action. Local officials and townspeople found Canadian designs for a semi-permanent Jersey Wall flood protection project and built a flood wall themselves using $100,000 in local resources. Based only on a sight-line and experience from the last flood, a foundation was dug by local public works crews and filled with concrete by a local contractor. Outdated Jersey Wall segments acquired at a discount firm were aligned and backfilled to create a floodwall over one mile long in the area where the Susquehanna had come over its banks in 2011. No

authorization or assistance from higher governmental authorities was sought and no regulatory permits were secured.

State and sub-state FRM funding were evident in both the Denver and Chesterfield cases. The Broome County case, on the other hand, illustrates the barriers to local FRM cost responsibility in economically-depressed communities, even as the citizens and community leaders became more attuned to flood risk and committed to finding new approaches to flood risk reduction and management.

7 Attachment B: Overview of Decision Heuristics

A wide range of heuristics has been identified in the behavioral economics and psychology literature. This attachment introduces several of the better established concepts and suggests how they may affect risk communication program design, the formation of perceptions of risk, and the effects of risk perceptions on choice behavior.

7.1 Availability

The "Availability Heuristic" refers to the observation that individuals at times assess the likelihood of an event by how readily examples come to mind (Tversky and Kahneman, 1973). This heuristic describes the finding that people seem to assign relatively more weight to events that are salient, memorable, and for which there is vivid evidence (Rabin, 1998). Threats that are viewed as particularly salient due to recent experience or media coverage, for example, are easier to imagine and are assessed as more likely to occur.

If the Availability Heuristic is operating, the probability of future flooding at a location will be thought to be high after a major flood has occurred, since a flood is now easier to imagine. Seemingly confirming this possibility, it has been found that previous experience with flooding leads to higher assessed likelihood of future flooding (Keller et al., 2006) and those who have been flooded in the past are more likely to implement risk reduction measures (Laska, 1986; Pynn and Ljung, 1999). Evidence for the Availability Heuristic can also be found in the way that land prices change after flood events. Some studies have found that land prices decline precipitously immediately after the land is flooded, and then recover slowly over time, although prices may not rise to levels for comparable properties that did not experience flooding (Driscoll et.al, 1998; Shabman and Stephenson, 1998).

It is also possible that newsworthy events reinforce the tendency of people to apply the Availability Heuristic to other types of events. For instance, after Hurricane Katrina, residents of California appeared to pay more attention to earthquake risk than before Katrina (The San Francisco Chronicle, 2005). The use of the Availability Heuristic as a mental shortcut for evaluating risks suggests that immediately after a disaster there may be a window of opportunity to encourage the adoption of risk reduction and management measures.

The Availability Heuristic refers specifically to estimates about the probability of an event occurring and not about the magnitude of the consequences of the event. Still, it is worth noting that some surveys have found that previous experience with flooding does *not* alter what individuals view as an extreme or dangerous flood (McPherson and Saarinen, 1977; Green et al., 2007). Assessment of the possible consequences of flooding may not be influenced by the Availability Heuristic.

7.2 Gamblers Fallacy

The "Gambler's Fallacy" is the belief that systems are self-correcting (Rabin, 2002), and so this heuristic represents a counterpoint to the Available Heuristic. For example, after a coin has been tossed several times and come up heads each time, someone invoking the Gambler's Fallacy would think a tail was more likely on the next toss. This is one component of what Tversky and Kahneman (1982) refer to as the belief in the "Law of Small Numbers." That is, individuals believe that small samples are representative of a population and that sampling is a self-correcting process.

With regard to flood risk, this heuristic helps to explain why some individuals may not believe that there could be two 1% annual chance (or 100-year) floods in the same area within a few years' time. It also helps to explain that when people go many years without experiencing a flood in some area, this leads some people to believe the area is not subject to flood hazard. Individuals conclude that a several year time period without a flood is a representative sample of the risk, when in actuality, hundreds of years of observations would be needed to estimate the likelihood of any given flood event from an analysis of the flood record. Experts would employ statistical procedures to interpret the available data record and account for the error associated with different sample sizes; individuals, on the other hand, may not have the skill, time, or inclination to do this.

The Gambler's Fallacy could make it difficult to discourage people from locating in high flood hazard areas or to encourage them to adopt risk reduction and management measures when a flood has not occurred in the area in recent years. Interestingly, immediately after a flood event, the Gambler's Fallacy may offset the Availability Heuristic for some people. While the recent flood experience may lead people to perceive a higher likelihood of future flooding in the area, the Gambler's Fallacy may lead some people to believe that the odds of another flood occurring in the area in subsequent years have fallen.

7.3 Truncation

Individuals often tend to ignore low probably events or treat them as having zero probability of occurring (Kunreuther, 1978; Camerer and Kunreuther, 1989). One hypothesis offered to explain this heuristic is that individuals have only a limited amount of time and mental energy to devote to

contemplating risk, and if they did not dismiss some low-probability risks they would become over-burdened in decision-making (Kunreuther and Slovic, 1978).

7.4 Optimism

Individuals can be optimistic in assessing whether they will be victims of a disaster, often believing that they are less at risk than the average person (Camerer and Kunreuther, 1989; Viscusi and Zeckhauser, 2006). Individuals often assess their personal risk as low, perhaps to reduce the stress caused by worry. This heuristic has been noted by the Director of Emergency Management for King County, Washington in relation to earthquakes. He was quoted in *Time Magazine* as saying that people often have four stages of denial: "One is, it won't happen. Two is, if it does happen, it won't happen to me. Three: if it does happen to me, it won't be that bad. And four: if it happens to me and it's bad, there's nothing I can do to stop it anyway" (Ripley, 2006). This same heuristic is seen as people consider flood risk. Surveys have found that individuals tend to believe that they are unlikely to be a victim of flooding even if they reside in a flood-prone area (Krasovskaia et al., 2001).

7.5 Myopia

Individuals tend to focus on the near-term, which often leads them to prefer "quick fixes" for problems rather than long-term solutions (Camerer and Kunreuther 1989). Myopia could lead individuals to fail to consider the long-term benefits from implementing a risk reduction action or purchasing insurance to manage residual risk, since they focus on the near-term and thus the immediate costs of those actions rather than the potential long-term costs of not taking the actions.

7.6 Certainty Effect

Individuals have been shown to place an added value on certainty, known as the "Certainty Effect" (Kahneman and Tversky, 1979). This is seen in the Russian roulette thought experiment of Richard Zeckhauser and cited by Kahneman and Tversky (1979). If faced with a six-cylinder gun aimed at them, most people are willing to pay more to remove one bullet if it is the only bullet in the gun than if there are two (or more) bullets in the gun. That is, a reduction in risk from 1/6 to zero is worth more to them than the reduction from 2/6 to 1/6, even though they are equal reductions in the probability of death. Applied to flood risk, this may mean that individuals are willing to pay more for measures that would completely eliminate flood risk instead of reducing it somewhat. Thus, if individuals believe that constructing a levee would reduce flood risk to zero, then they may be willing to pay more for it than if they understood that there would still be some level of residual risk with the levee in place.

7.7 Framing Effect

"Framing effects" refer to the observed phenomenon that how a question is asked can influence the response. One specific framing effect that has been well-documented is that individuals tend to base decisions in relation to a reference point. Often this reference point is current conditions, producing the so-called "status-quo" bias, in which individuals tend to disproportionally stick with the status-quo condition (Samuelson and Zeckhauser, 1988). One clear example of this is shown by "opt-in, opt-out" experiments. For example, in some countries people are considered to be organ donors upon death unless they explicitly state otherwise while alive. In other countries, the opposite is true—people are assumed not to be donors unless they explicitly give their prior consent. Under both situations, most individuals stay with the default option, and rates of organ donation are dramatically higher in countries where the default is to donate (Johnson and Goldstein, 2003). This suggests that if flood insurance were coupled with mortgages as a default, or automatically renewed each year after a policy has been purchased, more individuals would carry insurance.

Another framing effect relates specifically to natural disasters. It has been observed that whether a natural hazard is framed as an unavoidable act of God or nature, or instead framed as caused by poor development strategies, can influence what risk management measures are chosen (Stefanovic, 2003). Regarding floods, Stefanovic suggests that the former framing leads people to seek hazard reduction measures such as levees, while the latter framing leads people to seek risk reduction by reducing their exposure and vulnerability.

7.8 Cascading and Herd Behavior (Peer Effects)

This set of heuristics suggests that what other people do can influence an individual's choice.[13] Models of cascades and herding behavior, two types of "peer effects," demonstrate that an individual's choice is influenced by the decisions of others (e.g. Scharfstein and Stein, 1990; Banerjee, 1992; Bikhchandani et al., 1998). Described simply, these models are sequential games in which actors receive a private signal and observe the choices of those who precede them in the game before deciding on an action. The nature of uncertainty in the game, how game learning is structured, and whether actors have other private benefits or costs from the game actions leads to variations in model results. These types of models have been used to explain asset investments, stock market crashes, cultural fads, capital allocation, technology adoption, and other phenomenon where individuals may make choices that differ from the choices they would make if they had not observed the decisions of others.

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[13] Schelling's classic example of hockey helmets is an example—players said they did not want to be the only ones wearing a helmet, so if no one else wore one, they wouldn't either. But if some players wore them, other players would be more willing to do so (Schelling, 1978).

Applied to flood risk decision-making, an individual may implement a risk reduction action after observing a neighbor doing so. A third person may think that the risk is too low to justify a risk reduction action, but after witnessing the first and second persons adopt risk reduction measures, they may revise their risk assessment and also adopt the measure. In this way, cascades of behavior can occur. For instance, a 2003 survey of Florida homeowners found that in neighborhoods with relatively high rates of hurricane shutter use, the shutters were of higher quality and were more likely to include envelope protection (measures to prevent roof failure during a hurricane) than the shutters used in neighborhoods characterized by lower rates of shutter use (Peacock, 2003). When and where this effect plays a role in decision-making deserves further research as it is not always found to be important. For example, one survey found that cascading effects are not evident when it comes to carrying flood insurance (Pynn and Ljung, 1999).

7.9 Affect Heuristic

The "Affect Heuristic" is a mental shortcut whereby it is thought that individuals mentally "tag" things as positive or negative, and use these immediate reactions in making decisions (Finucane et al.,2000). This could explain the findings that individuals judge risks that have high benefits as also having low risks and vice versa, even when this is not the case (Alhakami and Slovic, 1994; Finucane et al., 2000). When situations are "affect-rich," or emotion-laden, individuals have been found to overweight small probabilities and underweight large probabilities (Rottenstreich and Hsee, 2001). While decision-making based on affect can lead to systematic biases, it is a fast and easy approach to decision-making involving risk (Slovic and Peters, 2006).

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