Informing Emergency and Risk Management With Climate Knowledge in Arid Urban Areas

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1. Introduction

Urban decision makers in Arizona's growing megapolitan area and the Southwestern United States as a whole are faced with myriad challenges related to prolonged drought and extreme heat events, extreme monsoon rain events, and other potential climate extremes. Of particular concern are the direct impacts on water resources, wildfire management, flash flood and erosion management, the health implications of these events, and other societal impacts such as those on agriculture, energy production and manufacturing. This paper overviews the preliminary work of a cross-disciplinary team of social, decision, and climate scientists at Arizona State University that have come together to work closely with local and regional hazard mitigation and preparedness planners to understand what long term decisions will be influenced by climate knowledge and how they relate within the whole physical-social system.

The driving question in this study is whether urgent and complex climate information is really needed in the emergency and risk management communities, and if so, what and how could this information be provided? To answer this question we need to who are the managers that use or potentially use climate information? What are they managing that depends on climate or climate change information? What climate knowledge do they need to have to successfully accomplish their mission? What do they use now and how could it be provided that would improve decision-making?

2. Methods

Given the complexity of this project and uncertainty in the requirements for information, a clear idea of the management style is imperative; the team came to an agreement that an agile-iterative approach would work best (Wysocki, 2014). This style allowed the researchers and collaborators to incrementally work their way through issues of priority to understanding climate information conveyance without having a preconceived notion of what and how the expert elicitation should take place. Rather, agile methods require the client, in our case emergency and risk managers to guide the project to the most useful findings. The iterative nature of the agile style highlights useful results that build one upon another.
Many of the conclusions/findings drawn thus far have occurred through semi-structured interviews and observation of current practices. The information obtained from these iterations often requires re-visiting old ideas and revising findings in a way that is consistent with what is being learned. Therefore, it is most appropriate that this project is understood in the context of being in constant cycles of collecting information for a baseline understanding, observing current practices, prototyping to verify findings and hypothesis, and validation of ideas in operations. When new information is uncovered, the iteration may require a revision to refine or correct an earlier cycle or finding but ultimately the method leads rapidly and reliably forward.

3. Background:

3.1 *The Risk Paradigm*
A solid understanding of the Risk Paradigm in terms of hazards, as put forth by the National Research Council (1983, 2009), is crucial to understanding the project. The hazard Risk Paradigm shown in Figure 1., asserts 3 stages of risk; research, risk assessment and risk management. This paradigm works well to describe the relationship between the science enterprise and the emergency management communities. In the paradigm, the climate community describes climate change effects on extreme weather events such as dought, frequency and magnitude of storms, and heat waves. The impacts of the events are projected onto the community and its resources. Once these components have been assessed, the magnitude, impact on community and probability that it will happen are combined to identify and characterize the “risk”. Characterizing the risk then allows for the option of mitigation or taking preventative measures to decrease the impact with the provided resources and support. It is the transition from Risk Characterization to Risk Management that we focus on in this study. That is, what climate information will inform risk managers to take action?

3.2 *Structure of Emergency Management* There are essentially 4 different phases of emergency management. The first is preparedness; those who work in this phase of emergency management

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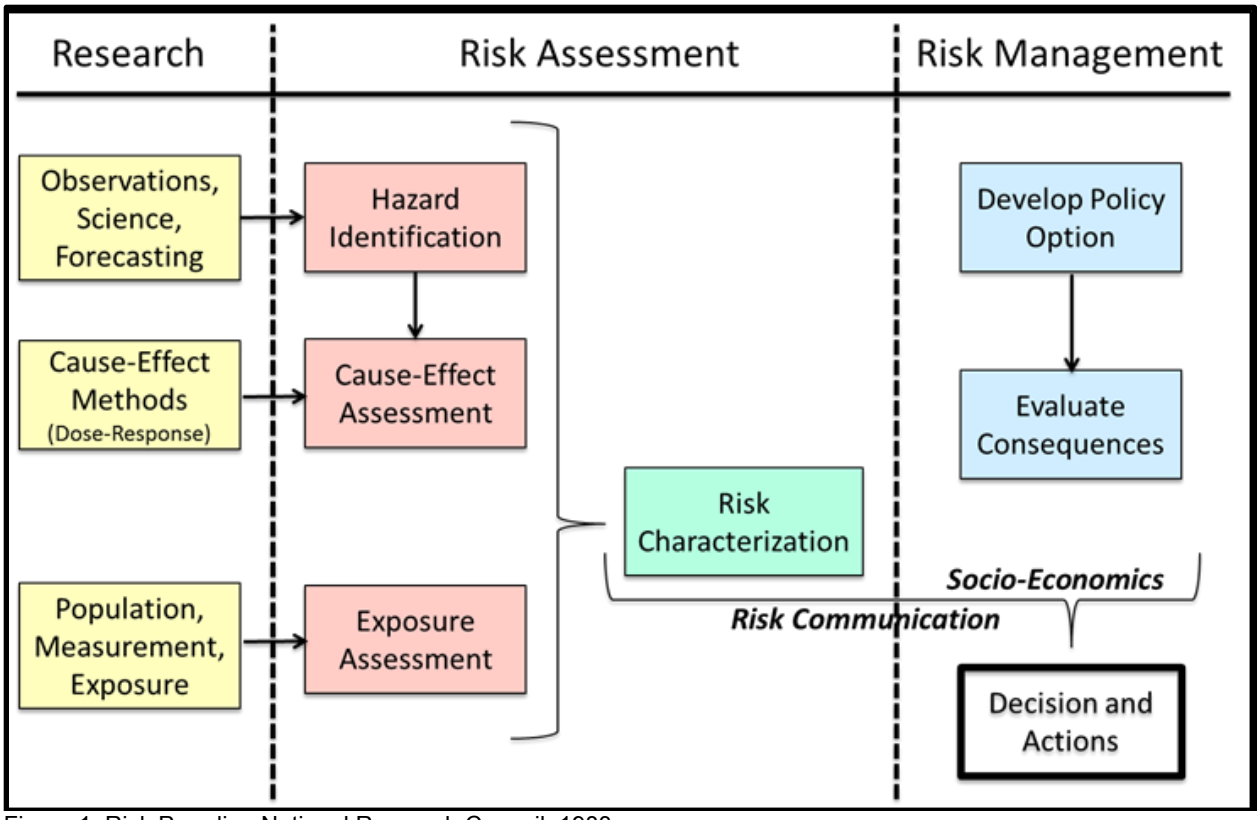

Figure 1. Risk Paradim, National Research Council, 1983.

devote their time to evaluating past disaster responses and putting strategies in place to improve preparation for the next disaster. Response is the second component and involves actions in response to actual disaster to help people and restore critical services impacted by a hazard, Typically police officers, firefighters, and paramedics all work to respond to an hazard after the event has occurred or is in the process of occurring, but many other emergency support function managers are also involved. After response is recovery to re-establish a "normal" societal condition such as replacing fallen buildings, distributing financial aid, etc. Finally there is mitigation, the phase in which a long-term plan is formed to decrease future damages from a similar/recurring hazard.

3.3 *Emergency Management Compared to Emergency Manager*

The 4 phases of emergency management can be compared to the single person designated the "Emergency Manager" (EM). EMs exist at multiple jurisdictional levels; private, local, county, state, regional and federal. They are not in charge of performing all levels of emergency management as one might suspect but rather, coordinating all other Emergency Support Functions (ESFs). There are 15 ESFs, namely: transportation; communications; public works and engineering; firefighting; emergency management; mass care, emergency assistance, housing and human services; logistics management and resource support; public health and medical services; search and rescue; oil and hazmat response; agriculture and natural resources; energy; public safety and security; long-term community recovery; external affairs. Any time a disaster hits, it is the emergency manager's job to communicate relevant information regarding the situation to the appropriate people in the correct ESF. In this context, the emergency management is a community of communities with varying roles and jurisdictions acting as a dynamic social network of hundreds of interactions and complex information flows. In addition to the 15 ESFs that have been identified, there are also 16 Homeland Security Critical Infrastructure Sectors which include: chemical; communications; dams; commercial facilities; critical manufacturing; defense industrial; transportation; water and wastewater; emergency services; energy; financial; food and agriculture; government facilities; information technology; nuclear reactors and materials. The Critical Infrastructure Sectors are the components in a given community that are critical to the function of the community (to varying degrees). When taken as a whole system of decisions and interactions, emergency is quite complicated

When a hazard strikes, up to 5 different jurisdictions of emergency managers are called upon to coordinate with any of the 15 emergency support functions that might be appropriate in order to protect/restore any and all of the 16 critical infrastructure sectors. Most of

emergency and risk management is focused on current conditions with little regard to long-term climate issues. Understanding EM (see Figure 2.) is critical to understanding how to convey climate information.

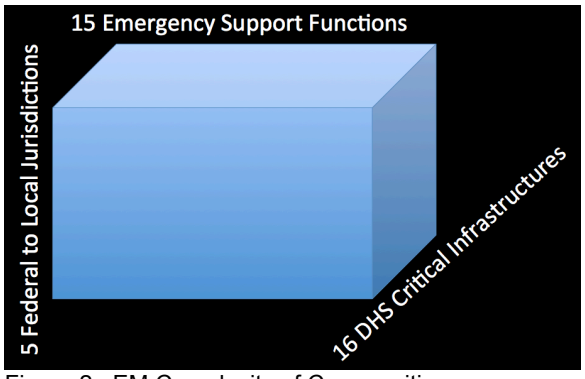

Figure 2. EM Complexity of Communities

4.0 Baseline Understanding

4.1 *Emergency Managers*
The first stage of the project attempts to define the baseline of who are the potential stakeholders in the project, what type of climate information could be useful to their specific operation, and the manner in which they perform their duties. In order to obtain a baseline understanding, the first step was interviewing Emergency Managers from different jurisdictions (small local jurisdiction and large county jurisdiction respectively) and having them guide us to understanding if and how climate information could be used in performing their job. For an initial iteration, two Emergency Managers were purposely selected based on disparity in population and availability of resources at their disposal. Initially, EMs had tremendously disparate attitudes regarding impending hazards. It was clear that the normal emergency management role is not conducive to planning actions beyond the next few weeks and often preparing for a response no further than 1-5 days in the future. When prompted as to whether or not they would utilize long-term climate information (information in the 1-5 year range), they allowed that it would prove valuable for the recruitment of resources if changes in event frequency could be clearly shown. However, the need for a precedence of experiencing a disaster is vital for the greater community to buy into behavior changes intended to mitigate future weather hazards. With EMs focused on relatively current weather conditions, the next iterations focused on mitigation, with different participants than the “emergency manager.”

4.2 *Mitigation*
Mitigation was selected as the second study target after it became clear that EMs were, operationally, too short-term for the purposes of using climate information direclty. The timely nature of this project allowed the team to observe the FEMA-required, 5-year, mitigation plan update meetings for two separate counties, one urban the other mixed urban but mostly rural. Mitigation plans have the potential to include all natural hazards (floods, winter storms, high winds etc.) in addition to some man-made hazards (hazardous material spills, traffic accidents, etc.). The information provided (whether by private contractor or state employee) was lacking in specific information about the natural hazards and impacts as they relate to the jurisdiction. Information that was meant to inform the planning team was largely vague in risk knowledge, particularly for a communities that are not accustomed to wading through scientific jargon and complicated graphics. On the occasion that data was made available to inform the planning team of expected frequency or magnitude of events, two problems were consistant. The first issue was the lack of knowledge conveyance of hazards and risk, and second, the facilitator of these meetings did not have a have a background in emergency management or weather/climate science. Given the inexperience of the group with climate science/meteorology, the facilitator is then put in a position to interpret the data as they see fit with little challenge from the team planners. The mitigation plan is then typically pulled together based on the biased, construal of the facilitator. After observing these meetings, it became clear that the mitigation plan was a possible injection point for climate information but would have to conveyed to a team that has little understanding of the hazards, their probability, their impacts, and how vulnerable their communities are. Armed with clear understanding, risk management planners may feel significantly more comfortable and confident in making decisions that, while they may seem unprecedented or extreme, could have dire consequences for the community. Mitigation planning could be a major benefactor of climate change information if a strategy for conveying the risk can be devised.

4.3 *ESFs and Critical Infrastructure*
In addition to speaking with those directly involved with emergency management, one of the main goals of this research project is to understand whether any ESFs or Critical Infrastructures managers are doing long-term planning for climate change. After speaking with an employee at the department of health services, it appeared that the range of time that employees in this field typically deal with is weeks to months, with years being the absolute maximum time that planning is being done for. In contrast to the emergency managers, when the health department representative was asked whether or not dramatic climate information would impact the way they did their job the answer was no. While this may differ for ESFs more directly affected by climate, it was clear that some ESFs may be better injections points than others. Again, while a potential user-base might exist, asking ESF managers to think long term will be challenge.

5. Summary and Next Steps

Some key stakeholders have been identified, namely, the mitigation planners and operational emergency support function managers. The current hook to these groups, and potentially emergency managers is providing information about hazards, their potential cascade of impacts on society, and the frequency of return. This level of information, such as used by floodplain managers, is needed for all hazards. As flood frequency is filled with uncertainty, it is recognized that other hazards frequency of occurrence is also also very uncertain. However, connecting to planners to understand current risk is needed as a reference point before injecting climate and climate change will have any meaning.

The project will continue to pursue where some potential injection points for climate information would be while, in turn, finding out where planners are getting their "climate" information from. In this project, we acknowledge two levels of knowledge needs, the rationale centered on facts, such as frequency of return, and the beliefs/values derived by individual or group experiences and influences. Beliefs and values are dominant in decisions under uncertainty making it essential to understand what influences and changes beliefs in particular when it comes to the controversies portrayed about climate. In order to uncover what these beliefs are and where they are coming from, the team will begin to hold focus groups in addition to the one-on-one interviews held up to this point. The purpose of these facilitated focus groups will be to give the, carefully selected, participants an opportunity to articulate what their belief is and where it came from. Once the team is aware of what the beliefs are and where they come from, a prototype can be created and presented to a group to see if rationale information can indeed inform and change beliefs that hazards will change due to climate variation.

6. References

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