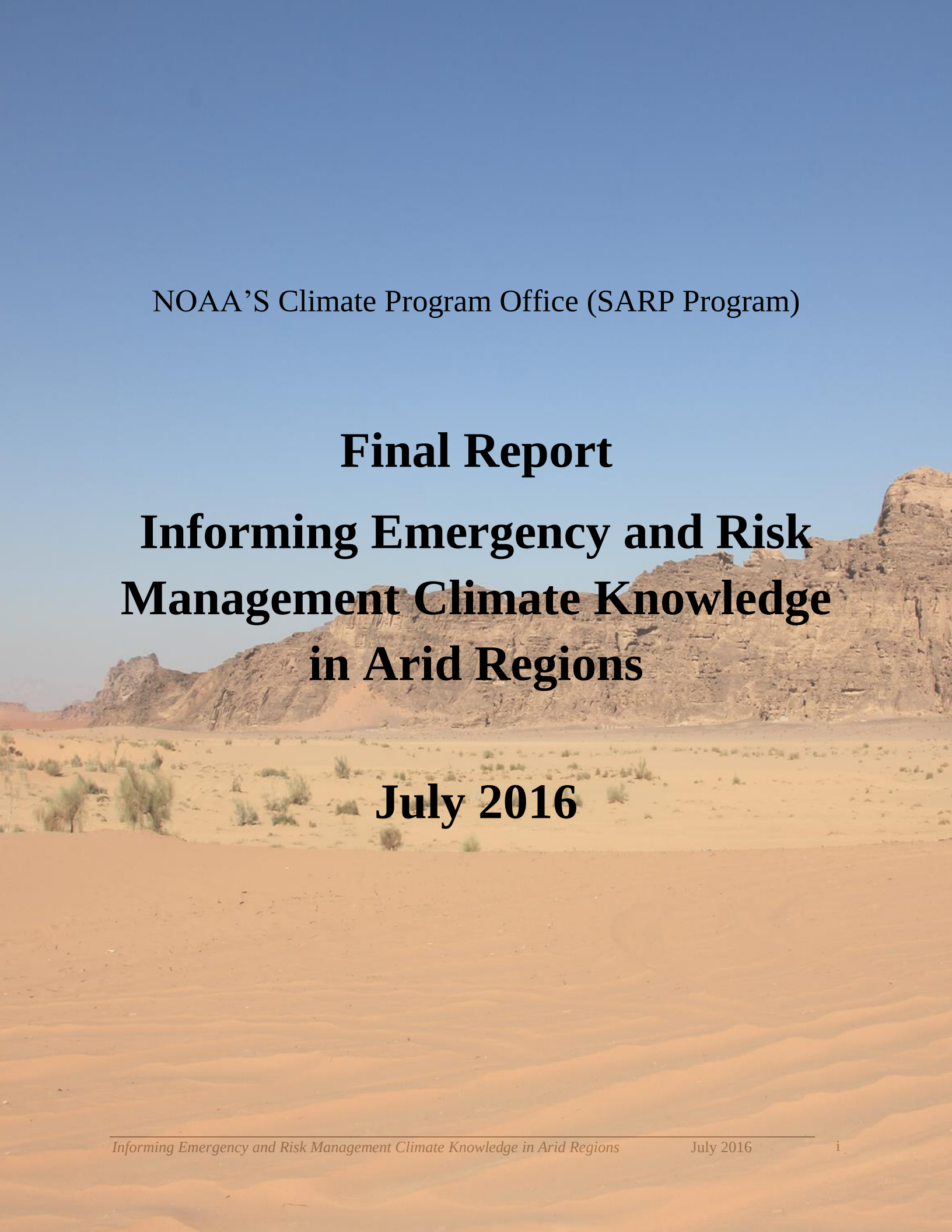

NOAA'S Climate Program Office (SARP Program)

Final Report

Informing Emergency and Risk Management Climate Knowledge in Arid Regions

July 2016

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Executive

Executive Summary

Unusual climate patterns pose challenges for risk and emergency management planning because of the low frequency of extreme weather occurrence but its varying impacts across different organizational responsibilities. In recent years, unusual weather patterns have impacted the state of Arizona and the arid southwestern regions not normally known for weather–driven disasters. The region has experienced prolonged drought, heavy snowfall events, heavy rainfall and flooding, early and extended fire seasons, and even large tornadoes. The losses from these events have reinvigorated the dialog about weather changes, planning processes and information needs with regards to hazards, cascade of impacts, vulnerability, communication and emergency and risk management planning.

The one year (with an additional year of no-cost extension) NOAA/SARP funded project established a baseline understanding of how the emergency and risk management communities perceive and plan for extreme weather in the hopes of learning how climate information could effectively be infused in their mitigation planning processes. The Federal Emergency Management Agency's (FEMA) mitigation planning process is conducted at both the state and county levels nationwide and aims to create a long-term robust plans with focus on reducing loss of lives as well as damages to property. Currently this institutionalized planning process is the primary means used in mitigating against potential disastrous impacts of natural and climatic hazards. Our findings show evidence that this community of risk and emergency managers were mainly focused on preparing to respond to imminent events using short-term weather forecasts with information coming largely from historical records of events and their personal experiences (the latter, particularly, if they had been working in their jurisdictions for a significant length of time). The variation in the prioritizations of hazards was largely subjective; based on past experiences and belief rather than factual data, so decisions are made based on perceived risk rather than on real risk.

Observations of county level mitigation planning meetings showed that there was a substantial lack of climate information in the training programs for any given natural and climate hazards. While historical information was provided, it is clearly not sufficient in allowing participants to assess future impacts of changing climate and extreme events. Participants were expected to predict the probability of an event happening, assess the magnitude of its impact on the community, and provide details on its potential frequency and duration; and then make planning decisions on the events' impacts on infrastructure/ loss of lives. Furthermore, planning for such future events remained a low priority and were delegated to community mitigation planners, many of whom were assigned to be there and were apathetic to the process, and did not have adequate and/or relevant climate information to update or create (if none existed) five-year mitigation plans.

What emerged from the findings was the articulation of inadequate institutional communication between NOAA and the emergency and risk management communities including FEMA. Of particular concern was the need for a communication channel to not only allow access to data

and climate modeling requests between NOAA and their agencies but the ability to send and receive regular feedback on current data and climate information as it relates to their region including the impacts of extreme weather events. Specifically, our findings show that in order to ensure that the FEMA mitigation planning process is more efficient and effective, the process would benefit from including specific standardized and comparable data about relevant natural and climate hazards. Such spatial and temporal data required for 2-10 year mitigation planning do not yet exist. Still future work on this subject should focus on a timeframe relevant to the planning and budget cycles of the planning process (2-10 years into the future). Without this kind of temporal and region specific information, planning efforts will be close to futile as decision makers would be forced to use just their own past experiences and deeply held beliefs as proxies for more evidenced based climate knowledge and data

Final Report: *Informing Emergency and Risk Management Climate Knowledge in Arid Regions*—NOAA Award Number NA14OAR431054, April 2016

Reporting period: 5/01/2015-4/30/2016

A. Background

NOAA's Climate Program Office's SARP program awarded Arizona State University's (ASU) proposal titled *"Informing Emergency and Risk Management Climate Knowledge in Arid Regions"* in 2014. The Project has principal investigator(s) Nalini Chhetri (ASU), Anthony Cox (Arizona Dept. of Emergency & Military Affairs); Nancy Selover (ASU/Arizona State Climatologist), Kenneth Galluppi (formerly with ASU); and Hana Putnam (Research Associate ASU). The project received a one-year no cost extension ending July 30th, 2016.

B. Goals and objectives

The two goals of the project were to 1) understand how local and regional emergency management (EM) communities function so that climate science knowledge can be effectively infused into their decision processes, and 2) develop a framework for identifying products and services that can deliver needed knowledge about climate extremes, threats, impacts, and resulting risk in order to prioritize mitigation and adaptation efforts. The objectives derived were: i) define who the EM community were, how they function and how they make risk management decisions related to climate extreme events; ii) identify the decision frameworks and processes that this community used and gaps that may exist; iii) determine if they currently use climate information, how they get their information, what is missing as well as what information may improve their decision making processes; and iv) explore the most critical issues that impair effective decision-making processes. These objectives were designed to develop an understanding of the existing products and services being utilized by the risk and emergency communities in arid regions, and to provide insight into new products or services, which might be more effective primarily in extreme weather events.

Given the delay in the start of the project, and movement of the original cast of PIs in the project within the university system, the project started implementation only in late 2014. As it picked up pace, we utilized a suite of methodological protocols including in-depth interviews of professionals (40+), observations and participation in planning mitigation meetings and trainings in two counties in Arizona, a one-day workshop for decision and policy-makers with the larger EM community, comprehensive literature review, and an analysis of the *WxEM* framework (Figure 1). The *WxEM* framework provided the conceptual basis for an understanding of how the emergency management and risk management communities, including government and the private sector, use extreme weather knowledge to inform and prioritize mitigation decisions. The framework describes a iterative process that involves getting a *baseline* reading of who makes up the community, understanding *current practices* of that community, creating a *prototype* based on the communities needs, and *validating the prototype* as it relates to the community.

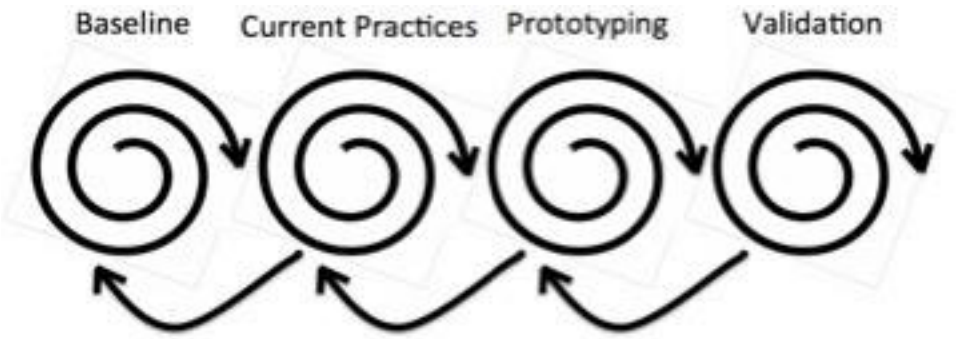

Figure 1. The WxEM framework iterative process.

C. Progress against objectives

Identification of key community members:
Objective 1 required that we define who the EM community was, how they function and make risk decisions. This was accomplished by conducting interviews (discussed above). The team identified, consulted and conducted in-depth interviews of key risk and emergency managers, in addition to those working in some emergency support functions (ESFs) in Maricopa and Coconino County. Our team conducted 40+ interviews of individuals in the fields of risk and emergency management in addition to stakeholders within the National Weather Service (NWS) and climate science communities.

Personnel /Agencies	# of Personnel Interviewed
Emergency Management-Preparedness	4
Emergency Managers	5
Emergency Support Functions (ESFs)	3
First responders	4
Non-Government Organization	1
Public Works	3
Risk Managers	2
Sustainability	2
Transportation Planning	1
Utility Provider	2

Table 1. Number of people interviewed based on jurisdictions and agencies.

Each interview was documented through an iterative process. The iterative process allows for data gathering to be done in a cyclical rather than a linear manner. This process was used so that during the baseline portion of the project our team could interview people with the goal of understanding how they fit into the landscape of the emergency and risk management communities. After gaining an understanding of who the relevant stakeholders were with regards to this project, we circled back with some of them with specific objectives regarding long-term planning, information they felt they needed to plan, extreme weather events that were of most concern to them, including impacts following extreme weather events. These semi-structured

interviews were documented with clear learning objectives and findings from each interaction, and acted as a potential launch pad for future iterations.

The second part of objective 1 involved understanding how risk decisions were made. This was done through direct observation of the mitigation planning process. The team participated in four hazard mitigation sessions led by Arizona's state planning team in order to understand how those decision makers focused on mitigation within emergency management were thinking about long-term planning as it relates to extreme weather and long-term changes in the climate. The two counties our team participated in to observe these mitigation meetings were Coconino and Maricopa Counties.

Observing and participating in the mitigation planning process also addressed objective 2, which aimed to identify decision-making frameworks and processes in place. Our direct participation also allowed us to readily identify knowledge gaps. In order to get a complete understanding of the kind of knowledge gaps that existed, our team invited key stakeholders to a workshop of selected participants. This workshop served as an opportunity to have a dialogue about how these communities understand the risk and impacts of climate change, and the resulting loss stemming from extreme weather events

Objective 3 aims to understand which, if any, products and services are being used to understand and plan for extreme weather events with regards to the changing climate. This objective was assessed by separating interviewees who were directly involved in the planning process versus those that were not as they were almost evenly split (Table 2).

Interviewees	Involved in Planning Processes	Not Involved in Planning
All	46%	54%
Emergency Managers	40%	60%

Table 2. Professionals interviewed that were involved in long term planning efforts.

These interviews revealed the detailed level of information that emergency and risk management communities felt they needed to carry out mitigation planning (Table 3).

Climate Science Information Requested	By All Interviewees	By Emergency Managers
Frequency of hazards	29%	33%
Probability of hazards	21.5	16.75%
Specific hazard information	7%	16.75%
Accuracy/reliability of occurrence of hazards	7%	16.75%
Appropriate time frame for planning	7%	0%
Accessible information	7%	0%
Not sure	21.5%	16.75%

Table 3. Type of information interviewees and emergency managers required for mitigation planning.

Objective 4 which sought to identify the most critical obstacles to decision making for emergency and risk management communities was completed initially through a combination of interviews, observations, and the workshop. This objective is being explored further with a follow up project through our team's partnership with Arizona Department of Emergency and Military Affairs (DEMA) (explained further in the "Deliverables" section below).

D. Deliverables

In a one-year period, the project was able to produce a significant amount of deliverables. These outcomes included multiple conference presentations of the project findings, a well-received workshop, a complete analysis of the NOAA's climate resilience toolkit, securing additional funding for a follow-up project with DEMA, and a manuscript under progress for publication in a peer reviewed journal as well as in a trade magazine most visited by risk and emergency managers.

D.1. Emergency and Risk Management Stakeholder Workshop

"*Planning for Losses and Impacts Resulting from Changes in Extreme Weather Patterns*" workshop was conducted in Flagstaff, Arizona on May 12th, 2015. The workshop invited representatives from: emergency and risk management, first responders, transportation planning, large private businesses, utility provider, sustainability, public works, and non-government organizations. The objectives of the workshop were to:

- articulate the meaning of weather-related loss for different stakeholders including an understanding of the scale, magnitude and categories of how such losses inform actionable decision-making;
- explore an initial look at a cascade of potential impacts to the local community from an array of weather scenarios; and
- articulate recommendations to NOAA regarding prioritized information for assistance in long-term planning as it relates to loss from changing extreme weather events.

A report was completed for this workshop, titled "*ASU-NOAA/SARP Workshop: Planning for Losses and Impacts Resulting from Changes in Extreme Weather Patterns*" (see appendix 1).

The workshop led to some major findings and recommendations which is represented here:

1. In order to improve ongoing mitigation planning, NOAA should attempt to supply the planning community with climate guidance that includes a time scale of 2-10 years; information regarding frequency, duration, and magnitude of extreme weather events; and any other actionable climate information.
2. An assessment of the current mitigation planning practices is needed to update the process, the information needed, availability of expertise, and current training procedures.
3. An improved understanding of how planners incorporate hazards, vulnerabilities and impacts into their understanding of risk is critical to increase the efficacy of information dissemination strategies.

4. Establishing a direct line of communication between consumers of climate information/guidance and those providing it would allow for enhanced understanding of climate information and potentially improve precision and accuracy of data.

5. Findings of community planning processes and information use needs to be confirmed at a larger scale to help improve the infusion of climate information for mitigation planning.

D.2. Additional Funding Secured

Early success of this project resulted in additional funds totaling $100,000 through DEMA (with ASU providing equal matching funds). The team had submitted a proposal outlining problems we had observed with the mitigation process during our participation in the mitigation planning meetings. We also drafted potential set of solutions to some of these problems in a White Paper that was submitted to the office Federal Emergency Management Agency (FEMA) Region 9 (see appendix 2). Some of the findings highlighted regarding the mitigation process included: lack of actionable and relevant information in the process itself, absence of a communication pathway between FEMA and NOAA, and an overall lack of understanding regarding the importance and purpose of the mitigation planning process.

D.3. Conference Presentations

The research team presented at four conferences, namely:

1. Putnam, H., N. Selover, N. Chhetri, K. Galluppi, A. Cox. 2015. *Need for Relevant and Actionable Climate Information in Extreme Weather Mitigation Planning: Why the Gap Still Persists*. Presentation at the Fourth Symposium on Building a Weather-Ready Nation: Enhancing our Nation's Readiness, Responsiveness, and Resilience to High Impact Weather Events, 96th Annual Meeting American Meteorological Society (AMS), January 10-14, 2016, New Orleans, LA

2. Galluppi, K. J., H. Putnam, D. Coughenour, N. Selover, N. Chhetri, M. Roy. 2015. *Gap Analysis of Community Risk Planning for Climate Changes to Extreme Weather Events*. Presented at The Society for Risk Analysis 2015 Annual Meeting (SRA), December 6-10, 2015, Arlington, VA.

3. Selover, N., H. Putnam, N. Chhetri, K. Galluppi. 2015. *Climate Information Needs for Hazard Mitigation*. Presented at NOAA's 40th Climate Diagnostic and Predictions Workshop (CDPW). October 26-29, 2015. Denver, CO.

4. Galluppi, K., H. Putnam, N. Chhetri, N. Selover, A. Middel. 2014. *Informing Emergency and Risk Management with Climate Knowledge in Arid Urban Areas*. Presented at The 95th Annual Meeting American Meteorological Society (AMS). January 4-8, 2015, Phoenix, AZ.

D.4. Climate Resiliency Toolkit Analysis

Our team prepared a position paper on the NOAA Climate Resilience Toolkit. This position paper was prepared as an internal document (see appendix 3) and is titled, "*Preliminary Assessment of NOAA's Climate Resilience Toolkit (CRT)*". The CRT is a current product where NOAA provides information on risks associated with climate change. In general, the Climate

Resilience Toolkit is a clearinghouse for tools that can assist decision-makers (including farmers, water resource managers, coastal communities, utilities, and government agencies and businesses) in preparing for near-term, seasonal and long-term changes in weather. They include case studies of specific applications of climate information in decision-making in a wide variety of contexts. However, the toolkit contains no forecast, predictions or climate guidance for extreme weather events related to climate change within the 2 to 10 year time interval. Our preliminary findings, stemming from interviews and the workshop our team organized reveal that this is the time period of interest to risk management and planners as it covers the FEMA Hazard Mitigation Plan update time periods, as well as the budget horizons of city and county agencies.

E. Next Steps

E.1. Publications and Manuscripts

With regards to publications and manuscripts, our team is preparing a manuscript to be published in the journal *Society for Risk Analysis*. Additionally, we plan to submit an article to the trade magazine, *Emergency Management*. By submitting our findings to both a scholarly journal and a trade magazine that is accessible and frequently read by professionals in the field, we hope to communicate our findings to larger and relevant communities in order to maximize our impact.

E.2. Further Research

During our time working on this project, we have identified a few opportunities for further research that were out of the scope of our current project that we hope to investigate in the future.

1. Exploration of public willingness to fund mitigation projects - including public attitudes towards mitigation in general.

2. Data on cost of various hazards - creation of a single portal that would allow various private and public sectors to input their estimates of costs of various extreme weather events (e.g. public works, fire department, chamber of commerce, etc.). This could later be incorporated into an "impacts report"…this would inform people in a given area the exact impacts of different hazards so that they would understand what to expect.

3. Exploration of how risk should be incorporated into planning, and in particular what should be weighed highest? In terms of costs, mortality and/or injury to humans.

4. Acceptable degrees of uncertainty in planning process for planning communities.

5. Overall communication of highly technical information that is accessible and relevant.

E.3. Local and National Engagement Framework—Emergency Management Communities

In order to come up with a prototype of the type of climate information or guidance the emergency and risk management communities need, we focused on utilizing information drawn from our observations, interviews and workshop. Our team identified a need to involve emergency management communities at the local level in Arizona and at the national level to

affect how mitigation planning is done. We have successfully done this by collaborating with contacts at the DEMA in order to create connections at the FEMA. Based off of these new connections, the Director of the Mitigation Division for FEMA Region 9 has agreed that a workshop should be held in Phoenix, Arizona in July 2016 to discuss potential improvements to the mitigation planning process. Our team plans to invite stakeholders from: NOAA's climate division, Army Corp of Engineers, DEMA, and FEMA region 9 (which includes Arizona, California, Hawaii, Nevada, and the Pacific Islands). The workshop in July will aim to begin forging a network of communication between the two agencies (FEMA & NOAA) while collaborating on ways in which stakeholders can contribute to the improvement of the mitigation process. This meeting will also serve as an opportunity for our team to test various ideas we have arrived at that could bridge the information gap.

F. Appendices

1. Emergency and Risk Management Stakeholder Workshop Report
2. DEMA White Paper
3. Climate Resiliency Toolkit Analysis

Appendix 1

Emergency and Risk Management Stakeholder Workshop Report: "Planning for Losses and Impacts Resulting from Changes in Extreme Weather Patterns"

1. Overview

The NOAA-ASU workshop "*Planning for Losses and Impacts Resulting from Changes in Extreme Weather Patterns*" was conducted in collaboration with Coconino County Department of Emergency Management and the Sustainability Program for the City of Flagstaff on May 12, 2015 in Flagstaff, Arizona. The purpose of the workshop was to gain an understanding of the planning perspectives of community stakeholders in reducing potential losses caused by extreme weather events, engage in a deeper dialogue about how this community currently view and plan for extreme weather events and what further information they need in order to understand potential hazards and impacts that could lead to effective plans and actions to lower the risk to lives, property, economy, and social well-being. The most significant findings of this workshop included the type of information this community needed: a 2-10 year time scale, forecasts with annual updates, and digestible information with infographics using language stakeholders without a technical background could understand.

2. Background

Unusual climate patterns pose challenges for risk and emergency management planning because of the low frequency of extreme weather occurrence and varying impacts across different organization responsibilities. In recent years, unusual weather patterns have impacted the state of Arizona, not normally known for weather-driven disasters. The State has experienced prolonged drought, heavy snowfall events, heavy rainfall and flooding, early and extended fire seasons, and even large tornadoes. The losses from these events have reinvigorated the dialog about weather changes, planning processes and information needs with regard to hazards, cascade of impacts, vulnerability, communications and emergency and risk management.

The first phase of the NOAA/SARP funded project established a baseline understanding of how the emergency and risk management communities perceive and plan for extreme weather in hopes to learn how climate information could effectively be infused. After a series of interviews with emergency managers, it became apparent that this community was mainly focused on preparing to respond to imminent events using short-term weather forecasts with some information coming from historical records of events. Planning for future events was delegated to community mitigation planners to update five-year mitigation plans or create one if none exists.

Following observations of all-hazards mitigation planning meetings, we noticed that there was a substantial lack of climate information present in the training program provided by the Federal Emergency Management Agency (FEMA) and the planning meetings themselves. The group was expected to predict the probability of an event happening and the magnitude of impact it would have on the community without relevant climate information detailing potential frequency and magnitude. It became clear based on the variation of prioritizations amongst the group that these predictions were largely subjective; based on past experiences and beliefs rather than factual data. Additionally, the team noticed that the majority of the participants involved in developing the mitigation plan were assigned to be there and, as such were largely apathetic about the process and the resulting plan. We hypothesized that, in order to create an effective plan, injecting the correct information wouldn't be sufficient; the relevant stakeholders, with adequate training and expertise needed to be present in order to utilize this information effectively. Our team arranged a half-day workshop that brought, who we carefully considered to be, the key stakeholders to the table and engaged them in dialogue about loss, impacts, risk and planning. Stakeholders were interviewed prior to the workshop to assess their role in planning (to avoid duplication of roles and perspectives), and to gain their view of what the workshop objectives should be. Ultimately, the following groups were represented:

- Emergency & Risk Management
- First Responders
- Transportation Planning
- Large Private Business
- Utility Provider
- Sustainability
- Economic Development
- Public Works
- Non-Government Organization

Further, the representation spanned county, city, private and NGO jurisdictions.

3. Goals and Objectives

The interest in assembling this workshop stemmed from our team's prior observation of the FEMA prescribed mitigation process that suggests inclusion of climate change as part of planning for extreme weather. Upon observing these mitigation meetings, we noticed that the planners did not embody all important stakeholders and that the planners seemed to lack experience with the mitigation process, despite most having attended training a day prior to the first meeting. We aimed to observe how the dialogue would change if the right participants were at the table. According to FEMA's mitigation training program, those present at the mitigation meetings should include Emergency Support Functions (ESFs), critical infrastructure, emergency and risk managers, in addition to any locally relevant NGOs and private sector representatives. The team hoped to learn how the interactions and thought processes would differ amongst the participants present at the workshop and the planners present at the all-hazards mitigation meetings.

The goal of the workshop was to elicit expert perspectives from each participant as to their own thinking on *loss, impacts, risk and planning* arising from extreme weather events.

The three objectives of the workshop were to:

- Articulate the meaning of weather-related loss from different stakeholders including an understanding of the scale, magnitude and categories of how such losses inform decision-making;
- Describe an initial look at a cascade of potential impacts to the local community from an array of weather scenarios; and
- Make recommendations to NOAA and other stakeholders regarding prioritized information for assisting in long-term planning to those in an operational field as it relates to loss from changes in extreme weather events.

4. Methodology

The workshop was organized into four sessions: Session one was structured as a polling inquiry, designed to ascertain the general demographics of the participants and their initial views on long-term planning, broad definitions of loss and extreme weather, and the level of urgency with which the participants viewed potential impacts for extreme weather events.

The second session was a facilitated focus group where we delved deeper into the perspectives of loss, impacts, risk and planning. This session allowed us to understand how different organizations (e.g. the private sector, the sustainability office, fire, EM) and jurisdictions (County, municipal, private sector) were thinking about loss, risk, impacts and planning. This session was intended to uncover both consistency of thinking as well as differences on issues underpinning an effective planning process.

The third session employed a scenario-based approach to connect participants to their operational concerns. In this session, a realistic weather scenario was posed and participants were asked to reflect on their definitions of risk and loss from the previous sessions in order to identify how a weather event could result in a cascade of impacts of importance to their organization. This session also aimed to demonstrate the broad extent of impacts, how they are interconnected, and which issues were of primary concern to the community partners. The scenario was a large wildfire resulting from prolonged drought, followed by flooding from monsoon rains.

In light of the exposure to extreme weather highlighted in the previous three sessions, the final session asked the participants to focus on planning for extreme weather, especially with respect to potential changes in patterns of events and the exacerbation of impacts and losses. This session was open-ended brainstorming to elicit the mode and content of climate information needed to confidently, competently and comfortably plan for changing patterns in extreme weather events. This session of the workshop was largely unstructured to allow for a free-flow of ideas, passions, and recommendations.

5. Findings

5.1 Perceptions of extreme weather events

- **The initial polling of the participants revealed that half of those present viewed the effects of extreme weather events as "minor impacts" and none of the participants concluded that impacts had the potential to be "devastating".** Participants appeared divided on prioritization of mitigation planning when polling

inquiries were utilized; roughly half indicated planning was “extremely” or “very” important while the other half asserted that it was only “somewhat” important.

- **When given the opportunity to explain and contextualize through discussion, participants seemed to come to a consensus that extreme weather events exerted a high impact on their organizations.** This differed from the results derived from a polling question, which asked participants to categorize how important they believed planning for the impacts of extreme weather was.

- **While death/injury to people was considered the most severe impact of an extreme event, discussion revealed that participants believed it to be an infrequent occurrence.** Few decision-makers felt death or injury to people was a typical consequence of extreme weather events. Higher priority impact planning focuses on the destruction of property or infrastructure that can impact the well-being of people.

5.2 Perspectives of extreme weather events across sectors

- **Organizational job responsibilities played a role in varied perceptions and prioritization of mitigating against loss resulting from extreme weather events.** Classification of loss revolved around 1.) definition of the term ‘extreme’, 2.) frequency of an event’s occurrence, 3.) duration of impacts (e.g. road and business closures, and impacts on income and revenue), 4.) magnitude (especially if event was out of the realm of expectations) and 5.) impact on people, compared to an event where no human population was present.

- **Business sector participants cited multiple economic concerns such as loss of employee time, decreased productivity, and delay of deliveries.** Those present mentioned an example from 2012, during which winds and blowing dust closed I-40 frequently. These events had a tremendous impact on travel and commerce and validated the thinking that shifting climate patterns have the potential to greatly distress the private sector, and ultimately the economy, in Flagstaff.

- **Risk management planning is focused on insuring government or private sector assets. Acknowledging and planning for changes to extreme weather frequency, magnitude, and durations were not found to be high on their planning priorities.** Risk managers presently approach their job by transferring the risk to insurers, though project planning would likely occur if reliable, actionable information were available to indicate that avoidance versus transferal was feasible.

- **First responders’ planning priorities were focused on developing capabilities to respond to short-term (less than 1 year) disaster occurrence with a reasonable guess as to what impacts may be caused by all hazards.** Intermediate (2-10 year) or longer planning of extreme weather is not a priority for this group.

5.3 Perceptions of losses due to extreme weather events

 Initial perspectives showed a clear majority of participants associated loss with effects on people, while few people focused on loss of operational capacity. Polling elicitation showed that participants defined "loss" from extreme weather events in terms of impacts on their community, more specifically, in terms of effects on people (as opposed to effects on infrastructure or dollars). Loss was ultimately more about death or bodily harm to people, which mattered most and would need to be avoided as much as possible. The example of The Schultz fire and the loss of lives were discussed at length including long-term impacts and recovery efforts to the county costing about $20 million despite no loss of life.

 Through discussion, participants concluded that extreme weather events could cause great economic distress, potentially leading to significant changes in utilization of certain industries (i.e. environmental tourism and recreation). Business closures, loss of employees, loss of revenue, decreased bond ratings, loss of employment, and decreased recreation and tourism were all impacts thought to arise from an extreme weather event. Further, a wildfire in one of the major recreational areas would cause a significant blow to Flagstaff's revenue in addition to causing stress on the community, the environment and the people who reside there year-round.

 Participants considered loss through an array of time frames and across several sectors. Facilitated discussion supplied examples including 1.) Dengue fever in Phoenix, if warming trend continued, could spread to Coconino County, 2.) Wildfires—impact on several sectors including public health, transportation, and recreation and tourism, 3.) Uncharacteristic heat waves in Flagstaff (temperatures in the 90-100 degree Fahrenheit range) for which the city has not prepared.

5.4 Cascading impacts and feedback loops

 After exploring the cascade of impacts, participants agreed that extreme weather events have the potential to disturb infrastructure, the economy, people and the social well-being of the community. The major components the participants thought would be impacted by an extreme weather event (using the example of wildfire), were the community, people, the environment, businesses, and transportation**.** Analysis from the extreme weather scenario activity revealed that these five major components are all intrinsically connected, indicating that if one of these facets were disturbed due to an extreme weather event, the other four would also be affected.

 Participants believed, almost unanimously, that compromised transportation could lead to "disaster" because of its effects on the movement of materials and people through a cascade of impacts. A representative from the private sector gave examples of impacts obstructed roads could have on the well-being of the company; he cited inability to ship out manufactured supplies, cascading impacts of closing the enterprise for multiple days, and a potential relocation of primary operations offices resulting from inaccessible roads.

 Given that power outages and damaged Internet pathways were determined to have serious implications for the community, participants agreed that planning

efforts to make these services more resilient could become a priority if they were provided with climate information detailing duration, magnitude and probable frequency of events. An employee of a power company gave a couple examples of disruptions that would occur if Flagstaff's Internet pathway were disconnected including: a halt to internet communication, and the inability to use credit and debit cards for purchases. Additionally, power outages have important implications for hospitals and nursing homes in which some patients are on life support or require medication that must be kept at a certain temperature.

It was noted that this perceived shift in prioritization of mitigation planning resulted from the extreme weather scenario activity, during which, participants heard the impacts a wildfire could have on each individual department. This created sort of a feedback loop as the participants considered not only the individual impacts of their own departments but, how the impacts of another sector could worsen the effects they had to deal with.

- **Participants expressed concern regarding impacts climate change could have on water availability in two scenarios: 1) extended drought resulting in an acute water shortage leading to human health or economic hardship, and 2) extended power outages resulting from extreme event (flood, fire, ice) preventing pumping of fresh water or movement of sewage.** Community planners are very attuned to the cascade of impacts resulting from water shortage and are very interested in climate change in this regard. Further, issues with water served as another example of how interconnected the different sectors are and how one area feeds back to other sectors. This view differs from what is typical of current mitigation planning practices in which each department plans for their own department without considering outside factors that will likely be at play.

5.5 Prioritization of mitigation planning

- **Amount of time and experiences in the jurisdiction may dictate how mitigation planning is prioritized.** When surveyed, the group revealed that about half had been in Flagstaff for six years or more while the other half had lived there for three years or less. This is noteworthy because, in absence of first-hand knowledge of the extreme weather events and climate data in the appropriate time frame, decision makers are forced to rely on second-hand knowledge or their own past experiences. Polling of the group revealed that 35% of decision makers from various organizations believed the biggest barrier to planning for extreme weather impacts was that the consequences were not significant enough to prioritize. This seems to mirror the response to a question regarding the number of extreme weather events participants had experienced: 35% experienced 1-2 extreme weather events in the Flagstaff/Coconino County area while only 14% had experienced more than eight. These data are consistent with the idea that experiences in the jurisdiction influence prioritization of mitigation strategies.

5.6 The risk paradox

- **Participants had difficulty articulating their view on how risk was connected to loss and impacts, the effect of which was an inability to define what exact**

information was needed and how it could affect the planning process. The facilitated discussion and brainstorming sessions of the workshop were tailored to help us understand the stakeholders' thinking processes. Throughout these sessions, our team prodded participants to explain why certain losses were more significant than others and why certain impacts were worth mitigating while others weren't. The goal of these queries was to gain an understanding of how these stakeholders were identifying risk. Though many anecdotes were offered regarding loss and impacts, a lot of ambiguity surrounds classification of risk.

5.7 Timeframes regarding mitigation planning and climate guidance

- **The ideal time scale for climate information was agreed to be 2-10 years into the future as this coincides with budget and planning timelines.** The participants asserted that in their organizations, information is not actionable if it does not fall within their budget and planning cycles. The timeframe of climate information this group needs in order to plan would be 2, 5, & 10 years into the future based on what participants voiced during the facilitated discussion and brainstorming session. Currently, no forecasts, projections, or predictions exist that address the time frame requested by participants in the workshop.

5.8 Information deficiencies for mitigation planning

- **According to polling inquiry, "insufficient information regarding hazards" was considered one of the "major barriers" to planning for extreme weather events.** Besides the belief by some that consequences of extreme weather lack significance, about one third of the group counted lack of information as a major barrier to planning.

- **Communication and comprehension of climate information are crucial to assist with mitigation and adaptation strategies**. With regard to communication of climate information, participants suggested criteria they believed would allow for greater comprehension of climate information; 1.) Digestible information, using language people can understand (fourth grade level recommended), 2.) The most important information should be conveyed through infographics, 3.) Technical details should be appended or supplied as links only. One participant acknowledged that when it comes to asking his organization for resources necessary to mitigate, the climate information he is supplied with needs to be in a form that is understandable to both him and his decision-maker. This was seen as a critical issue as many at the policy level do not have a technical background or expertise.

- **Connecting the impacts of extreme weather events to stakeholders in a way that makes them care, was thought to be more effective than data or statistics when attempting to increase prioritization of long-term planning**. Discussion of recent disaster (e.g. Schultz fire; Yarnell fire) allows for the level of details of such events and their impacts that mere data cannot. Associating events with a specific place has more emotional impact and therefore holds greater weight.

5.9 What "we" want: stakeholder requests

- **Stakeholders requested annual updates of climate guidance as information becomes more precise and accurate in order to increase relevance and applicability to planning.** During the brainstorming session, participants in the workshop agreed that if they received climate guidance in the preferred timeframe (2, 5, and 10 years), they would like updates to this information. This would allow an increased understanding of the data while supplying a context and trends that they can become familiar with. The participants asserted that using an iterative process would allow them to gauge the accuracy of the information they were being given, allowing them to build confidence in the source of the information. Essentially, they want a baseline of what to plan for in years to come with the ability to attain more focused and detailed planning information as time went on.

Engaging the planning community with regular updates to their forecasts will form a trusting and familiar relationship between the climate science community and mitigation planners. This added involvement and feedback could ultimately increase ownership of mitigation plans in the operations community while allowing climate experts to refine their data collection and analysis methods.

- **At the spatial level, climate guidance provided for the city or county was considered to be more useful to prevent extrapolation or misinterpreting by non-experts.** Data at the state and regional level is not as helpful or specific as data at the municipal or county level and therefore, not as useful. (The team recognizes that NOAA can't necessarily provide information at that spatial resolution, local experts can be utilized to bring the information down to this jurisdictional level).

- **The level of explanation required to understand climate information varied amongst stakeholders** owing to different levels of experience with climate information, their respective job description, background, and responsibilities**.** For a select group of stakeholders, a discussion (similar to forecast discussions, but not as technical) that accompanies the information that NOAA provides is just as important as the climate guidance itself. This additional information gives some consumers a greater understanding of how decisions were made and a higher level of trust.

6. Recommendations:

6.1 In order to improve ongoing mitigation planning, NOAA should attempt to supply the planning community with climate guidance that includes a time scale of 2-10 years; information regarding frequency, duration, and magnitude of extreme weather events; and any other actionable climate information.

- The all-hazards mitigation process lacks climate information that would allow the creation of an effective plan. In addition to adjusting the time scale of information so that it coincides with planning and budget cycles, information about the hazards themselves including frequency of occurrence, duration, and magnitude of the hazards are critical to

the efficacy of the plan. It has been established that this information is most useful when it comes at the county or municipal level. [Note: However, it is suggested that NOAA provides predictions at the regional level. With this information, local experts can make interpretations specific to their respective counties and municipalities. Further, efforts should make sure that communication of this information to planners is done in a manner that a non-expert could easily comprehend and explain to a decision-maker (e.g. using infographics and disseminating information at the 4th grade level).]

6.2 An assessment of the current mitigation planning practices is needed to update the process, the information needed, availability of expertise, and current training procedures.

- Although significant issues exist around the lack of climate information in the mitigation process, it is equally important that the process itself undergo a series of changes. The training of persons involved in the process needs to be improved such that the participants in the planning process have the skill sets to understand risk, vulnerability and impacts of hazards pertinent to their fields. Without revision of the process, the insertion of actionable climate information will not greatly alter the resulting outcomes. For this reason, FEMA may need to reexamine their training protocols as they relate to mitigation if they hope to make progress in planning for climate change.

6.3 An improved understanding of how planners incorporate hazards, vulnerabilities and impacts into their understanding of risk is critical to increase the efficacy of information dissemination strategies.

- Due to the significant ambiguity that surrounds the process by which planners define risk, steps should be taken to understand the type of climate guidance this community needs in order to prioritize mitigation planning with the appropriate amount of urgency.

6.4 Establishing a direct line of communication between consumers of climate information/guidance and those providing it would allow for enhanced understanding of climate information and potentially improve precision and accuracy of data.

- Setting up a direct line of communication between the planning and climate science communities eliminates guesswork for both parties and may ultimately result in increased trust and accountability. This straightforward system could also help increase buy-in, currently lacking, in the mitigation process. If the climate science community is able to see that their guidance has a direct effect on the mitigation measures taken by the planning community, it will likely motivate them to continually adjust their techniques to improve precision and accuracy. Conversely, the planning community will increasingly trust the source of the climate guidance if they are able to see a trend of increasing accuracy.

6.5 Findings of community planning processes and information use needs to be confirmed at a larger scale to help improve the infusion of climate information for mitigation planning.

- Variations in perspectives, job descriptions, level of experiences and locations may point to a need for different types of information. Further, more research is needed

surrounding emotional buy-in to all-hazards mitigation planning in order to improve ownership of the planning process.

7. Long-Term Outcomes

The outcomes of this workshop are intended to benefit several stakeholder groups:

- National Oceanic and Atmospheric Administration (NOAA) about information needs;
- Emergency Management (EM) mitigation officers about the potential hazards and their impacts, and information that would improve planning, and
- Community leaders and other stakeholders about potential extreme weather hazards and potential changes that could result in significant community impacts.

This guidance will enable information providers and users alike to assess what program and planning changes may be required to improve the mitigation of potential weather impacts.

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- The City of Flagstaff's Fire Department
- The Coconino County Public Health Services District
- The Coconino County Public Works Department
- The Flagstaff Metropolitan Planning Organization
- Northern Arizona University
- The Red Cross Northern Arizona Chapter
- The Summit District Fire Department
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NOAA/SARP Team at ASU:

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- Hana Putnam, B.Sc (Research Associate)
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Appendix 2

DEMA White Paper: Current State of Mitigation Planning System in the Southwest: Identified Gaps and Recommendations for Increased Efficacy

Problem Overview:

The Federal Emergency Management Agency's (FEMA) Mitigation planning process is conducted at both the state and county levels nationwide, and aims to create long-term robust plans with focus on reducing loss of lives as well as damages to property. Currently, this institutionalized planning process is the primary means used in mitigating against potentially disastrous impacts of natural and climatic hazards. Our current National Oceanic and Atmospheric Administration (NOAA) funded research shows that in order to insure that the FEMA Mitigation planning process is more efficient and effective, the process would benefit from including specific, standardized and comparable data about relevant natural and climate hazards. Specifically this data should be made available in a timeframe relevant to the planning and budget cycles of the planning process (2-10 years into the future). Without this kind of temporal and region specific information, planning efforts will be close to futile, as decision-makers will be forced to use just their own past experiences and deeply held beliefs as proxies for more evidenced based knowledge and data.

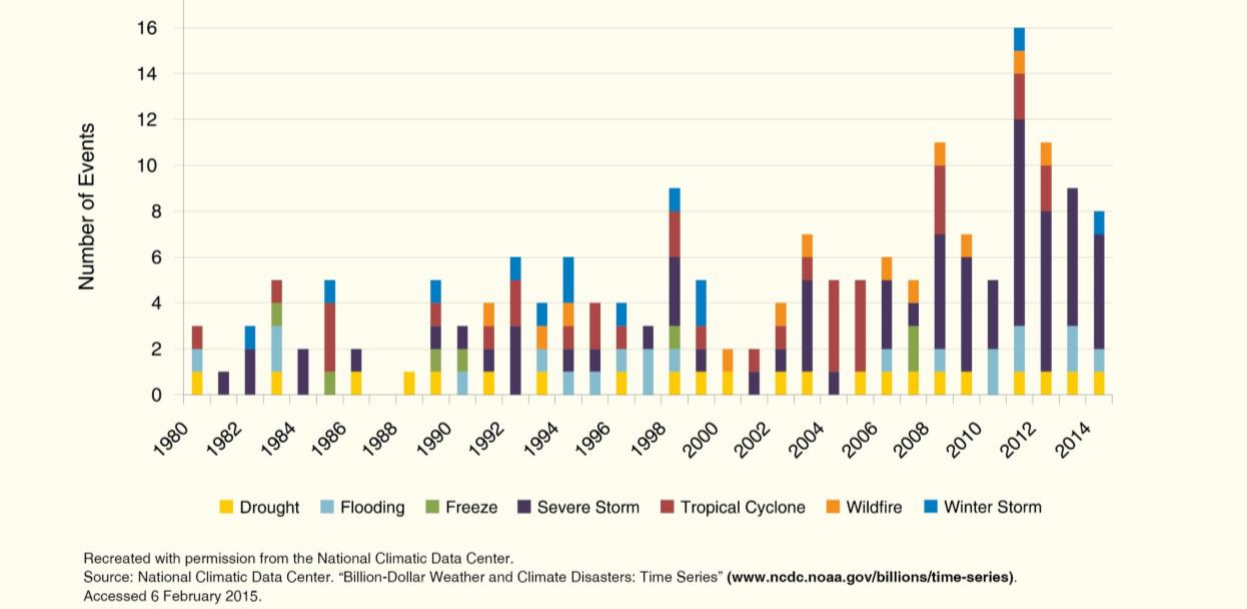
Background:

Heightened sensitivity towards preparation for future extreme weather events (EWEs) became priorities especially after the catastrophic impacts of Hurricane Sandy. Federal agencies such as the FEMA and Department of Homeland Security (DHS) compiled planning and strategy documents such as the National Strategy: Disaster Preparedness 2013 and created the National Mitigation Framework. Further, the President's Office's Climate Action Plan, emphasized the need to prepare the country for the impacts of the changing climate in addition to outlining ways in which the nation, with the rest of the world, could decrease greenhouse gas emissions. However, in the years since then, the U.S. has not faced another weather event with equal or greater impact than that of Hurricane Sandy, resulting in a lower urgency to take mitigation action, and making it harder for stakeholders to implement new planning measures.

Review of these emergency and hazard documents, as part of our ongoing project indicates that they were a first iteration to a process that warrants constant modification and improvement especially in an age where EWEs inflict more damage than ever before. In other words, these

documents need constant updating based on new knowledge being generated and experiences in implementing these plans.

Billion Dollar Disaster Events 1980-2014



Recreated with permission from the National Climatic Data Center.
Source: National Climatic Data Center. "Billion-Dollar Weather and Climate Disasters: Time Series" **(www.ncdc.noaa.gov/billions/time-series)**. Accessed 6 February 2015.

NOAA funded risk and emergency management in arid regions

Our team was assembled to understand the interface between the emergency and risk management communities and climate information. Our team examined all aspects of the process including: stakeholders involved in the development of plans, ideas and understanding of long-term planning for extreme weather events, the mitigation training and process itself. The aim of

our research is to make realistic recommendations to FEMA region IX as to how this important process can be modified to increase its efficacy.

Our research has employed several methodologies such as: in-depth interviews (40+) of professionals in the fields of emergency and risk management, sustainability and meteorology; observations of 5 county-level mitigation trainings and meetings; a workshop with selected stakeholders aimed at understanding the planning perspectives and knowledge gaps; inputs from presentations at conferences; and comprehensive literature review. Based on the data collected through this portfolio of methods, our team has identified the need to insert specific information regarding natural and climate hazards into the Mitigation Planning Process in order for a Disaster Risk Reduction strategy to be more relevant and implementable. The knowledge and communication gaps our team has identified are supplemental to and consistent with gaps identified in important documents such as the National Strategy: Disaster Preparedness for Fiscal Year 2013.

Specific (albeit preliminary) Findings:
The findings are:

1. Inadequate communication between NOAA and emergency/risk management communities including FEMA
   a. No institutional avenue currently exists for FEMA to make data or modeling requests to NOAA and/or give feedback on what they currently have.
2. The spatial and temporal level data needed in this planning process does not yet exist
   a. Planning process lacks access to relevant information
      i. Pertaining to the majority of natural and climate hazards in regards to frequency, intensity, duration, and the implications of the hazards within their jurisdictions, and the cascading human and infrastructural impacts of these hazard on their communities.
      ii. Timeframe needed to make these plans (2-10 years)
      iii. Confusing and/or inadequate requirements for climate change required by FEMA for their respective plans. Preferences and or prioritization of information source is lacking or insufficient (e.g NOAA, State Climatologist, State EM Office). The specificity of information on risks related to climate change is also lacking
   b. Historical information is provided but is insufficient in allowing stakeholders to assess future impacts of the changing climate and extreme events.
3. Decisions are made based on *perceived* risk rather than *true* risk.
   a. Participants in the process are asked to make decisions without information about frequencies, probabilities, projected magnitudes, or detailed damage to infrastructure/loss of lives of natural and climate hazards
4. A large degree of apathy and inexperience exists among personnel involved in the process
   a. In general, participants were uncertain about the exact purpose and application of the mitigation planning process.
   b. Typically only one person from each jurisdiction attends such meetings and they are often not the right representatives.

c. The person who attends often has neither desire nor the backgrounds to participate in the creation of an effective plan.

d. Attendees are often not the ones empowered to make decisions, which slows the process.

e. Most are first responders—while their perspective is needed for the plan, they should not make up the majority of the participants who attend and provide inputs, given that their planning process is much more near term than the timeline generally sought out in the mitigation plans.

f. Many do not have a science background to understand much of the natural and climate hazard information that is currently being supplied in the mitigation planning process

g. Many do not have experience with creating plans of this magnitude

Recommendations for Next Steps in collaboration with FEMA Region IX:

1. Explore improved communication between FEMA and NOAA with state agencies (i.e. DEMA) and the State Climatologist's office serving as local expertise. The aim is to ensure dialogue/create relationships with NOAA in order to collaborate and achieve mutual goals on mitigating impacts of natural and climate hazards.

a. and comparable across natural and climate hazards.

2. Different training curriculum for mitigation planning framework
    a. As evidence of the ineffectiveness of the current training, after "successfully" completing the required training many participants still are unsure of:
        i. Importance of the mitigation planning process
        ii. Purpose of the mitigation planning process

    Our team suggests a more hands-on and interactive approach that could employ scenarios and role-play based curriculum rather than standard presentations.

3. Facilitate communication channels for FEMA to request and receive from NOAA "actionable climate information"

a. Actionable information in this context is defined as data that coincides with FEMA's 5-year hazard mitigation plan update cycle, in addition to municipal, county, and state planning cycles, which are generally 2-10 years into the future. Furthermore, actionable climate information should be standardized and comparable across natural and climate hazards.

4. Ensure the objectivity of data for improved mitigation plans.
    a. The current data available to the mitigation planning groups is not standardized, comparable or complete at this time. The result of this is a mitigation plan that is based on the beliefs and opinions of participants engaged in the planning process. The subjectivity of the planning process could be eliminated if standardized, comparable, and digestible information was supplied during the meeting. By eliminating the biases that presently exist in this process, we ensure that the mitigation process reflects *true* risk as opposed to *perceived* risk.

Our Proposal:

As a mechanism to obtain the recommendations listed above, our team proposes the following work plan with responsibilities and timeline to be discussed:

1. Collaborative work session during which relevant parties including our team, representatives from FEMA region IX, and AZ DEMA are present to discuss these recommendations.
2. This session should lead to action plan for creating pathways to making and receiving requests to and from NOAA, and
3. Creating training requirements and curricula aimed at delivering a more efficient and productive mitigation planning process for natural and climate hazards.

If it is not possible to make revisions to the Mitigation process region-wide, DEMA would like to request the privilege of creating more stringent state-wide requirements to govern our own mitigation planning process.

Appendix 3

Preliminary Assessment of NOAA's Climate Resilience Toolkit (CRT)

Background and Information Gap

National Oceanic and Atmospheric Administration's (NOAA) Climate Resilience Toolkit (CRT) was evaluated by a team of researchers at Arizona State University, working on a separate NOAA SARP grant to investigate how climate knowledge was being used by the emergency management planning community. For the NOAA-SARP funded project, the team's stakeholders are planners with vast experience in vulnerability and risk assessments. This project included extensive interviews (40+) and a workshop with Flagstaff and Coconino County emergency and risk management planners in May to identify their climate risks and to assess how such risks intersect across management responsibilities. The team found that the missing component of their planning (particularly mitigation planning) process, which the stakeholders conducted regularly, was not how to perform vulnerability and risk assessments (as stakeholders were already skilled in this area), but rather, the *absence of actionable climate information*. Furthermore, the 2-10 year time interval has consistently been listed as an optimal time period given the need to align with FEMA's 5-year Hazard Mitigation Plan Update cycle, as well as the municipal, county, and state planning cycles.

In Flagstaff and Coconino County, climate hazards are extreme weather events such as EF3 tornados, winter snow storms, heavy monsoon rainfall, flash flooding, flooding from rain- on-snow events, drought, drought-related wildfires and flooding from subsequent precipitation events. Historically, there is no trend of increased frequency or intensity of these extreme weather events, but the sample size is small and temporal and spatial variability is high. Currently planners use the past extreme events as their basis for planning as they have no alternative information on future climate expectations for this region. **Their challenge is incorporating changes in extremes of climate into their planning process, given that they have no actionable information on what those changes might look like over their 2-10 year mitigation and adaptation planning horizons.**

Our research team was directed towards the CRT after participating in mitigation planning meetings for two different counties in Arizona. The CRT was recommended to the team after

concern was expressed that the emergency and risk managers were not equipped with adequate information regarding the changes in magnitude and frequency of the extreme weather events that they were planning for. The consequence of this information gap was significant in that planners involved in the mitigation process were not able to come up with a functional plan.

Climate Resilience Toolkit (CRT) Assessment

As a standard and basic vulnerability and risk assessment document, the CRT provides fundamental educational material, familiar to all planners and risk managers.

For a variety of climate hazards, the toolkit provides links to many useful tools to assess the risks from current and past climate and weather events. Much of the climate information on impacts is derived from historical data, and the toolkit links them to those data (e.g. "Climate at a Glance" and Climate Explorer). However, the Climate Explorer overlays a limited number of variables of only a few hazards including coastal flooding and drought in a snapshot in time, which is in turn overlaid with social demographic information of population density, social vulnerability and land cover. Non-hurricane extreme weather events are not represented at all. **Only the link to NOAA Atlas 14 has data on extreme precipitation events, defining probabilities for intense rainfall at various time intervals. However, there is no guidance on how the frequency or intensity of the heavy precipitation events may change in the future.**

For a few climate hazards that are occurring on a continuous and gradual basis, such as coastal flooding, the toolkit provides many tools to assist communities in planning mitigation efforts for both the near and long-term. It also provides tools to deal with current changes in vegetation cover, land use, invasive species, and other factors. The tools in the toolkit come from a wide variety of agencies and collaborations in many sectors, including agriculture, water resources, storm water management, civil engineering and infrastructure, coastal ecosystems and erosion, heat-related health, flood mapping, and forest changes. **As a compendium of tools developed by many researchers and agencies state, federal, and academic, the CRT is a convenient place to look for specific tools. However, as the resource for climate resilience, especially intended for climate change, the toolkit has little actionable climate information.** As a NOAA product, the CRT was anticipated to provide useful climate information to be used by planners. In some aspects, however, it comes off much more as a social science primer on vulnerability and risk assessment. Moreover, the lack of substantial climate data, projections, or guidance for future or current resilience projects is significant.

More detailed comments of some sections are provided below:

- **The Federal Highway Administration study, described in the toolkit, is perhaps the most useful model for providing the needed climate inputs to do any type of future risk and vulnerability analysis for climate hazards.** It estimates extremes for specific locations including number of days with high temperatures above several thresholds, highest 7-day air temperatures, and annual return intervals for 1", 2", and 4" precipitation per day, as well as the daily precipitation for probabilities of 0.2%, 1%, 2%, 5%, etc., and 2 and 4-day precipitation totals for a range of exceedance probabilities, and maximum cumulative 5-day rainfall depth. However, these are all calculated for the years 2050 and 2100. This is appropriate for transportation infrastructure as it requires very

long-term planning. **If the modelers could provide the same sort of projections for the 2-10 year time window, rather than the distant future, this sort of tool would be very useful for stakeholders in areas other than transportation infrastructure.**

 The Taking Action section provides a number of case studies of how the toolkit has been used, but most of the cases are education or very long-term infrastructure projects such as storm water management. This is useful and indeed the City of Flagstaff has embarked on a large scale storm water and flood infrastructure program. However, planning for shorter term, and less expensive mitigation actions that can be undertaken for the FEMA Hazard Mitigation Plan Update cycle, requires more actionable local climate extremes projections, forecasts or guidance.

 Few in the planning community are well versed in climate and the relationships between extreme weather events and impacts in their community, beyond the most recent disaster that is still fresh in their memory. They are not likely to remember the quantity of precipitation that caused flooding or the quantity of snow that shut down the transportation corridors, or how short or long the duration it lasted. **So, simply providing them with information that they can expect "10% heavier" or even just "heavier" rainfall or snowfall events provide no useful information as they are not likely to correlate that information into impacts**. However, if NOAA could provide that sort of metric, some percentage heavier precipitation or some percentage more frequent storms, local experts could translate that into the specific local impacts that could guide the planners. A complicating factor, to note, is that some mitigation has likely been planned to handle the past largest rain events, so planners may think they are prepared for a "somewhat" larger event in the future.

 The current climate information in the toolkit from the Climate Explorer, LCAT (Local Climate Analysis Tool), and Climate at a Glance provide some historical perspectives on what has occurred, **but those data are not analyzed to provide guidance on whether there are actually significant trends in frequency or intensity of extreme events at the local scale.**

 The team notes that the climate change projections are long-term GCM and downscaled GCM projections of average temperatures and precipitation, and *cannot* be considered as extremes. **The planners are concerned about the extremes and not the long-term averages.**

 While the CRT certainly has utility for planners making long-term infrastructure investments or for farmers looking at seasonal changes in climate that may affect crop choice or water resources, **there is currently no actionable climate information for the 2-10 year time window that FEMA's mitigation plan updates require.**

 Since future weather events may not resemble past events the "Determining Vulnerabilities" step requires some new climate impact information, which may or may not exist at the temporal and spatial scale needed for vulnerability assessment by planners.

 Inundation of coastal areas due to projected sea level rise can be shown in map form but this is essentially the only future scenario available to future planners. **For non-coastal locations there is no specific climate information available to help with mitigation or planning**. Specific guidance to future climate impacts across many regions and locations is currently missing from the toolkit.

 The steps, "Investigate Options" and "Evaluating Risks and Costs" is well within local expertise of the planners but cannot be accomplished without knowing the expected range of impacts within the planning time and budget horizons. For some sectors this is known to a sufficient degree to make mitigation decisions particularly for long-term infrastructure projects like flood control, coastal erosion, bridges, or levees. For other sectors with shorter planning horizons and smaller budgets, there is insufficient climate guidance.

 The toolkit sends the user to a large list of tools, some of which may be useful to the hazard at hand. However, a large proportion of the tools seem to have nothing to do with climate change but provide decision support for current climate conditions such as when to spray crops for certain pests. While tools for assessing and managing vulnerabilities may be useful for the general public or a novice, this process is already well-known to planners and emergency managers.

 Climate data currently exist for four different time frames: Historical climate data, often used to indicate trends that may continue into the future; current weather forecasts which predict weather from real-time to 10 days out; seasonal outlooks extend out 12 months or so; and climate projections for 2030, 2050 or 2100. There is no climate information between the seasonal outlooks and the vague projections for 2030. **The toolkit lacks specific future climate information and impacts that planners need to incorporate into their mitigation and adaptation plans within that time frame. Furthermore, to be useful, climate information needs to be specific to the region or location as well as address the time interval appropriate for the planning and mitigation activities.**

 Many of the links in the CRT lead to other websites or articles on general climate change where links to actionable data specific to a region are buried or nonexistent. While the CRT certainly has utility for planners making long-term infrastructure investments or for farmers looking at seasonal changes in climate that may affect crop choice or water resources, there is currently no actionable climate information for the 2-10 year time window that FEMA's mitigation plan updates require. The ASU Research Team reports that this is the next time window for which climate information needs to be developed for the Toolkit as mitigation from these extreme weather events is critical to

avoid system disruption and expensive disaster recovery. We look forward to the opportunity to assist NOAA in defining the type of actionable information needed by hazard mitigation planners.

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