

## **Climate Information Needs for Hazard Mitigation**

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The Federal Emergency Management Agency (FEMA) has indicated that Hazard Mitigation Plans will soon be required to include climate change, and several states and other jurisdictions have already instituted this requirement. The implementation of this directive is difficult for many jurisdictions whose major natural hazards are extreme weather events. Emergency response is generally well-coordinated with NWS hazardous outlooks, severe weather statements, watches, and warnings which typically cover the present out to 6 to 10 days. Planners working on long-term coastal infrastructure projects may have sufficient information from global climate models, downscaled or otherwise as their mitigations for coastal flooding involve multi-million dollar projects with a lifetime of 50-100 years. Planners in areas with hurricanes or tornadoes are already familiar with the level of damage that the strongest storms may bring and are mitigating to the extent their budget and the laws of physics will allow. Farmers and water managers may be satisfied with seasonal outlooks of probabilities for above or below average temperature or precipitation. However, hazard mitigation planners currently have no guidance for what to expect in the 2-, 5-, or 10-year planning window when it comes to extreme weather events, such as severe thunderstorms and flooding, winter storms, or even drought.

The researchers conducted a workshop with the Coconino County and Flagstaff Arizona Hazard Mitigation Planning team to explore their needs for climate guidance regarding extreme events. The planners believe the impacts of extreme weather events are a major cause of significant losses that could be reduced through mitigation efforts if they had appropriate information. Many of the extreme weather events lead to a cascade of impacts that may result in a loss of power, shutdown of transportation corridors, economic loss both to individuals and the city, and potential health issues. However, resources are limited and there is no actionable information to support mitigations for anything beyond the historical extreme events. Multi-day snowstorms have crippled the city, exceeding the capacity to keep roads open, leading to loss of services and significant economic losses. Severe thunderstorms following devastating wildfires have led to widespread flash flooding and loss of life and property. While NWS forecasts minimized immediate loss of life, lack of mitigation resulted in substantial losses to the County, City and the community. The hazard mitigation planning team is looking for guidance, be it in the form of forecasts, predictions, projections, or outlooks. If the consensus is that extreme weather will get worse, either more intense or more frequent, we need to quantify that in a way that planners can understand and apply appropriate mitigations.

Currently the planners have various levels of experience with extreme weather events in either their current jurisdiction or in other areas of the country. The process of assessing the probability, severity or magnitude, duration and warning time of an extreme weather event are subjective – depending on their time in the jurisdiction. Further, their understanding of the cascade of impacts is dependent on their time in their current position of responsibility and experience with past events. Current practice is to prepare for the 100-year event, though California is shifting to the 200-year event for precipitation and flooding events. The economic reality is most jurisdictions don't have the resources to move to the 200-year event as a standard on the "possibility" that these events could become the norm. Public infrastructure, which is what most mitigation efforts cover, is expensive to upgrade or replace. The severe weather events of concern to Flagstaff and Coconino County include winter storms, rain on snow events, drought, and heavy rain associated with thunderstorms during the monsoon. Impacts include flooding; flash flooding; transportation shutdown due to roads being blocked, closed, washed-out or cut-off by erosion or debris flows; loss of supply lines; loss of power or water; medical emergencies; and economic losses.

Currently, emergency management uses 3-7 day forecasts to plan for severe weather events, but this only allows planning for response, not significant mitigation. Mitigation planning is based on the historical worst case event to the extent that that event is known to the planners. In Arizona, there is no statistically significant trend toward more intense or more frequent extreme events. FEMA has mandated that Hazard Mitigation Plan updates include climate change, but actionable climate guidance is currently not available for extreme weather events in the 2-10 year time interval which matches the budget and planning cycle for city and county mitigation efforts for extreme weather. The participants identified “insufficient information regarding hazards” as one of the “major barriers” to planning for extreme weather events. They would like “digestible” information in plain language, as both the planner and decision-maker need to understand the information. Infographics would be helpful to convey the information and there needs to be a connection between the weather event and the potential impacts. Technical details available as an appendix or supplemental information would be useful. Regional guidance provided by NOAA could be brought down to the local jurisdictions by state and local experts. Annual updates to the guidance, as skill in this time interval improves, would help increase confidence in the guidance.

The planning community understands that there will be significant uncertainty, but right now they are guessing what might happen and the uncertainty is 100%. We know NOAA can make a much more educated guess than the planners, so we are looking for the climate prediction community to address this huge gap in extreme weather guidance for the 2-, 5-, or 10-year time window that is critical to mitigation planners. The field here seems to be wide open, whether it’s re-scaling models for shorter timeframes and more regional coverage or identifying trends in large scale circulation patterns that are necessary (though maybe not sufficient) for these extreme events. While this may be a heavy lift, the need for this short-term guidance is not going away, and who better to create the knowledge than climate prediction community?