Climate Forecasts: A New Tool for Hazard Management in the Southwestern U.S.

Astute management of limited water resources in the Western U.S. is more important than ever. New tools available to resource and flood managers include climate forecasts that predict above or below normal precipitation and temperature up to a year in advance. Predictions of the 1997-98 El Niño event and its potentially damaging impacts greatly increased the visibility of these forecasts and have left many wondering how best to take advantage of this new technology.

To find out which forecasts agencies access, how they are interpreted, and how they are used, we conducted in-depth interviews with water suppliers, flood control districts, and emergency managers in Arizona. We asked agencies to discuss their experiences with the forecasts, suggest improvements to them, and discuss some of the barriers that prevent agencies from responding to forecasts effectively. The intent of this article is to provide practical advice to emergency managers who are considering incorporating climate forecasts into their operations.

The 1997-98 El Niño and Arizona

El Niño refers to the appearance of anomalously warm waters along the equator from the coast of Peru nearly to Indonesia. La Niña is the appearance of anomalously cold waters; collectively, they are known as El Niño Southern Oscillation (ENSO) events. These events reappear every two to seven years and can last for one or more years. El Niño effects in the U.S. are strongest in winter, particularly in the Pacific Northwest (dry), Florida (wet), and in the Southwest (wet); La Niña has opposite impacts.

Prior to 1997-98, the 1982-83 El Niño was the strongest event in modern history, during which the Southwest experienced unprecedented flood damage. Hence, many agencies paid heed when forecasts indicated the 1997-98 El Niño would be as strong or stronger than the prior event and that Arizona was in store for a wet winter. Media coverage was pervasive, especially in September 1997 when Hurricane Nora threatened the Southwest. Although hurricanes rarely strike this region, their probability is higher in El Niño years. Early forecasts placed Nora on a track

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toward the metropolitan centers of Arizona--Phoenix and Tucson-- although the observed track was over a hundred miles to the west. While little rain fell in urban regions, 24-hour rainfall records (approximately one foot) were broken west of Phoenix, two towns were flooded, and crop losses reached $300 million. As predicted, the 1997-98 winter was wetter than normal, although ultimately only Hurricane Nora produced floods. Winter precipitation was steady and produced elevated streamflows during winter and spring 1998, without significant flooding.

Arizona's Response

Several unprecedented water management actions were taken in Arizona in anticipation of El Niño. The major water supplier for Phoenix, the Salt River Project (SRP), released 41,000 acre-feet of water from Verde River reservoirs in anticipation of elevated streamflow. This water replaced pumped groundwater and the resulting reservoir storage space reduced downstream flood risks. SRP faced losses of $5-$6 million if the forecasts were wrong. In addition, various emergency management agencies sponsored interagency briefings, reviewed flood response plans, identified hazards in the field, prioritized mitigation opportunities, and provided information about flood insurance, among other activities. One flood control district's in-house research revealed that floods during El Niño tend to occur on large rivers. Subsequently, the district shifted their annual flood training to involve multiple agencies and focus on large river floods instead of flash floods in usually dry washes. However, a surprising number of agencies were not able to respond to the forecasts and engage in serious preparations for a wet winter.

Getting the Most from the Forecast

Based on the Arizona experience during the 1997-98 El Niño, there appear to be four major questions that agencies should ask before they can effectively incorporate forecasts into their decision-making process.

- **Is this forecast the official product?** There is a confusing mix of forecast products available, some experimental, others official. The official climate forecast is the "Climate Outlook" produced by the National Weather Service (NWS) Climate Prediction Center (CPC).
- **Do I understand this forecast correctly?** There were surprisingly diverse interpretations of the Climate Outlooks. A common mistake was to think the outlook maps identified regions where precipitation quantities would be extreme. However, the map contours actually express forecast *confidence*, not *extremity*.

- **Is this forecast relevant to my operations?** Many agencies are more concerned with floods than seasonal precipitation totals. However, the translation from precipitation to streamflow is not direct, and connections between seasonal precipitation and flood events are even more tenuous.
- **Given what I know about forecast accuracy, am I willing to risk taking action?** Forecast accuracy was unknown to many agencies; thus, they were reluctant to act. Unfortunately, few evaluations of forecast accuracy exist. Most agencies prefer to avoid negative consequences that can result from using poor forecast.

Agencies with the most sophisticated understanding of the forecasts had the closest connection with forecasters. Therefore, we recommend that you get to know your local or regional NWS forecasters and understand, in advance, the forecast products. We fully agree with the sentiments expressed in the ***Natural Hazards Observer*** (Vol. XXIII, Number 3, p. 1) that the forecast process should be open to user involvement. The CPC, local and regional climate offices (e.g., Regional Climate Centers, NWS Weather Forecast Offices), and regional assessment projects (e.g., CLIMAS) are all interested in suggestions from forecast users that lead to better products.

Institutional Barriers

Even if a forecast is sufficiently accurate and relevant, barriers can exist to its appropriate use. For example, some agencies contend they are always prepared for floods. Does being more prepared during El Niño mean agencies can be less prepared otherwise? The issue is not being more or less prepared, but rather *how* your agency prepares and *where* your resources are focused. Major institutional barriers to readiness include:

- **Multiple Hazards**--Flood and drought are only two of many hazards that influence agency operations. Potential impacts from the 1998-2000 La Niña were overshadowed by the Y2K millennium bug.
- **Personal versus Institutional Risk**--Who accepts responsibility for agency decisions if the forecast is wrong? Blame may be shifted to climate forecasters or an agency may face rebuke after a difficult experience. However, individual decision makers within an agency shoulder significant personal career risk. Further, a long record of appropriate decisions can be negated by one "bad" decision.
- **Reactive versus Proactive Response**--Some mitigation activities require a long and complicated approval process that can be bypassed in an emergency (e.g., infrastructure repairs in environmentally sensitive regions). Further,

mitigation can stress limited budgets, while crisis response may be funded with emergency, off-budget appropriations.

- **Fixed Operating Procedures**--Agencies may be required to operate facilities using procedures fixed by legislation or legal decree. Adapting those procedures to include climate variability promises to be a long, complicated, and painful process, even though gains may be significant.

Future Directions

Water management agencies are paving the way for others to take advantage of climate forecasts. However, broad progress requires shifts in agency perspectives and procedures, including recognition that forecasts for winter precipitation in certain regions of the U.S. are useful, especially during strong ENSO events. Now is the time for agencies to develop close relationships with climate forecasters, as well as adaptive management strategies and contingency plans to maximize the utility of climate forecasts for hazard mitigation.

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