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Global Resilience Institute
at Northeastern University

Using The National Water Model As A Data Source For Emergency Management

Case Location: Denver metropolitan area, Colorado

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Introduction

The National Water Model (NWM) is a visual, user-friendly, and dynamic tool that can equip local practitioners with essential information for preemptive flood planning thereby enhancing their ability to anticipate, withstand, and effectively respond to potential flood disasters. The NWM also offers a unique capability for engaging community members so that they better understand their exposure to flood risk.

The Challenge

The Denver, Colorado metropolitan area is exposed to complex weather conditions due to its location along the Rocky Mountains' Front Range. Denver sits at a high elevation that rises sharply from the ascending Great Plains to the east. Moisture and pressure systems are fueled and steered by two nearby river systems (the South Platte and the Arkansas) along with the influences of various divides and foothills and the even higher elevations of the mountains backing the Front Range where elevation rises from 5,000 feet to Pikes Peak at 14,115 feet. The abrupt rise of Pikes Peak has led it to be dubbed as the "thunderstorm maker" where during summer months, the Denver metro area often experiences convective thunderstorms of great unpredictability. These conditions complicate the ability of emergency managers' to receive timely rainfall forecasts that position them to make decisions about when and how to take life-saving actions. Having access to better tools and information that bolster forecasting capabilities and improve preparedness for potential flood threats will greatly enhance the Denver metro area's emergency management and help the region strengthen its resilience.

The Value

The National Water Model has helped flood responders in the Denver metro area of Colorado to better plan for likely flood scenarios. In a region where emergency planning must take into account uncertainty in precipitation forecasts, the National Water Model provides the means for flood responders to flag likely problem areas ahead of time. Any improvement in the ability to plan in advance can be a lifesaver. For instance, in regions with more predictable precipitation patterns such as coastal California, the National Water Model has been leveraged to guide pre-staging before storms strike, allowing emergency responders to begin recovery work in heavily impacted areas as quickly as possible.

Partner Community Overview

Colorado's Front Range, characterized by diverse landscapes and a mix of urban and rural communities, faces special challenges when it comes to monitoring flooding and rainfall. The Mile High Flood District (MHFD), which covers much of the Denver metro area, grapples with flooding from convective thunderstorms, presenting challenges in predicting the precise location and timing of storms. The NWM provides local decision makers with additional data for predicting impacts.

Bruce Rindahl, the Flood Warning Manager for MHFD, has found the NWM to be an important tool for contributing to flood safety across the region. White the model is not able to resolve the challenge of limited local accuracy of rainfall forecasts, Rindahl emphasizes its usefulness in helping to identify areas that face the most serious risk of flooding. Plans to enhance the capacity for the NWM to provide terrain and basin data would be helpful to floodplain managers as well.

Local stakeholders in the metro-Denver area conveyed their view that as a free and public tool the NWM can be easily accessed by any community to improve their means for flood detection, monitoring, and preparedness. The MHFD stands ready to share information about the positive impacts and practical applications of the NWM as other communities across the United States seek to enhance their resilience and preparedness in their localized contexts.

Case Characteristics and Features

The Mile High Flood District (MHFD) was established by the Colorado Legislature to facilitate cross-jurisdictional management and protection of water resources in the Denver metropolitan area. MHFD supports both long-term water-related planning and day-to-day flood monitoring and provides alerts for 36 municipalities in seven counties across the region, including the City of Denver. According to Bruce Rindahl, MHFD's Flood Warning Manager, the National Water Model provided valuable new data for a flood district that had lacked predictive capabilities. MHFD has integrated NWM flow outputs into its GIS interface for known problem areas for which there are no existing stream gauges. This interface that uses code from Leaflet, allows floodplain managers to view NWM predictions both alongside gauge output where such data is available, as well as NWM flow predictions for locations where gauge data is not available. National Water Model data is accessed through a National Water Prediction Service (NWPS) Application Programming Interface (API), which allows users to pull a range of NWM-related outputs provided by the National Water Prediction Service. The NWM has allowed MHFD to monitor known problem sites without monitoring instruments and to prioritize sites where the development of additional monitoring infrastructure would be particularly valuable.

The NWM is also successful as a supplement to local knowledge. Stakeholders have found value in using the National Water Model to corroborate data they already have and to pinpoint where more data may be necessary for effective long-term planning. Rindahl of MHFD emphasized that the memory of past flood events by impacted communities is still a valuable source of information. The NWM, Rindahl says, is valuable in helping corroborate first-hand reporting where hard data is unavailable. Communities hoping to implement the NWM effectively will also benefit from engagement with organizations such as the National Hydrologic Warning Council and input from field experts.

Tool Comparisons and Limitations

Floodplain managers rely on a variety of real-time data sources, along with a depth of accrued local knowledge and historical data, to assess where tough-to-predict storms are likely to be most destructive.

Alongside the National Water Model (NWM) in Colorado, these stakeholders use data sources that range from traditional gauges where they are available, to predictions from NOAA River Forecast Centers. However, all these sources end up providing only limited insight into where water will flow on the ground. The uncertainty in rainfall forecasts, especially in areas prone to convective thunderstorms like the Denver metro area, pose a significant challenge for accurate flood predictions that rely on any single tool.

Previously, in a role with the Ventura County Watershed Protection District in coastal California, Rindahl used the National Water Model to support emergency response planning. Rindahl reports that the climate and geography of Southern California, where severe weather systems follow more predictable patterns, resulted in better precipitation predictions that allowed local emergency managers to issue evacuation orders based on NWM predictions. Emergency managers were also able to pre-stage response equipment and crews, a practice that could not be replicated in the Denver area due to more limited weather predictability. Improved precipitation prediction models currently being developed by NOAA (Atlas 15), combined with the implementation of the NWM's NextGen framework, will result in more accurate outputs in regions with high forecast uncertainty.

The NWM supplements the existing range of tools by delivering up-to-the-hour, dynamic and geographically comprehensive, flow prediction data. Unlike existing tools, the NWM's visualization capabilities enable stakeholders without specialized water expertise to actively participate in knowledgeable discussions about flood risk. It provides flow predictions for entire watersheds, including ungauged waterways, effectively filling a gap in municipally-relevant hydrological data. The NWM doesn't replace existing tools, but functions as a supplementary resource, broadening the scope of data accessible to stakeholders and cultivating a proactive stance towards flood resilience amidst weather conditions.

Lessons for Communities

The starting point for communities who seek to strengthen their flood preparedness is to recognize that they will have to tailor their efforts to the unique challenges every location presents when it comes to predicting flood events. It is important to take into account the specific storm patterns prevalent in their areas. Real-time data comparison is crucial, necessitating the use of tools like gauges and River Forecast Centers to make informed decisions during potential flooding events. The utilization of National Water Model (NWM) data provides communities with valuable insights, allowing them to validate and compare forecasted information with actual rainfall and flood events, thereby enhancing their understanding of potential impacts. Nonetheless, it is

important that communities recognize the limitations and uncertainties of the NWM, especially in terms of rainfall forecasts and basin data accuracy, to make well-informed decisions. The best outcomes for flood preparedness are achieved when local knowledge is integrated with a variety of data sources. As is the case of the Mile High Flood District, sharing success stories of how the NWM has improved flood detection, monitoring, and forecasting can inspire other communities to adopt similar practices and collectively enhance their resilience to potential disasters.

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