

Colorado–New Mexico Regional Extreme Precipitation Study (REPS)

Improving extreme precipitation estimates to enhance dam safety and community resilience

Dams are essential for storing water for household use, irrigation, energy, and recreation. However, a dam failure releasing stored water poses a risk to populations living downstream. Because of the potentially devastating consequences, all practical methods must be applied to prevent such failures and ensure public safety and maximize water storage.



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The Challenge

All dams have spillways to safely route flows from extreme runoff events around them and prevent overtopping. In the last 100 years, overtopping due to inadequate or improperly designed spillways is the leading cause of dam failure and resulting loss of life. In Colorado and New Mexico, some spillways at existing *high* and *significant* hazard dams (those most likely to result in loss of life if a failure occurs) have deficiencies.

Estimating extreme rainfall amounts is a critical component of building safe dams. However, the data and methods currently used to calculate these quantities are dated and studies have shown current methods can both overpredict and underpredict rainfall, depending on location. A tenuous balance exists between the safety provided by conservatively designed spillways to protect dams against extreme events and the cost of that construction.

The Need

Modern meteorological methods to estimate probable maximum precipitation can reduce the likelihood of over- or under-estimating rainfall. New approaches aim to produce more realistic estimates of maximum

precipitation to strike an appropriate balance between the protection of public health and safety and the required level of construction infrastructure.

The Colorado Division of Water Resources and the New Mexico Office of the State Engineer have identified and set as a priority the need to update their extreme precipitation estimates for use in the evaluation of spillway adequacy for dams in these states, based on the most modern methods and scientific understanding available.

Innovation

Due to similarities in geography and meteorology between Colorado and New Mexico, a cooperative, regional study has been undertaken, the first instance of states combining resources and working collaboratively toward a solution to the problem. The project began in June 2016 and is scheduled to be complete in June 2018. Of particular concern in both states are questions about the physical limits on high elevation rainfall amounts and the annual exceedance probability (AEP) of the extreme rainfall amounts used for spillway design. This reality has led to using an innovative ensemble approach and methods to update extreme precipitation estimates.



This study includes three technical tasks, which are conducted concurrently and in collaboration with each other. Task 1 consultants ([Applied Weather Associates](#)) are updating the conventional deterministic “storm-based” methods. Task 2 consultants (Extreme Precipitation Group - EPG - [MetStat](#) and other partners) are developing a risk-based regional precipitation frequency estimation tool to enable AEP estimates of the Task 1 results. Task 3 ([NOAA ESRL Physical Sciences Division](#)) includes a proof-of-concept scope utilizing NOAA’s state-of-the-art High Resolution Rapid Refresh (HRRR) physically-based dynamical weather prediction model. A dedicated project manager ([Acclivity Associates](#)) has been hired to coordinate project activities.

NOAA Contributions

NOAA is working with REPS partners to provide innovative solutions to meet this project’s unique challenges drawing on NOAA expertise in modeling and understanding of the physical processes that affect extreme precipitation. Experience from related stakeholder-driven research also allows NOAA scientists to critically consider limitations of past methods to estimate extreme precipitation and design updated alternative options. Research scientists in Earth System Research Laboratory are leading this effort, with critical input from members of the Project Review Board, which includes NOAA representation from the National Weather Service, the Office of Water Prediction/National Water Center, and the ESRL Physical Sciences Division.

Potentially actionable science being developed by NOAA includes:

- Novel high-resolution datasets and post-processing techniques using a super-ensemble of hourly forecasts from the HRRR model.
- Improved understanding of the limitations of older estimation methods and assumptions.
- Actionable recommendations based on improved physical process understanding, such as the relationship between elevation and heavy rainfall.
- Assessment of climate change implications for future estimation studies.

Outcomes

The regional collaborative effort of the two states, combined with an ensemble scope of work and project oversight will ensure the development of scientifically robust processes and procedures for the prediction of extreme rainfall and the design of effective dam spillways. The project sponsors will be able to develop policies and rules that minimize the risk of dam failures by overtopping and ensure public safety, while at the same time allow for the most efficient use of existing and new facilities to maximize water storage potential in their states. If all project goals are fulfilled then similar benefits can be achievable by other states and/or regions across the nation.

This project is funded by grants from the Colorado Water Conservation Board, the New Mexico Office of the State Engineer, the Albuquerque Metropolitan Arroyo Flood Control Authority, and the New Mexico Watershed and Dam Owners Coalition.

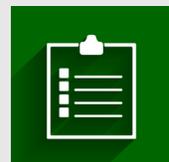
Project Goals



Creating updated, broadly accepted tools and procedures for estimating extreme precipitation depth, area, and duration relationships, as well as precipitation frequency estimates for individual basins within Colorado and New Mexico. This information will be used as part of new rules and regulations for determining spillway adequacy for dams in these states.



Developing a draft standard of practice guidance document for these studies suitable for use in the development of a national model for other states or regional groups of states to follow.



Evaluating the uncertainty of various components, elements, and variables as the project progresses. The project team will create a list of those issues that could benefit from further research or study to reduce or quantify their uncertainty, and help ensure the quality and longevity of the processes developed.