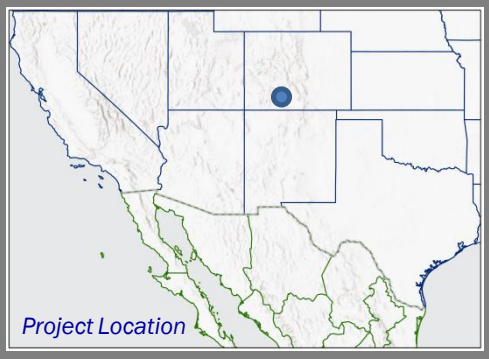
ACTIONABLE SCIENCE

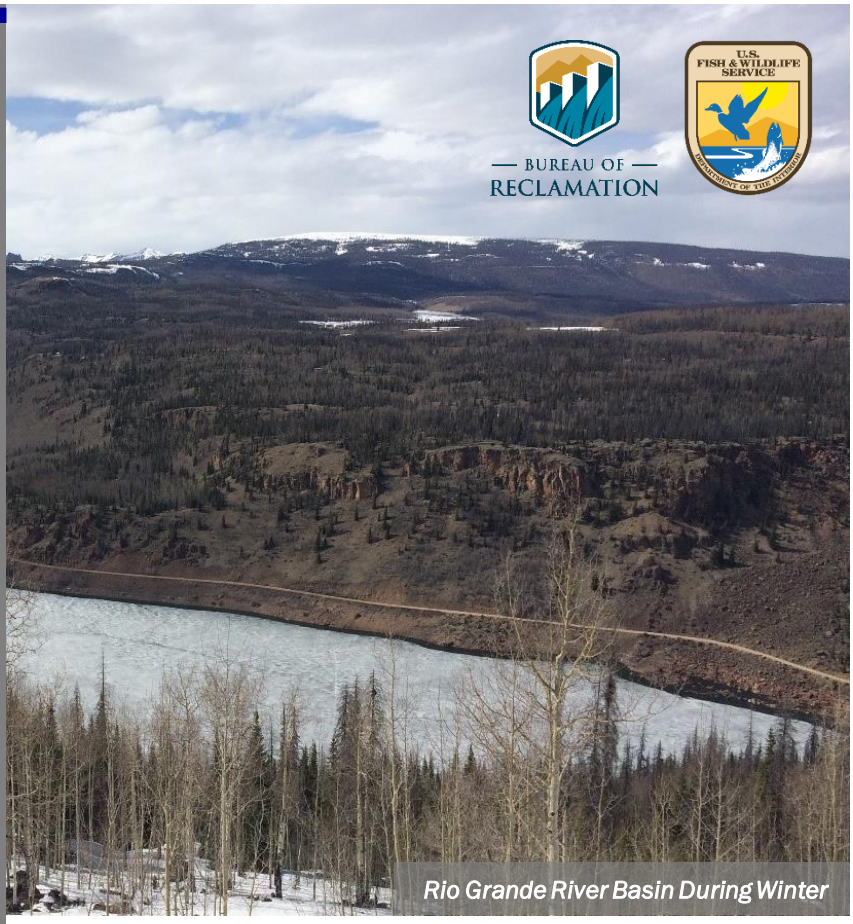
Developing Tools for Improved Water Supply Forecasting in the Rio Grande Headwaters

USGS

SOUTH CENTRAL CLIMATE ADAPTATION SCIENCE CENTER

The Rio Grande provides water for drinking, irrigation, hydroelectricity, and recreation for communities throughout the southwestern United States and northern Mexico. More than half of the river's streamflow originates as snowmelt from Colorado's mountains, which serves as an important indicator of water availability for community use. However, changes in climate and land cover conditions may influence snowmelt, leading to declines in accuracy of streamflow forecasting models. Addressing this concern, researchers sought to identify potential sources of errors and improve forecasting for the Upper Rio Grande (URG) region.





Rio Grande River Basin During Winter

KEY ISSUES ADDRESSED

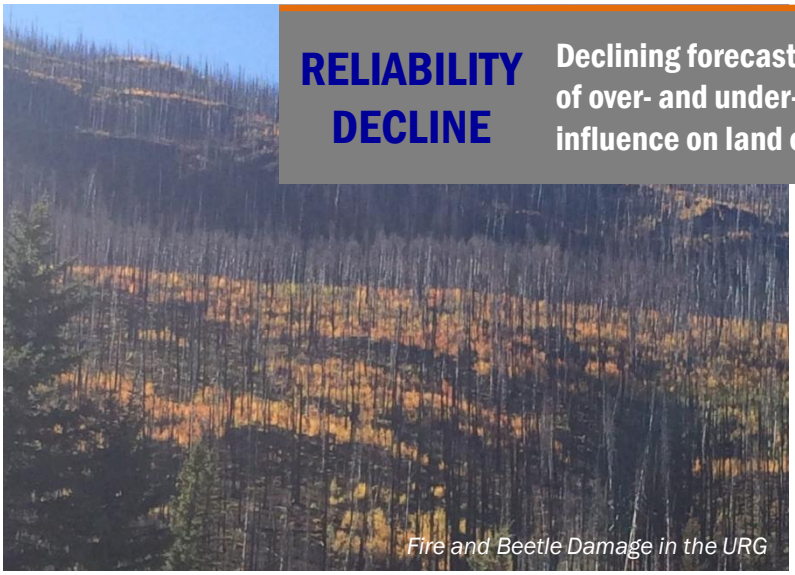
A network of snow telemetry stations (SNOTELs) monitor snowpack in the URG region and aid in predicting streamflow availability for water resource managers. However, the statistical models that rely on SNOTEL data do not account for factors in the environment that might change over time. Climate change, bark beetle infestations, and wildland fires have grown in severity in the URG region and may have an important influence on the water cycle. Without consideration for these variables, streamflow forecasting tools may become increasingly unreliable. Inaccurate predictions of streamflow availability could cost states millions of dollars due to ill-informed allocation of water and impede agricultural productivity.

PROJECT GOALS

- Identify water supply forecasting errors and their sources
- Test more accurate representations of snowpack in models
- Use physically based models to explore effects of changing environmental conditions

RELIABILITY DECLINE

Declining forecasting reliability was confirmed by comparing periods of over- and under-prediction. Changing conditions, particularly fire's influence on land cover, significantly influences forecasting reliability.



Fire and Beetle Damage in the URG

PROJECT HIGHLIGHTS

Shifting Snowmelt Season: Changing climate in the URG region contributes to a shift in runoff seasonality. Warming springtime temperatures matched with decreasing springtime precipitation result in less snow accumulation and earlier runoff in the spring.

Wildland Fire Influence: Land cover change as a result of wildland fire had a strong positive influence on seasonal runoff forecasts, suggesting land cover is an important factor to consider to improve forecasting accuracy.

Future Precipitation Importance: Although land cover change, climate, and better-represented snow measures explained much of the forecast variance, a substantial source of variance remained unidentified. Through further numerical experimentation, the research team found that improved precipitation projections for spring and summer months could help further improve forecasting.

Visualization Tool: The research team created a simple spreadsheet tool to aid in visualizing the importance of land cover change and climate on seasonal streamflow for users.

Collaborators

- Natural Resources Conservation Service
- National Weather Service

Funding Partners

- South Central Climate Adaptation Science Center

LESSONS LEARNED

The researchers approached the issue from a system-wide perspective. This approach, which explored multiple dimensions of streamflow forecasting with a variety of research methods, allowed the team to gain greater clarity for envisioning solutions.

Managing data presented a large, but achievable, challenge for the team. Exploring multiple aspects of streamflow with a variety of research methods required attention to detail in the data compilation process.

Predicting summer precipitation is even more challenging than springtime precipitation due to precipitation variability. However, summer precipitation should not be ignored, especially in regions like the URG that receive both substantial winter snow and summer rain from the North American Monsoon. Efforts to improve spring and summer precipitation forecasting may further advance streamflow forecasting.

As temperature and snowpack continue to change, it is important to monitor the occurrence and degree of its influence on snowmelt to maintain accurate streamflow forecasts.

NEXT STEPS

- Identify the influence that shifting snowpack season has on the duration and severity of fire season
- Examine the influence of beetles and fire on water quality
- Bridge the gap between research results and monitoring, management, and policy

For more information on this project, contact Colin Penn: cpenn@usgs.gov

Dead Trees in the URG During Spring

CCAST Author: Maude Dinan, USDA Southwest Climate Hub, March 2021.
Photos courtesy of Colin Penn/USGS
For more information on CCAST, contact Genevieve Johnson (gjohnson@usbr.gov) or Matt Grabau (matthew_grabau@fws.gov).

Visit CCAST: