Impacts of Global Warming on New Mexico's Water Resources

An Assessment of the Rio Grande Basin

This study was conducted by:

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The study is available online at:
http://agecon.nmsu.edu/bhurd

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Warming is projected to lead to:

- *A relative shift from snow to rain*
- *Less snowpack*
- *Earlier snowmelt*
- *More water lost to evaporation*
- *Earlier peak streamflows*
- *Reduced total streamflows*

This is projected to cause:

- *Shrinking water supplies*
- *Greater competition for water*
- *Transfers from agricultural to urban uses*
- *Substantial economic losses*
- *Losses to wildlife and cultural values*

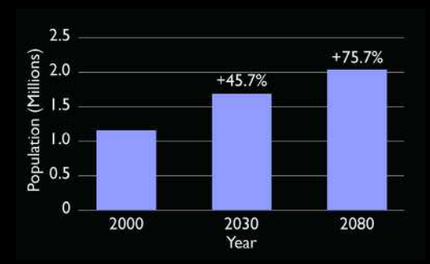
New Mexico's social, economic, and environmental systems are highly vulnerable to the increasing water scarcity that is projected to affect the state as a result of future climate change.

The health of New Mexico's economy, cultures, and ecosystems is tightly hinged to water supply. Currently, there is no spare water in the Rio Grande Basin. Virtually all surface water resources are used by people, plants, and animals, either directly consumed or indirectly used in growing food and providing other services. Projections suggest significantly less water in a warmer future, and at the same time, significantly more people. Major changes will be required in patterns of water use, and even with such changes, there are likely to be significant disruptions in important services provided by the State's water resources.

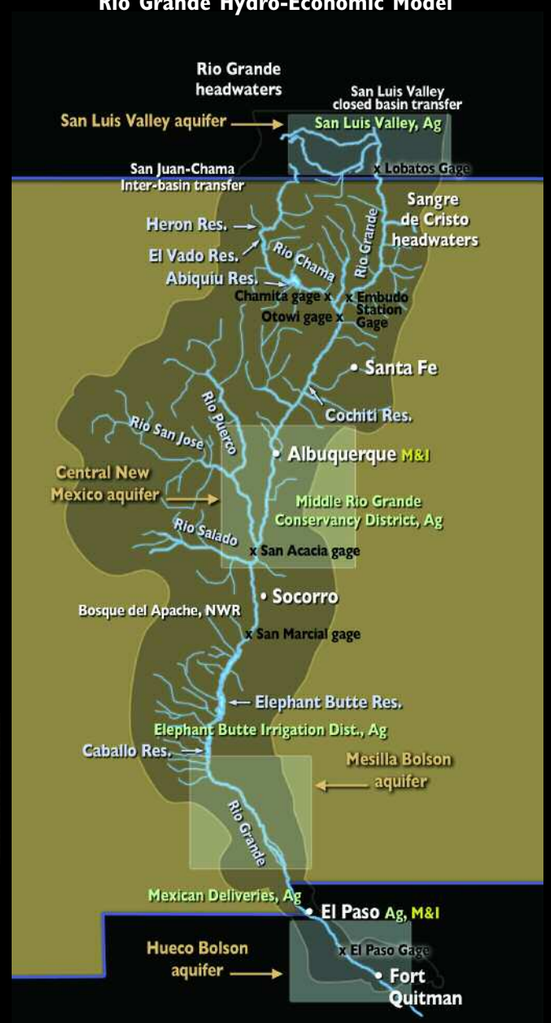
In this context, a scientific study was undertaken by researchers at two New Mexico universities to evaluate the potential impacts of future warming on water resources in the Rio Grande basin. This brochure briefly summarizes the findings of this study. The full technical report is available on line at: http://agecon.nmsu.edu/bhurd

This study used a moderate assumption about future greenhouse gas emissions, not a best or worst case scenario. Even under such middle-of-the-road scenarios, surface water supplies are projected to decline. Forecasts of future reductions in streamflow come from recent observed changes and projections from climate and hydrological models using monthly averages. Furthermore, reconstructions of past streamflows from tree-ring data show that even drier conditions have existed in this region in the past. As the continued build-up of greenhouse gases in the atmosphere increasingly warms the Earth's climate, water supplies in New Mexico's Rio Grande basin could become all the more scarce in the coming decades.

Projected Population Growth



Rio Grande Hydro-Economic Model



Snow to Rain

Less Snowpack

Earlier Snowmelt

More Evaporation

Reduced Streamflows

Floods

Droughts

Satellite Image: ©NASA

Limitations of the Study

There are many limitations in the capability to measure and express the economic consequences projected to result from changes that affect the regional character and economy in such profound ways, much less the social and ecological values that cannot be expressed in economic terms. These limitations, coupled with some optimistic assumptions suggest that this analysis underestimates some of the future economic impacts of warming on New Mexico's hydrologic system.

First, the analysis assumed that changes in future water use would reflect the uses with the highest monetary value. The analysis also assumes efficiently functioning water markets in which buyers and sellers are motivated by their private economic interests. In actuality, the potential for significant economic and legal conflict could be costly and unavoidable.

Another assumption that reduces the projected costs is that this study assumes that future runoff and streamflow conditions are known with certainty and that adjustments and adaptations, in the form of storage and use decisions, would be optimally executed without errors in amount or timing of adjustments.

Other issues not considered in this study that might contribute to economic losses:

- Decreasing agriculture will mean a reduction in open space and the many services it provides, such as wildlife habitat and scenic landscapes, that are not valued in monetary terms.
- Damaging effects are projected to result from the potential increases in flooding due to more frequent and intense monsoonal storms. This study is based on monthly averages and does not consider the effect of individual storms.
- Warming-induced drying of New Mexico's soils will further stress rangeland vegetation, adversely affecting the beef cattle industry that provides 40% of New Mexico's agricultural income, or $2 billion.
- Drying increases the frequency and severity of forest fires.
- Tourism may be adversely affected by the degradation of scenic and recreational opportunities.
- Detrimental impacts on water quality could result as reduced streamflows lower the capacity of streams to assimilate pollutants.

Key Findings

1. Warming is projected to result in less snowpack, earlier snowmelt, and more water lost to evaporation. Peak flow and total streamflow are projected to decline while peak runoff occurs a month earlier. Such changes in runoff would affect water storage systems and patterns of water availability, which in turn could seriously disrupt current human water use patterns, vegetation, and wildlife habitat.

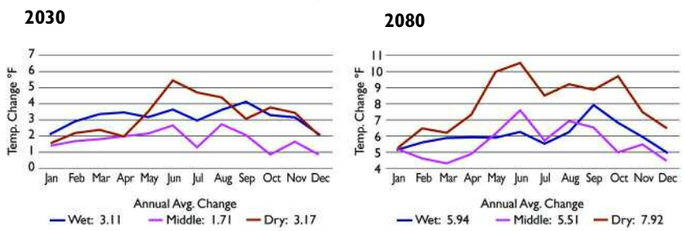
2. Shrinking surface water supplies and rising populations will increase competition for water and raise the economic pressure to transfer water from agricultural to urban and industrial users.

3. Some water uses could be curtailed as surface water supplies are significantly diminished. The drier scenarios considered in this analysis lead to declines in surface water availability and use of about 12% by 2030, and 33% by 2080. Even the wettest scenarios project water use declines of 5% by 2030 and 8% by 2080 due to higher evaporation losses.

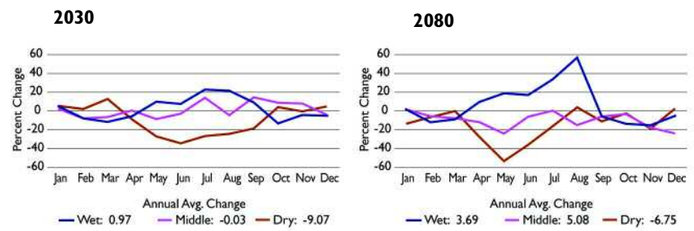
4. Substantial and transformational disruption to New Mexico's agricultural and rural economy is projected in a warmer and drier future. Under optimistic economic and institutional assumptions, direct and indirect economic losses are projected by 2030 to range from about $13 million under a relatively mild climate scenario to $115 million under the driest scnenario, with losses that rise by 2080 to range from $21 million to over $300 million.

5. Agriculture's real value – and potentially the real loss to New Mexico's residents, tourists, and wildlife – goes far beyond this market value to the services that agriculture provides to the environment and quality of life. Losses and transfers amounting to over 30% of current water use levels will dramatically and negatively affect communities and environments across the region.

Projected Temperature Change

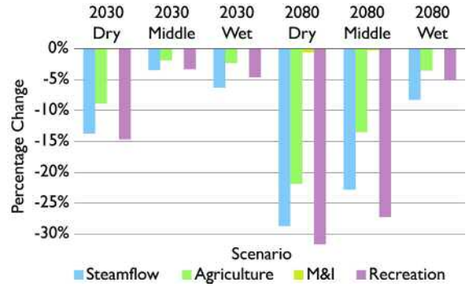


Projected Precipitation Change



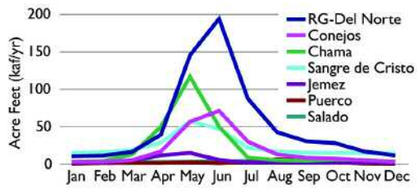
The charts show how much the future is expected to differ from present conditions in each month as projected by three different climate models, all assuming the same moderate level of greenhouse gas emissions. For example, the driest of the three models projects average June temperatures to be 5.4°F hotter by 2030 and June precipitation to be reduced by nearly 40% compared to present conditions..

Streamflow and Economic Output Changes by Sector and Scenario

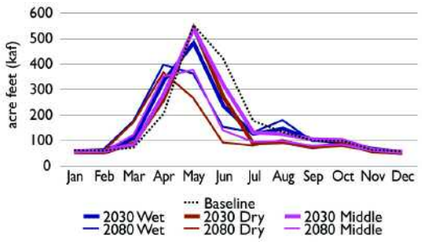


The chart shows the percentage reductions from present by 2030 and 2080 in streamflow as well as in economic output for the agricultural, municipal & industrial, and recreational sectors. As the figure illustrates, economic losses are projected to be greatest in the agricultural and recreational sectors, and the reductions become more dramatic over time.

Historic Monthly Streamflow 1971-2000 for each of the Upper Rio Grande Tributaries



Average Aggregate Streamflow for each Scenario



The chart shows the aggregate streamflow by month for the Rio Grande. The black line is the historical average and the colors represent different possible futures. As illustrated here, a warmer future could mean earlier and lower peak flows and less water available in summer.