Panel Discussion: Can Vegetation Management Increase Water Yield from Forest and Rangeland Watersheds?

Panel Moderator

Lee MacDonald, Colorado State University

Lee MacDonald is professor emeritus and a senior research scientist at Colorado State University. His academic training includes a BS in human biology from Stanford, an MS in resource ecology from the University of Michigan, and a PhD in forest hydrology from the University of California at Berkeley. He did a post-doc at the University of Washington, was a hydrologist for the U.S. Forest Service, and has worked as a consultant. From 1990 to 2012 he was a professor of land use hydrology in the Watershed Science Program, and he has advised more than 40 graduate students and published more than 50 peer-reviewed articles, monographs, and book chapters. His research focusses on how changes in land use and vegetation affect runoff, erosion, and sediment yields, particularly in forested areas, with special emphasis on the effects of fires, roads, and timber harvest. He also has taught and published on cumulative watershed effects, hillslope and wetland hydrology, forest management effects on stream channels, and erosion in steep agricultural areas. The bulk of his work has been in the western U.S., but he has worked and traveled in more than 60 countries on all seven continents, and given dozens of invited workshops and lectures throughout the U.S., Europe, Asia, and the Pacific. He also was appointed to a National Academy of Sciences panel to assess the hydrologic effects of a changing forest landscape. In his current positions he is leading research projects, advising graduate students, consulting, and directing a long-term curriculum development project in Vietnam. More details and links to his publications and student theses can be found on his web site http://www.nrel.colostate.edu/macdonald-lab/.

Changing Snowmelt Runoff

Dagmar Llewellyn, Bureau of Reclamation

Dagmar Llewellyn has served as a hydrologist at the Bureau of Reclamation office in Albuquerque since 2010. At Reclamation, she coordinates projects related to the projection of the impacts of climate change, and to building of resilience to resulting changes in our watersheds and water supply. She provides her expertise to endangered species and other environmental compliance in the Rio Grande Basin, as well as to research and outreach efforts related to water supply and demand challenges in the Rio Grande basin. Prior to employment at Reclamation, she worked for 22 years at S.S. Papadopulos & Associates, a firm that specializes in quantitative analysis of groundwater and surface water, in its Washington DC office, and as the manager of the firm's Albuquerque office. She is an adjunct faculty at the University of New Mexico, where she has taught hydrogeology in the Civil Engineering Department, and New Mexico Water Management at the Law School, and served on Master's Thesis committees.

New Mexico is experiencing significant changes to the accumulation and melt of our mountain snowpacks (Figure 1), and therefore, the usable water supply available to us from this source. These changes include:

- **Temperatures that have been steadily increasing**, and which are projected to continue to increase (Figure 2 and Figure 3). These continuing temperature increases are leading to:
  - More precipitation falling as rain rather than snow, leading to higher winter runoff, earlier spring melt-off of the snow that does accumulate, and decreasing ability to store water in mountain snowpacks into the summer.
  - More losses through evaporation and transpiration of the snowmelt as it works its way down from the mountain to the locations that we use it.
  - More demand for water at each point along the system, which decreases the magnitude of the spring snowmelt peak.

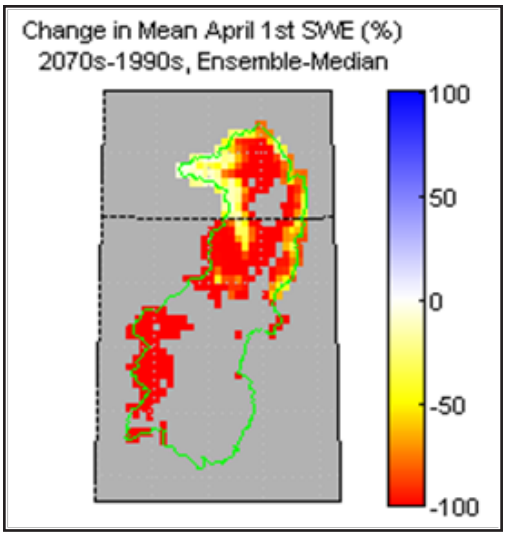

Figure 1. Future climate: basin-distributed snow (2070s).

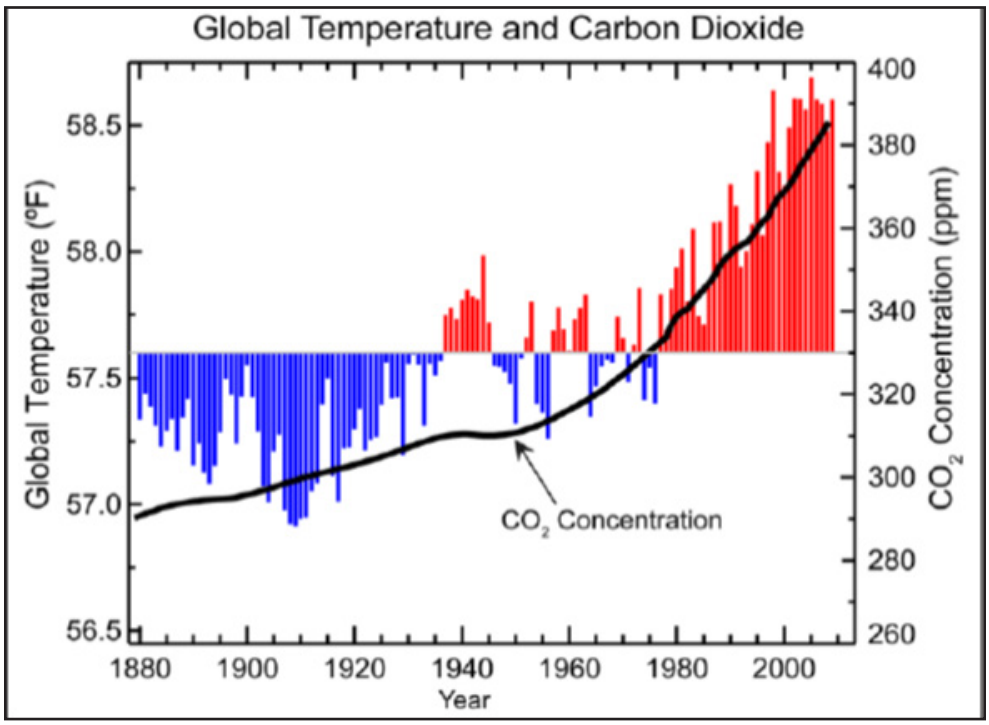

Figure 2. Temperatures that have been steadily increasing, and are projected to continue to increase.

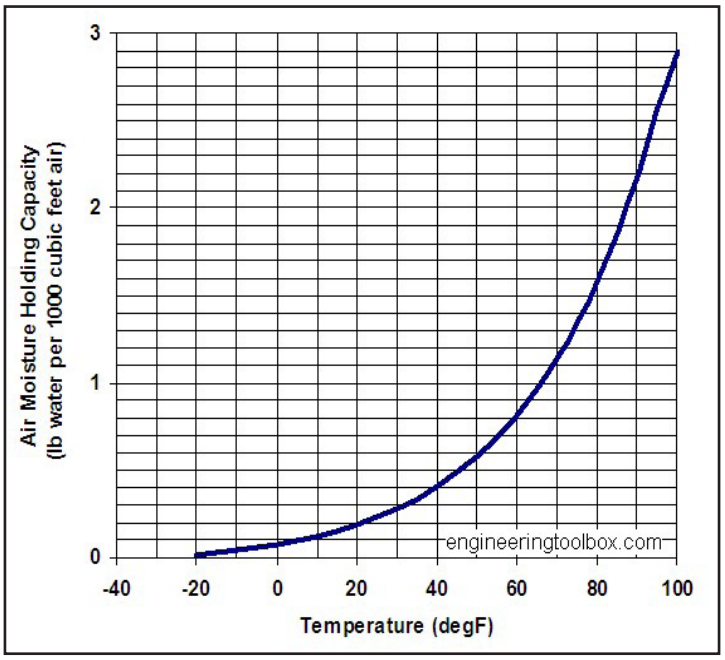

Figure 3. Exponential relationship between air temperature and water-holding capactiy.

- **Decreasing health of our mountain forests** and their ability to accumulate and maintain winter snowpacks (Figure 4). Causes and impacts of these changes include:
  - A history of fire suppression that has led to overgrowth of forests. These denser forests intercept more snow as it falls, therefore decreasing snowpack accumulation.
  - Decreasing soil moisture, and increasing vapor-pressure deficits for our forests, that result from increasing temperatures. These stressors are decreasing forest health and making trees vulnerable to bark beetle and other infestations
  - Increasing risk of catastrophic wildfire (Figure 5). The forest stresses and overgrowth described above significantly increase the potential for catastrophic wildfire. Post-fire, mountain slopes are subject to increased erosion and debris flows, which may clog streams and rivers and inhibit their ability to convey the snowmelt runoff. They may even bury infrastructure such as diversion structures, and inhibit their function.
- **Increasing dust accumulation on our snowpack** (Figure 6): Land use practices such as over-grazing, in combination with increasing temperatures and decreasing soil moisture, is leading to increased vulnerability of soils to erosion from spring winds, which has been leading to greater falls of dust on snow. This dust decreases albedo (reflectivity) and leads to greater sublimation and earlier melting of snow.

Figure 4. Decreasing health of our mountain forests and their ability to accumulate and maintain winter snowpacks.

Figure 5. Increasing risk of catastrophic wildfire.

Figure 6. Increasing dust accumulation on our snowpack.