
# Over Estimating Winter Precipitation in Western Snowpacks

Based on the research of Steven Fassnacht
*Watershed Science Program, CSU* (Steven.Fassnacht@ColoState.edu)

**P**olicymakers and managers make decisions about water allocation and use based on estimates of available water. These decisions prioritize the use of water for many sectors, from agricultural and urban to recreational and rural needs. To estimate available water, managers and scientists measure precipitation amounts throughout the year. During the winter, this requires monitoring the accumulation of snow using precipitation gauges located across the country.

Measuring snowfall is not an exact science, as Steven Fassnacht reveals in his research on winter precipitation measurement. He identifies multiple problems with the methods used by water managers and even scientists to determine the water available in a snowpack. These include:

- Undercatch: previous research has developed equations for measuring the difference between the actual amount of snow and the amount measured by precipitation gauges. Typically, water managers do not take into account these differences when reporting available water;
- Snowpack sublimation (evaporation): through evaporation, the available water in a snowpack decreases, yet this change is not measured nor considered in estimating the water balance; and
- Blowing snow transport: wind moves snow across snowpacks, resulting a decrease in the snowpack that is not measured.

Fassnacht found that in wet climates, evaporation and blowing snow transport are more likely to cancel each other out (as one results in less snow measured than available and the other in more snow measured than available). However, this is not true in dryer climates, where gauges are more likely to overestimate total available snow. In both climates, snowfall undercatch is not always taken into consideration by water managers and scientists, resulting in additional overestimation of available water. Overall, Fassnacht found that the tools used to measure snow accumulation did not work equally well in all climates and overestimated at varying degrees the snowfall at four western research sites located in Colorado, Idaho, Wyoming and California.

For water managers in the Rocky Mountain West, Fassnacht's work suggests that they may be over predicting the potential runoff volume of snowpacks when using the standard meteorological data. To accurately gauge winter precipitation, more data must be collected. Not only does this research have management implications, it also has implications for policymakers, including:

1. If accurate estimation of water resources is considered a high priority, policymakers must allocate additional resources to institute new data collection procedures, alter streamflow estimation techniques, or otherwise improve the information collecting systems; and
2. At the least, policymakers must rethink the allocation of water resources in light of the actual water available, rather than the inaccurate, overestimates based on existing models.

**F**assnacht studied six sites in the United States using data on their climates and precipitation to explore snowfall undercatch, evaporation and blowing snow transport. The six sites studied were:

1. South Lake Tahoe, California;
2. Stanley, Idaho;
3. Rawlings, Wyoming;
4. Leadville, Colorado;
5. Rhinelander, Wisconsin; and
6. Syracuse, New York.

For each site he collected between 9 and 17 months of data on the length of the, winter period, precipitation, temperature, humidity, vapor pressure deficit and wind speeds.

At two sites, Lake Tahoe and Stanley, the estimated undercatch was comparable to the sum of the evaporation and blowing snow transport. However, other sites such as Rawlings, Leadville and Rhinelander, the undercatch was not comparable to the evaporation and blowing snow transport. Consequently, the estimated precipitation was higher than actual precipitation. Using this information and equations developed by previous researchers who are well-respected for their ability to estimate snowfall undercatch, evaporation and blowing snow transport, he assessed the total precipitation in each area.

Estimating first for undercatch in each area, he found precipitation levels after accounting Estimating first for undercatch in each area, he found precipitation levels after accounting for undercatch ranged between 46.9% and 91.4% of the originally estimated precipitation. At the Colorado site, the estimates after accounting for undercatch were just under 70% of the originally measured precipitation.

Overall, Fassnacht found that both the undercatch, evaporation and blowing snow transport loss was significant in all the sites except for Stanley, Idaho, where wind speeds were substantially lower. While the patterns of precipitation varied across the six sites, the wind speed and precipitation quantities were consistently the most important variables in estimating the three causes of inaccurate precipitation measurements.

**Table 1. Difference between average monthly precipitation measured and month precipitation after accounting for undercatch.**

| Site | Precipitation (millimeters) | Estimated Undercatch (mm) | Precipitation minus estimated undercatch (mm) | % of Precipitation Remaining After Accounting for Undercatch |
|---|---|---|---|---|
| South Lake Tahoe, CA | 34.6 | 9.3 | 25.3 | 73.1% |
| Stanley, ID | 31.4 | 2.7 | 28.7 | 91.4% |
| Rawlings, WY | 19.2 | 46.9 | 9 | 46.9% |
| Leadville, CO | 27.0 | 8.5 | 18.5 | 68.5% |
| Rhinelander, WI | 26.7 | 8.2 | 18.5 | 69.3% |
| Syracuse, NY | 89.9 | 26.8 | 63.1 | 70.2% |

**Based on: Fassnacht, S.R. 2004. Estimating alter-shielded gauge snowfall undercatch, snowpack sublimation and blowing snow transport at six sites in the coterminous USA. *Hydrological Processes*, 18: 3481-92.**