Climate and Snowpack at Big Bear

SAWPA

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

Key Findings

- Simulations indicate significant decreases in April 1st snowpack that amplify throughout the 21st century.
- Warmer temperatures will also result in a delayed onset and shortened ski season.
- Lower elevations are most vulnerable to increasing temperatures.
- Both Big Bear and Snow Summit lie below 3,000 m and are projected to experience declining snowpack that could exceed 70% by 2070.

Results

Will skiing at Big Bear be sustained?

It is likely that future snowpack at Big Bear will be significantly less than what is currently normal and accumulated snowpack will remain on the ground for a shorter season. Projected declines in April 1st snowpack are between 30% and 40% by the 2020s and are generally projected to be greater than 70% by the 2070s. These changes are largely a result of increased winter temperatures and potential declines in winter precipitation. Warmer temperatures will result in a delayed onset of the ski season as well as earlier spring melting. Future precipitation is much more uncertain but many projections show decreased winter precipitation. Lower altitudes will likely be the most sensitive to increased temperature because small temperature changes can results in precipitation falling as rain rather than snow. Hayhoe et al. (2004) note that reductions in SWE are most pronounced below 3,000 m where roughly 80% of California's snowpack storage currently occurs. The Big Bear and Snow Summit ski areas both fall between roughly 2,100 and 2,600 m, making them vulnerable to increased temperatures.

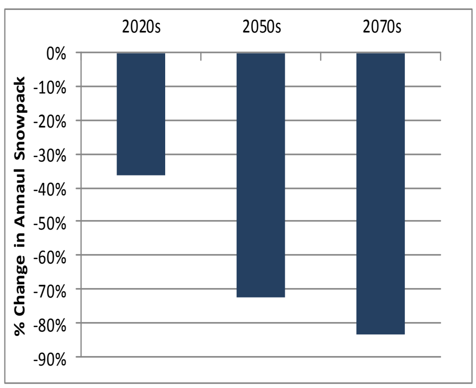

Figure 1 - Median percent change (from 112 climate scenarios) in April 1st SWE for the grid cells containing the Big Bear and Snow Summit ski areas

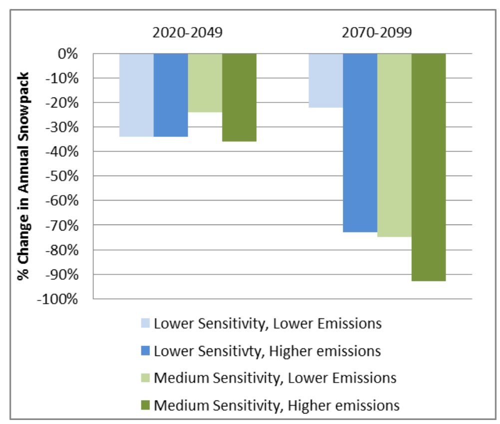

Figure 2 - Percent change in April 1st snowpack (SWE) from Hayhoe et al. (2004). for areas of 2,000 to 3,000 m elevation

Additional Considerations

- Downscaled climate variables can be biased and there is significant variability between projections. For example, note that the low sensitivity low emissions scenario in Figure 2 projects only a 20% decrease in snowpack by 2070 while the other scenarios project greater than 70% decreases.
- The grid resolution for both methodologies is 1/8th degree which is much larger than either ski area and therefore results have been averaged over the ski area in addition to surrounding areas at lower elevation.

Methods

April 1st Snow Water Equivalent (SWE) values from 1950 to 2099 are generated for 112 CMIP-3 climate projections using the VIC model forced with downscaled climate variables. Each climate projection has 1/8th degree x 1/8th degree (~12 km x 12km) grid cell daily forcings. For this analysis the locations of the Big Bear and Snow Summit ski areas were mapped the single grid cell that contained them. Results summarize the median change (take from the 112 projections) in April 1st SWE compared to the 1990s.

Results are also provided from a study of climate change impacts in California. Hayhoe et al. (2004) analyzed climate change scenarios. They use climate forcing data generated with two climate models of low (Parallel Climate Model, PCM) and medium (Hadley Center Climate Model version 3, HadCM3) sensitivity, forced using two emissions scenarios, one lower (B1) and one higher (A1fi). SWE results were generating using the VIC model forced with the bias-corrected and spatially downscaled temperature and precipitation. Results are provided on a statewide basis grouped by elevation

Hayhoe, K. et al. 2004. *Emissions pathways, climate change, and impacts on California.* PNAS, 101:34, pp 12422-12427.

Link to full technical report-http://www.usbr.gov/lc/socal/basinstudies/OWOW.html