
Mountains as Water Towers E-Discussion:
The Quantity and Quality of Water in - and from -
Mountain Areas

TOPIC 2: DISCUSSION SUMMARY

Impacts of Climate Change

Sincere thanks to everyone who contributed to the second topic of discussion. It was a pleasure to read your messages. Like the first summary, this second summary is categorized by discussion thread, however recommended resources are noted at the end of the summary.

IMPACTS OF CLIMATE CHANGE

Discussion Threads:

- *** Climate System Complexity
- *** What do we know?
- *** Developing Mountain Specific Information
- *** Resources

*** Climate System Complexity

Both Shawn Marshall and Chris Landry noted that the climate system is highly complex - being both temporally and spatially variable - and is not subject to simple rules. It is therefore unpredictable and more comparable to a human brain than a complex machine. Because of this, most of the signs of climate change are difficult to extract from temporal weather patterns or specific geographic data. This is particularly true for mountain places, which as Chris notes, also exhibit a host of complex and, on occasion, "emergent" behaviors.

Chris also noted that the alpine snow system may be a particularly responsive "earth surface system" because it is a "solid" system that exists at temperatures very near its "triple point" where solid, liquid, and vapor phases exist simultaneously. According to Chris, the mountain snowpack yields a 'wealth' of system behavior data directly linked to weather and climate behavior each winter.

*** What do we know?

Shawn Marshall lamented the "steady stream of information and misinformation" about climate change presented by traditional media sources, and attempted to summarize the conclusions he believes are now generally accepted by most of the scientific community:

- 1) Greenhouse gases make the Earth warmer;
- 2) Greenhouse gases are increasing as a direct consequence of human activity and are now at concentrations unprecedented in human history;
- 3) The Earth is warming;
- 4) The observed 20th century warming is consistent with what is expected from the increased greenhouse gas concentrations.

Chris Landry described the effects of these changes as they appear on the ground. According to Chris, the San Juan Mountains and surrounding regions, are experiencing a water crisis due to several relatively dry winters followed by hot summers. This is a significant problem for regions in other parts of the western U.S. because mountain snowpacks provide between 50% and 80% of the water supply required by residents in what is already a semi-arid/arid region.

Shawn suggested that changing temperature and precipitation regimes cannot help but impact alpine ecosystems, geomorphological processes, and hydrological systems. According to Shawn, available observations from the Canadian Rockies suggest warmer, drier winters, with an increasing frequency of winter rainfall at the expense of snowfall.

*** Developing Mountain Specific Information

Shawn Marshall also suggested that it is difficult to quantify climate change in alpine regions because there are few weather stations in most of the world's mountain environments. Long-term monitoring sites are concentrated in valley bottoms, and understanding alpine regions requires that data from, for example, a 1500 m altitude site must be extrapolated upward to ~2500-3500 m, which is very difficult.

Chris Landry noted that the western United States is fortunate to have a network of ski areas scattered throughout the western ranges, many of which have collected climate and snowpack observations for extended periods of time. Data have been archived with the WWAN (Westwide Avalanche Network), a subscription based, industry service. The U.S. also has an extensive network of "Snotel" sites monitoring mountain snowpack snow-water equivalents (SWE). Snotel is operated by the U.S Dept. of Agriculture's Natural Resources Conservation Service (<http://www.wcc.nrcs.usda.gov/snotel>).

Furthermore, Chris's organization, the Center for Snow and Avalanche Studies, hopes to help create a "North American Snow System Observation Network" (NASSON) specifically organized and operated to collect observations documenting the multiplicity of snow-related processes that mountain snowpacks 'drive', including the storage and release of water.

*** Resources

Westwide Avalanche Network (WWAN)

<http://www.avalanche.org/>

Snotel (SWE)

<http://www.wcc.nrcs.usda.gov/snotel>

Center for Snow and Avalanche Studies (CSAS)

<http://www.snowstudies.org>

Mountain Forum Online Library - Climate Change Resources

<http://www.mountainforum.org/resources/library/liblevels/lib308a.htm#change>

US Climate Change Science Program

<http://www.climatescience.gov/default.htm>

Government of Canada Climate Change Web Site

<http://www.climatechange.gc.ca/>

UNEP.Net

<http://www.unep.net/>

UNEP Mountains and Climate Change Site

<http://mountains.unep.net/cc.htm>

Northern Climate ExChange

<http://www.taiga.net/nce/index.html>

GRID/Arendal: Climate Change

<http://www.grida.no/climate/>

GRID/Arendal: Impacts of Climate Change on Mountain Areas

<http://www.grida.no/climate/vital/28.htm> (graphic)
The Intergovernmental Panel on Climate Change
<http://www.ipcc.ch/index.html>