Eyes on the Hydrosphere Unit 2.2: Student Preparation Reading and Exercise – Western Mountain Watershed

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*Now that you are well-versed in the water cycle and the myriad reservoirs and transport pathways it comprises, it is time to look at some real data from real locations with real users and real implications when water supplies are compromised. The case study site will be a Western Mountain Watershed in Colorado, USA, but the same issues are present in other watersheds in the mountain west of North America. The reading and questions will help you come to class ready to do the main exercise. You will need to refer to this in class.*

# Introduction

In most agricultural valleys of the western U.S., the climate is too dry to support the crops grown on it during the growing season without supplemental irrigation water. Many of these places do not have access to a regional aquifer like the High Plains Aquifer from Unit 2.1. Instead, in mountainous areas of the interior western US (much of Idaho, Montana, Wyoming, Utah, Nevada, Colorado, Arizona, and New Mexico), water resources depend largely on snow accumulation in the winter, and a ‘melt’ season in the spring-summer where snowmelt flows down rivers into lower-elevation valleys.

Some of this seasonal runoff is tapped by municipalities to provide water to residential and commercial water users, but a large quantity of it goes to irrigation of vast agricultural fields. Irrigation water is commonly diverted directly from creeks into networks of irrigation ditches that deliver the water to the fields, whereas municipal water is pumped from surface waters (or aquifers) into water treatment plants. Many of the cities and towns of the western U.S. also rely on dams to capture runoff and store it in reservoirs to extend the duration of the growing season beyond the end of the snowmelt.

In this unit, we will think about challenges faced by water managers for populations living in the arid regions of the western US. Water managers must have reliable estimates of current and future water supplies in order to efficiently manage a scarce resource. What water measurement techniques might help water managers in western mountain watersheds keep track of their water resources? To answer that question, first let’s consider how the water gets there.

# Review

Below are brief synopses of the surface water measurement techniques that you will be using in this exercise. For more details, see the materials from Unit 1 and the accompanying presentation.

## Measuring water storage in snow with **SNOTEL** stations

Snow Telemetry (SNOTEL) stations measure the amount of water stored in snow (snow water equivalent). A typical SNOTEL remote site consists of a snow pillow, a precipitation gage, and a temperature sensor. When snow accumulates on the snow pillow, a pressure sensor inside of the pillow measures the snow water equivalent of the snowpack. SNOTEL sites can collect a variety of other hydrologic and meteorologic data as well including snow depth, precipitation, air temperature, soil moisture, and soil temperature, wind, and relative humidity.

## Measuring water storage in snow with **reflection GPS**

High precision GPS stations can measure very small movements of the Earth’s crust (millimeters to centimeters per year). Originally they were designed to measure things such as plate tectonics. However, scientists have found that the some of the signal from the satellite reflects off the ground around the GPS station and then reaches the GPS antenna from below. The GPS receiver can then measure the difference between the direct and reflected signals. The reflected signal changes depending on the type of surface that the signal hits, which means that **reflection GPS** can be used to measure surface characteristics like vegetation, soil moisture, and snow depth.

## Measuring water transport with **stream/river gaging**

Stream gaging is a method that has been used by the US Geological Survey since the late 1800s and today includes a network of over 9000 stream gaging stations in the United States. Stream gages are typically installed adjacent to the channel and calculate the total amount (discharge) of water passing the station per unit time. The gaging stations measure how the height of the water surface (stage) changes over time. The height of the water is combined with previously measured water velocities at each height and used to calculate the entire discharge at that time.

1. Below, list the water reservoirs and transport pathways present in mountainous regions of the western U.S. Include each of the three measurements listed above with the reservoir and/or transport pathway they measure.
 **Reservoirs:

Transport Pathways:**
2. Based on the readings, what are four or more ways that a decreased snow pack can affect the environment and society in mountain watersheds?