

Lesson 2: Teacher Reference 1

Rationale for Case Sites

The case sites in the StoryMap were purposefully chosen for this lesson to introduce important aspects of droughts and floods in the US without overly complicating the data for students. They were purposely chosen from different regions of the US as well. In general, locations in the Midwest and Northeast will show places experiencing more severe flooding/increasing precipitation, and locations in the Western US, and particularly the Southwest, will show longer or more severe droughts/decreasing precipitation. The information in this teacher reference is provided so that you can know more about why each site was chosen for this lesson, and how your local case site might be similar to or different from these six sites.

- **Temperature:** All case sites in the lesson show increasing trends in temperature, which is representative of the vast majority of the US. There are a few locations that might have flat or decreasing trends, but this is not a common result. Overall surface air temperatures are increasing globally.
- **Precipitation:** Data for precipitation is much more complex, in that some places are seeing wide-ranging variability in data but almost no change in long-term trend. Where water is located for communities varies greatly. Some communities depend on snowpack accumulating in the winter to slowly release water as snowmelt in the spring. Some communities depend on the recharging of groundwater supplies from steady precipitation throughout the year. Groundwater supplies are declining as a result of growing populations needing access to water and agricultural communities needing to offset losses in rainfall by pumping more groundwater for crops. But perhaps the most important overall change in precipitation is the increased frequency of very short, heavy precipitation events, which run off the surface quickly and do not allow for normal replenishment of moisture to the soil and groundwater systems. These complex situations are not visible by viewing total annual precipitation alone. As such, students are given additional snowpack, groundwater, flood/storm frequency, and the Palmer Drought Severity Index in order to provide more information for students to consider.
- **Palmer Drought Severity Index:** The Palmer Drought Severity Index (PDSI) is not available at the county level, but it is available at the climate-division level within each state. The PDSI is a combination of temperature and precipitation data to estimate relative dryness in a climate division. It is a standardized index that generally spans -10 (dry) to +10 (wet). Most places stay within -4 to +4, but the data will show more extreme measurements in places experiencing higher or lower wetness indicators. One drawback to PDSI is that it does not account for delayed runoff from melting snow or ice.
- **General note about the data:** The Dust Bowl period is visible in almost all the case sites. Students might notice extended periods of drought or lower precipitation during the 1930s.

Rationale for each case site:

1. **Porterville, CA:** This site has seen increasing temperatures over time and longer periods of drought, according to the temperature trends graph and the PDSI graph. Overall precipitation has not changed significantly over the last 125 years. However, groundwater reserves are diminishing rapidly because the aquifers under the Central Valley region of California support the towns and the agricultural production of the region. Short, heavy rain events run off more quickly, not allowing for as much replenishment of the aquifers or soil moisture in the region. So, even though total precipitation hasn't changed much, the amount and timing of the precipitation has changed, not allowing for normal ground and surface water storage to replenish.
2. **Vicksburg, MS:** This site has seen both increasing temperature and precipitation over the last 125 years, and the PDSI also shows great periods of wetness in recent years. However, Vicksburg's floods are also exacerbated by upstream increases in heavy precipitation and flood events, such as those in Windom, MN. The Mississippi River Basin accumulates water from all upstream sources. Increased precipitation trends are seen throughout the basin, which all flows downstream through Vicksburg.
3. **Navajo Nation:** This site is located in part of the most severe region of long-term drought in the US. The data will show increasing temperatures, decreasing precipitation, and also dry scores on the PDSI graphs. The drought in the Navajo Nation is also complicated by part of the region being located near high elevations and dependent on snowpack that is decreasing. Likewise, groundwater reserves are very deep and expensive to tap, creating a situation in which local residents do not have easy access to alternative sources of water beyond the normal precipitation they depend upon. Many sites in the U.S. Southwest will show similar trends in the data, but the video that accompanies this site discusses the change in precipitation over time.

4. **Boston, MA:** This site has seen increasing temperatures, precipitation, and flood events in recent years, with a PDSI graph also showing high levels of wetness in recent years. Boston's flooding is exacerbated by two conditions: (1) increasing winter precipitation falling in the form of heavy rain instead of snow and (2) increasing sea levels that cause both tidal flooding and storm surge during events. Sea-level rise will be addressed in Lesson 6 but will be one small piece added to this site that can be revisited after Lesson 6.
5. **Yakima, WA:** This part of Washington is on the eastern side of the Cascade Range and would typically receive less precipitation because of the "rain shadow" effect of mountains. However, the very vibrant agricultural region has long depended on slow snowmelt from the Cascades to provide spring and summer water to the region. As snowpack in the Cascades declines so does the surface water supply to the Yakima Valley. The data for Yakima shows increasing temperatures, but precipitation is not obviously decreasing. The story for this site is more focused on the loss of snowfall in the mountains, which causes decreasing surface water when it melts.
6. **Windom, MN:** This case site represents many towns in the upper Midwest that have experienced higher precipitation totals and more severe events and flooding in recent years. They have not experienced a lot of extreme floods; but the precipitation and temperatures continue to increase, and they experience more flood events overall. This site also represents the upstream sites in the large Mississippi River Basin that are experiencing heavier precipitation that eventually flows downstream to places like Vicksburg.