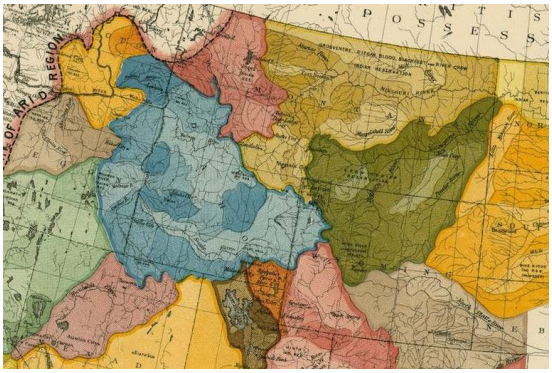
# Western Watershed Uses, Issues and Management



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## INTRODUCTION

Watersheds are impacted by many human activities. These human activities impact water quality throughout streams, rivers, riparian areas, wetlands, reservoirs, and even the oceans. Human activities affect surface water flow and groundwater infiltration rates, changing the water budget. They alter soil chemistry and cause soil erosion and sedimentation to occur, causing additional environmental impacts.

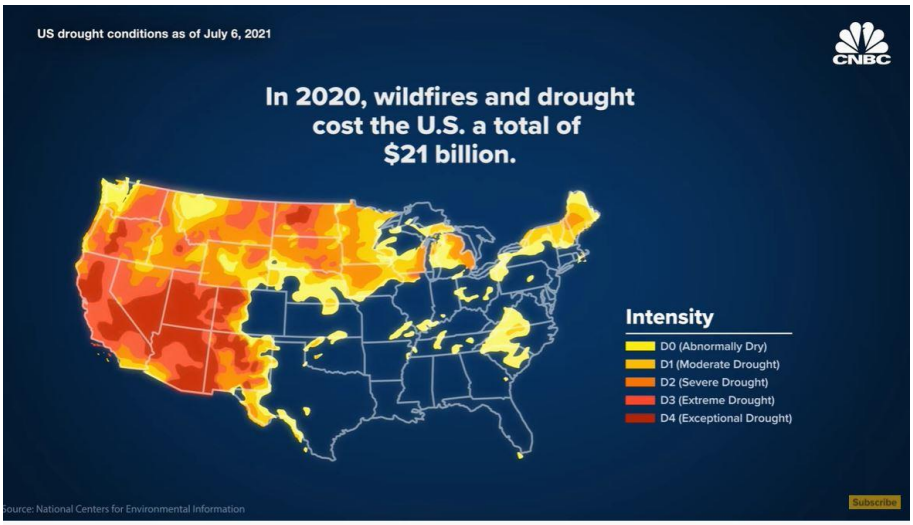


Fig. 1 – Cost of wildfires and drought in the U.S. in 2020.
Source: CNBC

Watersheds are also impacted by effects from climate change. Climate change has been affecting the environment since the 1980s. Two of the biggest destructive effects are drought and forest fires. Climate change has already changed watershed functions including the transportation and storage of water, and nutrient cycling.

Water rights in the west cause water conflicts between farmers, ranchers, Native Indian tribes, private land owners, municipalities, industries, recreation businesses, and more. Conflict between different areas of the same state can happen when water is transported from a lower populated area to a higher populated area due to water rights being sold.

This paper will discuss five different issues that affect watersheds in the western United States. It will also include an opinion of the best approaches for watershed management.

## OUTDOOR RECREATION AND WATERSHEDS

Outdoor recreation brings in billions of dollars per year. Many rural areas, small towns, and cities rely on this income for economic growth and prosperity. Outdoor recreation brings many new jobs that in turn bring about more local development which brings in more taxes. However, outdoor recreation does bring negative impacts to the water, soils, vegetation, and wildlife.

Outdoor recreation, i.e., hiking, biking, horseback riding, rock-climbing, and off-road vehicles, causes major disturbances to ecosystems. The arid landscapes of the western United States contain cryptogamic crusts that are very sensitive to disturbances. The degradation of soil occurs from these outdoor activities, causing it to break apart and be susceptible to wind and water erosion. The structure and composition of the cryptogamic crusts changes causing their ability to photosynthesize to decrease. They also lose their ability to infiltrate water and keep the soil in place. Gibson (2017). The less infiltration of water in soils, the less ground-water recharge.

Fig. 2 - Biological soil crusts
Source: SageStep.org

When outdoor activities occur near streams and riparian areas, the loose soil enters the water and causes sediments to buildup. This change in the streamflow affects the hydrology and water budget of this system and the system downstream. It also degrades the habitat for all aquatic species. Even agriculture performed downstream will be jeopardized with less water availability and lowered water quality. Last but not least, there is contamination of water, land, and soil from human pollution and human waste.

The demand for water for recreation (boating, fishing, etc.) and fish and wildlife habitats are causing water conflicts. Water 2025 was created by the U.S. Department of the Interior to establish a framework to help avert water wars that are expected to increase as the crisis for water continues. Water conflicts are expected to increase as water becomes more scarce and overpopulation increases both municipal water needs and irrigation for agriculture.

## NATURAL GAS EXTRACTION AND WATERSHEDS

Natural gas extraction is detrimental to watersheds. In terms of water demand, in 2021 over 6.3 billion barrels of water was estimated to be used to fracture shale and rock. This enormous amount of water used for fracking affects the quantity of both surface water and groundwater. The water budgets in areas of fracking are forever changed. There are thousands of gallons of chemicals added to this water before it is pumped into the ground. UCS (2014). Unfortunately, this water is not reusable as the wastewater from fracking will never be clean enough to use for humans, wildlife, or even irrigation for agriculture.

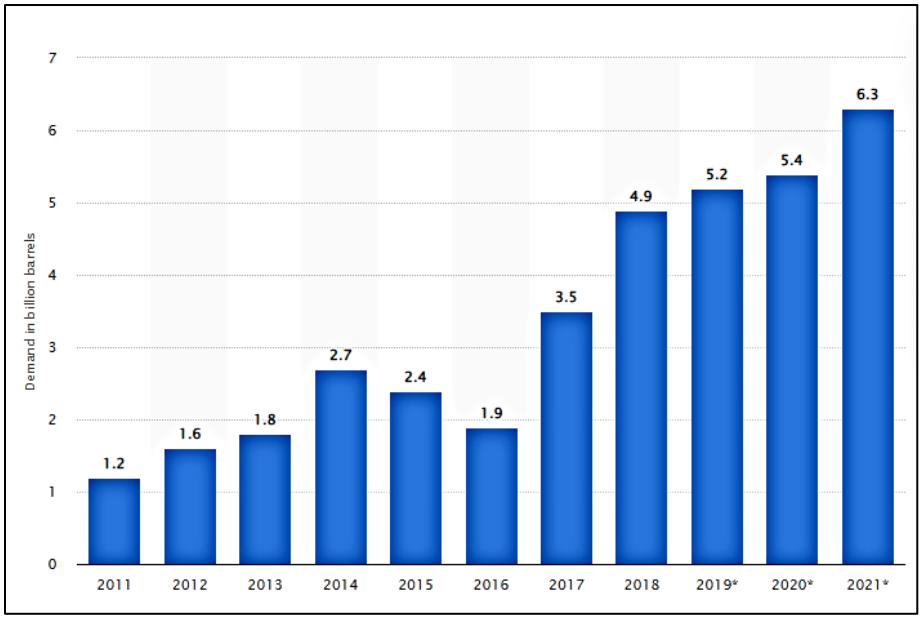

Fig. 3 – Water demand from hydraulic fracturing in the U.S. from 2011 to 2021
Source: Ian Tiseo/Statista.com

Fracking is very dangerous as both surface water and groundwater are at risk. Contamination of water happens from spills and leaks of the chemical additives and from leaks of wastewater from storage facilities. These leaks and spills are usually radioactive or corrosive, and are always toxic to humans and wildlife, including both terrestrial and aquatic ecosystems. UCS (2014).

Fracking causes poor hydrology to ecosystems, lowering water availability to surrounding areas. This affects plant production and reproduction affecting the erosion control that vegetation provides. The soil becomes degraded, decreasing its ability to both cycle and store water. Soil chemistry changes allows for much easier erosion of the land.

The construction of oil and gas pads, pipelines, and access roads also causes erosion and the buildup of dirt, minerals, and other pollutants. This sediment finds it way into local streams affecting everything downstream. Construction also changes plant communities and soil chemistry through degradation.

## CLIMATE CHANGE AND WATERSHEDS

Climate change has already altered the environment and impacted the economy. Changes in precipitation and temperatures will continue to cause damaging impacts to watersheds as temperature regulates water and energy fluxes. Figure 4 is a flowchart of these impacts.

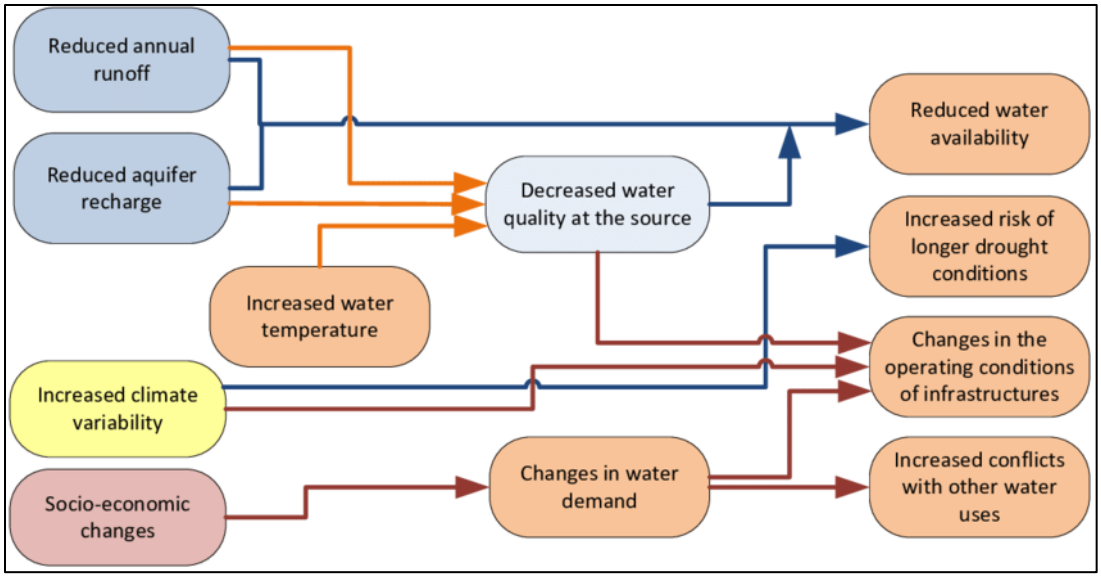

Fig. 4 – Impacts of climate change on water supply systems.
Source: Proenca de Oliveira et al. (2015)/Research Gate

The quantity of water is being severely impacted by less winter precipitation and snowpacks. Less snow protection for soil means more erosion. Spring runoff is happening sooner which reduces water availability in the summer and fall. The water budget will change due to the timing and distribution of water, and will worsen effects from droughts. Furniss (2010).

As patterns of precipitation and runoff change, groundwater levels will also change. These changes will influence water flows through streams and riparian areas. Climatic changes causing heavy rains and flooding will occur, cause sedimentation from soil erosion to alter stream channels and affect aquatic habitat.

Agriculture in the west uses about 80-85% of available water, with that water sometimes being transported hundreds of miles. With rising temperatures and drought expected to worsen as climate change continues, that amount of water will need to be lowered for agriculture to make up for losses elsewhere. Water stress will hit every watershed in the nation.

Temperature increases bring about rises in soil temperatures and changes to soil chemistry. Soil acidification and salinization can occur, harming vegetation communities. USFS (2017). In turn, ecosystem services from vegetation will decline, including the exchange of carbon dioxide for oxygen (photosynthesis). Plants will now provide less protection against water runoff and soil erosion, and store less water. Even organic matter in the soil can decrease due to loss of moisture and mycorrhizal fungi relationships can be altered. Increases of carbon dioxide in the atmosphere will change plant metabolism and photosynthesis capabilities.

According to Furniss, potential consequences to watershed services include changes in riparian habitats by changes in water flow, altered inputs of nutrients in streams and lakes, longer and

dryer droughts, increased depletion of groundwater, and changes in moisture to wetlands, lakes, streams, and soils. Furniss (2010).

## INVASIVE SPECIES AND WATERSHEDS

Invasive plants disrupt both terrestrial and aquatic habitats, and can alter watersheds through water quantity and water quality. According to the EPA's Watershed Academy Web, estimated damages from invasive species are as high as $138 billion annually. Invasive plants affect water quality and the health of ecosystems by displacing native species. Forest succession, both terrestrial and riparian, in watersheds can happen from an influx of invasive species, whether understory plants or the change in tree species. O'Keefe et al. (2022).

Ecological droughts cause metabolic changes in native plant communities. The decreasing health of plants allow invasive species to enter and take over nutrients, water, and sunlight from native species. Research is also finding that invasive plants are more likely to be drought-tolerant, and more willing to adapt to climate change than native plants. O'Keefe et al. (2022). These plants will change landscape patterns and the composition of watersheds through their disturbance of native plant communities.

Fig. 5 below shows how invasive species impact organisms, ecosystem engineering, and ecosystem processes/functions.

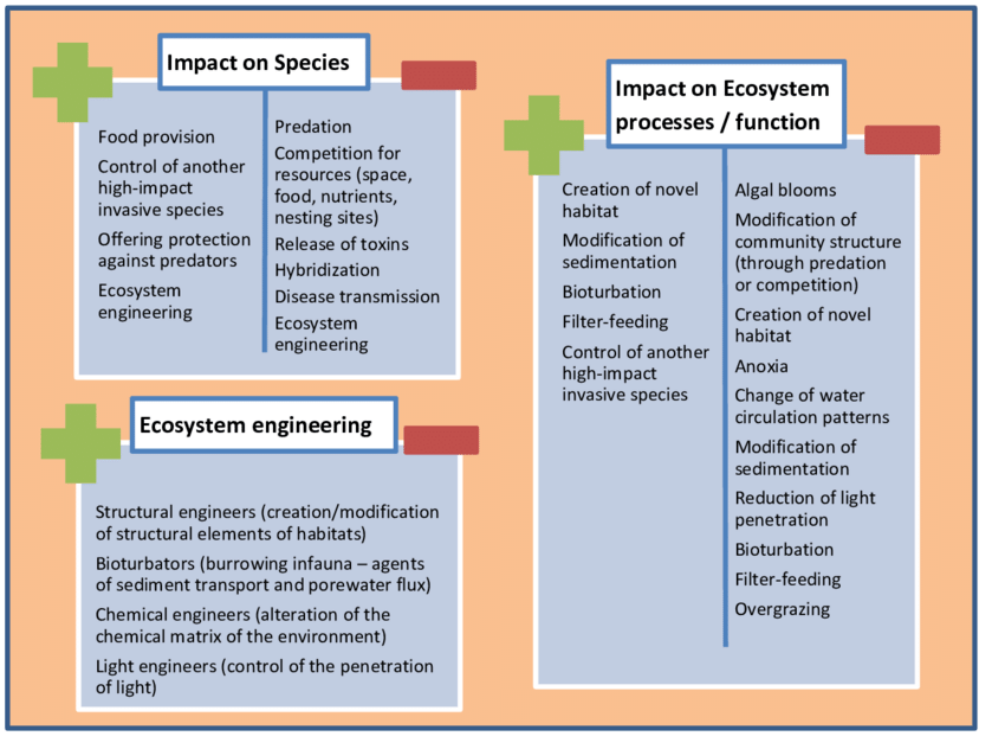


Fig. 5 – Main mechanisms through which alien species impact biodiversity.
Source: Katsanevakis et a. (2014)/Research Gate

## WILDFIRES AND WATERSHEDS

Wildfires are becoming more frequent and severe due to drought from climate change. Wildfires can be bring both positive and negative affects to a watershed. It can renew ecosystems, but it can also destroy ecosystems. Due to fire suppression and climate change, high severity fires are becoming commonplace. These scorched places have decreased the capturing, filtering and regulating of water. Bryant (2017).

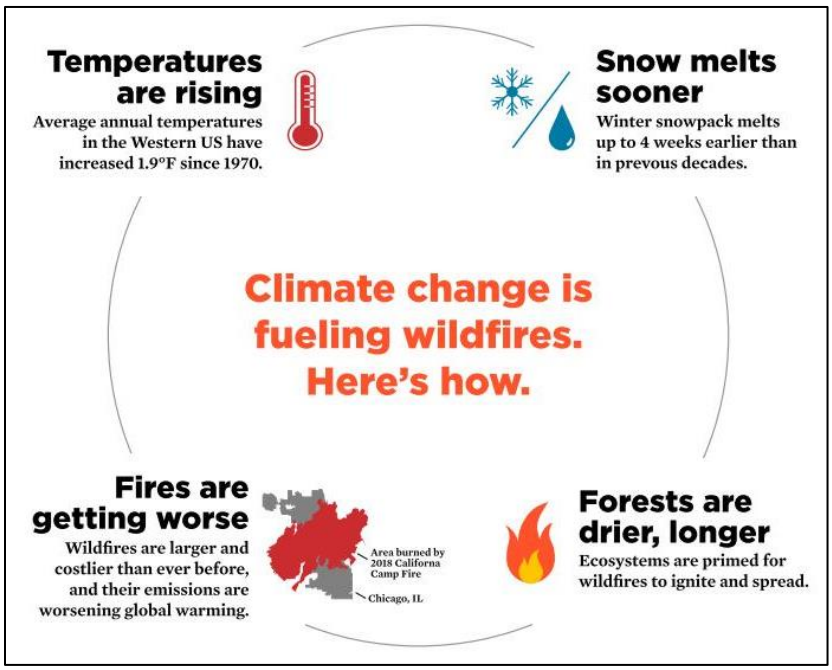


Fig. 6 – Climate change and wildfires.
Source: UCSUSA.org

Based on the strength of the fire, shrubs, grasses, and smaller trees are usually destroyed. Forest fires can leave larger trees standing based upon the damage to the canopy. This loss of trees, shrubs, grasses, and other understory vegetation allows for more erosion, flash floods, and landslides. The additional sediment in the water leads to a decline in water quality. It also changes the regular flow of water, allowing downstream areas to become drier with less vegetation. Flash floods and landslides also occur allowing high levels of sediments, soil, and dead trees and plants to enter streams and rivers, damaging the riverine/riparian areas and downstream habitats.

Due to less vegetation, stormwater runoff increases instead of infiltrating and percolating into the soils, and recharging groundwater. This stormwater runoff can harm terrestrial and aquatic ecosystems and wildlife by metal and other chemical contamination

Forest fires put carbon dioxide, carbon monoxide, and soot into the air. The smoke can also contain other chemicals, like sulfur dioxide and nitrogen oxides. This can form acid rain, which is harmful to soil, forests, and water sources. Water quality in a forested watershed can be comprised for years after a wildfire.

## FRAMEWORKS AND APPROACHES TO WATERSHED MANAGEMENT

Integrated Watershed Management is a great framework approach to watershed management. This framework includes a multi-disciplinary approach with numerous stakeholders that work together to coordinate efforts for social, economic, and environmental management of water resources.

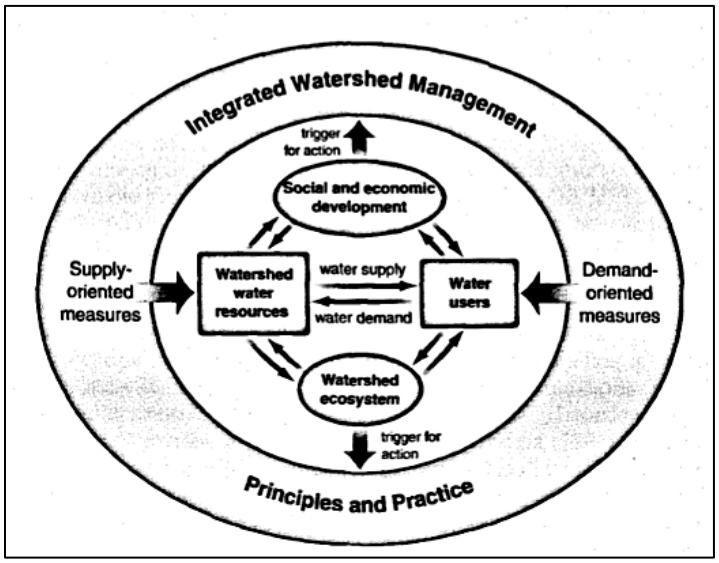


Fig. 7 – Forces affecting Integrated Watershed Management
Source: Heathcote (2009)

According to Heathcote, the following general approach is recommended:

1. Identify water uses and water users and their needs
2. Identify and put in order the problems or restoration needs
3. Identify detailed goals
4. Identify constraints and reasons for decisions
5. Identify alternatives for comparison
6. Identify management options
7. Eliminate options that are not feasible because of constraints
8. Look at remaining feasible options
9. Identify economic impacts and legal implications of the chosen options
10. Identify management strategies with one or more options for review by all stakeholders
11. Identify implementation procedures

Heathcote (2009).

Another approach is the The Watershed Management program that is taught by the Watershed Academy Web through the U.S. Environmental Protection Agency. It has four core principles:

1. Watersheds are natural systems that can be managed
2. Watershed management needs a multi-disciplinary approach that is continuously used

3. A watershed management framework supports stakeholders using sound science taking actions that are well-planned to achieve desired results
4. Flexible approaches are needed – there is no “one fits all” approach

I believe that if we combine ideas and principles from numerous sciences and work together to find a complete, cohesive management plan that takes in all possible impacts both environmental and social, then we will be much better prepared to management our watersheds.

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