What is the Fate of Your Rainfall?
By properly managing rainwater and the factors that affect it, Texans can help reduce flooding, replenish water supplies, and protect water from pollution.

Water moves back and forth between the oceans, the soil, groundwater supplies, fresh surface water, and the atmosphere in a process known as the hydrologic cycle (Fig. 1). After rain falls to the ground, it either seeps into the soil or runs off the soil surface to streams, rivers, and lakes.

The water that seeps into the soil adds to the soil moisture levels and often percolates through the soil to replenish the groundwater stored in aquifers. In lower elevations, the groundwater interacts with surface water supplies by seeping into streams and rivers. In upland areas, surface water filters down into groundwater supplies (Fig. 2).

The soil moisture is used by plants, which release the water into the atmosphere as water vapor in a process called transpiration. Water can evaporate from both soil and water surfaces, returning to the atmosphere in a process called evaporation.

The water in the atmosphere forms clouds that move the water vapor around until it falls as rain, thus completing the hydrologic cycle.

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What determines where the rainfall goes?

The path that rainfall takes—whether it runs off a piece of property or soaks into the soil—is affected by many factors:

- Land cover, whether impervious such as buildings, pavement, and rock, or permeable such as vegetation and some soils
- Density of the vegetation cover
- Intensity of the storm
- Amount of moisture in the soil before the storm
- Capacity of the soil to hold water
- Slope of the land

The slope of the land divides the land into watersheds. A watershed is an area of land that drains to a common point (Fig. 2). Everyone lives in a watershed, and people can help enhance the quality and quantity of water supplies by managing their watersheds properly.

Watershed management involves:

- Increasing the amount of water that filters into the soil
- Reducing the amount of soil lost to erosion
- Raising the amount of harvestable forage that is produced, such as grass for livestock
- Improving conditions for wildlife by increasing the amount of food, water, and cover
- Protecting water from pollution
- Creating a sustainable watershed

How is the path of rainwater altered?

Although some factors affecting rainwater flow cannot be changed, people can change the path of rainwater by altering the land cover and the condition of the soil.

Rainfall moves differently on developed land than in natural areas (Fig. 3). When pastures, cropland, and rangeland

Figure 3. Relationship between impervious cover and surface runoff. Impervious cover in a watershed results in increased surface runoff. As little as 10 percent impervious cover in a watershed can result in water-quality problems (Source: U.S. Environmental Protection Agency).
are developed into urban or suburban areas, the amount of impervious cover increases. This changes the path of rainwater.

In an urban or poorly managed agricultural setting, rainwater that once could infiltrate the soil leaves the site as runoff. Agricultural and urban activities may be conducted in a manner that leaves the soil bare, making it vulnerable to erosion (Fig. 4).

Healthy vegetative cover protects the soil surface from erosive forces, promotes the infiltration of water into the soil profile, and slows runoff. The roots and organic matter from plants loosen the soil, providing a pathway for the water to seep into the soil. The water that filters into the soil is then available for vegetative growth and recharging or replenishing the aquifers below.

Recharging aquifers is critical because they are a major source of water for both agricultural and municipal operations.

Because rainfall runs off much faster in developed areas (Fig. 5), erosion is increased on land and in stream banks. This erosion can be extreme (Fig. 6).

Once the soil detaches from the land and banks, it is carried by the flowing water until the water slows and the suspended soil particles fall out.
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This process, called deposition, removes valuable soil from the upper portions of watersheds and deposits it downstream in lakes, rivers, and bays.

Increased runoff can also transport contaminants downstream. Such contaminants include excess fertilizers, chemicals, and bacteria from urban and agricultural lands, and oils and other contaminants from paved roads, parking lots, and driveways.

Effective management practices of urban and agricultural land can make the difference between excessive runoff with degraded water quality and minimal runoff with improved water quality. If you properly manage your land, whether it is a city lot, agricultural fields, or a sprawling ranch, you can help protect resources and use rainwater to benefit your property. You must properly monitor current conditions and the conditions that change over time in order to determine if damage to the soil, plant communities, and water resources is occurring. Timely management decisions must be made to protect your resources.

What is happening to Texas groundwater?

It has been estimated that centuries ago, about 10,000 springs flowed in Texas. Today, only 60 percent of them still flow. The decline in water levels in the major Texas aquifers (Fig. 7) has been outlined in the 2007 State Water Plan by the Texas Water Development Board.

There are three main reasons for the decreased water in our aquifers: increased pumping of water for human use, discontinued use of fire to control the growth of woody plants, and decreased amounts of deep-rooted grass in the state.

1. Water pumping: As the population grows, more water is pumped from aquifers for household, industrial, and agricultural purposes. Texas aquifers will continue to dry up unless their recharge can be increased and the demand on the water sources can be decreased.

![Water level decline in feet](image)

**Figure 7.** Estimated total water level declines in the major aquifers of Texas. Water level declines in the eastern part of the state tend to be declines in artesian pressure, while water level declines in the western part of the state tend to be declines in the water table. These estimates are from the groundwater availability models and are calculated by subtracting water levels from the most recently calibrated year (generally about 2000) from simulated predevelopment (pre-pumping) water levels. (Source: Texas Water Development Board).
2. **Use of fire:** An account by the Spanish explorer Cabeza de Vaca in 1520 suggests that before European settlement in Texas, Indians routinely and indiscriminately used fire as a management tool.

“The Indians go about with a firebrand,” de Vaca wrote in his diary “setting fire to the plains and timber so as to chive off the mosquitoes, and also to get the lizard and similar things they eat, to come out of the soil.”

Because of this human activity as well as fires started by lightning, the vegetation on vast areas of Texas was dominated by mid-sized and tall grasses with deep, fibrous roots. In the Hill Country, cedars, which were easily killed by fire, were limited to steep canyons. Live oaks were scattered as large trees, surviving the fires or re-sprouting following burns. Other woody plants, were restricted to areas in the canyons and along streams or in clusters of sprouts in open grassland.

As woody plants increase, less water moves into the aquifers to supply springs, because of evaporation and transpiration.

3. **Decrease in deep-rooted grasses:** Heavy grazing by livestock has caused deep-rooted grasses to be replaced by short grasses, woody plants, weeds (forbs), and bare ground. Water infiltrates best in soil that is covered with deep-rooted bunch grasses such as big bluestem, Indian grass, little bluestem, sideoats grama, and switchgrass (and blue grama in West and North Texas). As these plants were replaced, more rainwater ran off the surface instead of seeping into the soil.

Loss of vegetative cover because of drought, fire, or excessive grazing increases water runoff, erosion, and sedimentation in lakes and rivers. As erosion increases, less water infiltrates the soil, which then decreases forage production and the number of animals that the land can support.

An additional problem in areas where the ground is bare is that the soil can heat up to 30 to 50 degrees hotter than when it is shaded. The bare ground and elevated temperatures can disrupt life in the soil; speed up organic matter degradation, which seals the soil; and promote water runoff and soil erosion after rains.
How can watersheds be managed?

Several practices can be adopted to help prevent excess runoff, avoid erosion, recharge aquifers, increase forage or plant production, and protect water quality:

- Use water wisely. One way to use less water is by xeriscaping or smartscaping, a technique that minimizes the use of water in landscapes. Xeriscaping reduces waste and pesticide usage, reduces the size of turf in the landscape, increases natural or “wildscape” areas, decreases water use in and outside the home, and uses rainwater to supplement water needs.

- Think on a watershed or subdivision level. Work with your neighbors to check the landscape or rangeland for areas where water naturally filters into the soil. Protect these areas so they can allow water to collect and percolate into the soil and recharge groundwater supplies.

- Manage woody plants and restrict invasive species by “brush sculpting,” which removes woody plants in a planned manner. Brush sculpting helps increase the amount of forage for livestock, improve conditions for wildlife, protect endangered species, and protect riparian areas (those near rivers and streams) to reduce soil erosion.

- Develop rangeland management techniques that prevent overgrazing: balancing animal numbers with what the land will support, which may mean reducing livestock numbers; rotating livestock among pastures; and developing a good range management plan. For forage, use the rule of thumb “graze half and leave half,” and provide an extended period of rest to allow plants time to mature and strengthen their roots.

- Teach others to use water wisely and to be good stewards of natural resources. It takes an average of 500 years to rebuild 1 inch of soil; human actions can have long-lasting effects.

Be a good steward of the land in your care so it will be in better shape for future generations. President Teddy Roosevelt said it well when he said, “A nation behaves well when it treats its natural resources as assets which it must pass on to the next generation increased and not impaired in value.”
References and sources of more information


- *The Journey of Alvar Nunez Cabeza de Vaca and His Companions from Florida to the Pacific, 1528-1536*, by Nunez, Alvar, Cabeza de Vaca (author), Adolphe Francis Bandelier (editor), and Fanny Bandelier (translator). A.S. Barnes & Company, 1905.


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