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Farm Water Quality Planning
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This Reference Sheet is part of the **Farm Water Quality Planning (FWQP)** series, developed for a short course that provides training for growers of irrigated crops who are interested in implementing water quality protection practices. The short course teaches the basic concepts of watersheds, nonpoint source pollution (NPS), self-assessment techniques, and evaluation techniques. Management goals and practices are presented for a variety of cropping systems.

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Reference:

Watershed Function

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WHAT IS A WATERSHED?

All life depends on the soil, the water falling on that soil, and the air above and within the soil. Entire societies have disappeared because they didn't properly understand and care for their soil resource. Without productive soil, plant and animal diversity would decrease and our current human population could not be maintained.

We can think of a watershed, using the simplest description, as the land on which water falls from the atmosphere and in which that water is stored underground and then released to other locations over a period of time. All land is part of a watershed.

We can also visualize each watershed as a catchment area divided from the next watershed by topographic features such as ridgetops. The water that falls within a watershed or catchment but is not held or used by existing vegetation will ultimately seep and flow to the lowest point available. It will eventually reach the streams and rivers that drain the system or be stored in ground water until it is removed by pumping.

With respect to watersheds, the hydrologic cycle refers to the process beginning with the water falling to earth in either liquid or solid form (Figure 1). The captured water is either taken up by vegetation, retained in the soil, or percolates through the soil. The water may enter into springs, streams, rivers, lakes, groundwater reservoirs, or the sea. It can then return to the atmosphere by evaporating and start the cycle again.

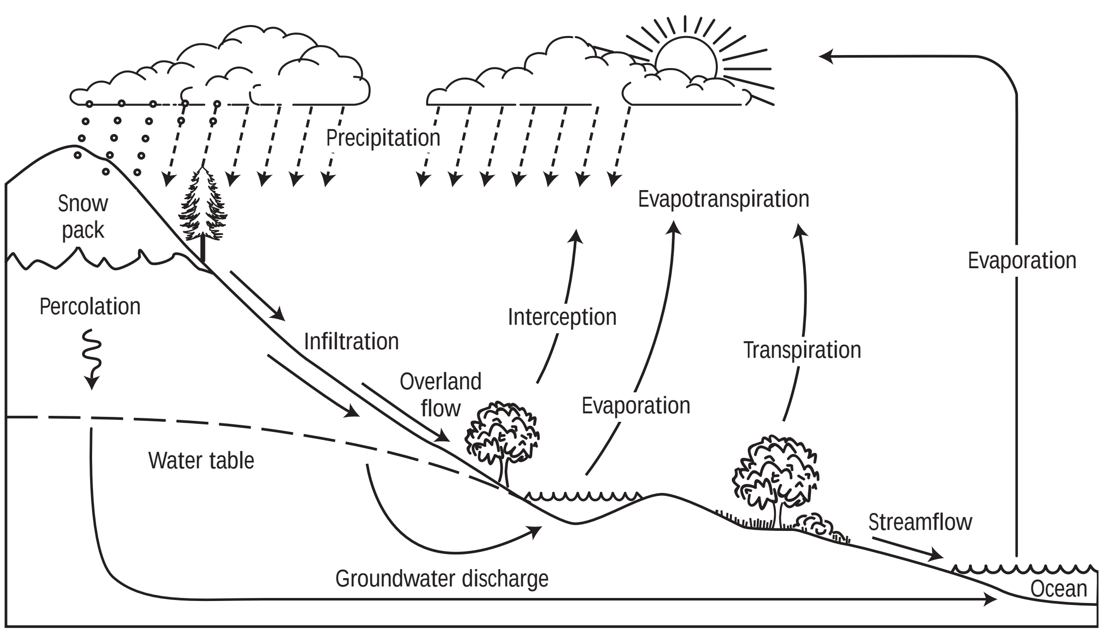

Figure 1. Hydrologic cycle

Ground water is part of the watershed and is tightly linked to the hydrologic cycle within the watershed. It is important, though, that you keep in mind that watersheds have traditionally been defined and managed with respect to surface water and the network of channels and streams that connects to the surface outlet of the watershed. Groundwater basins are defined by the geology underneath watersheds so they do not always have the same boundaries as their overlying watersheds. In this publication we discuss watershed functions that relate to surface water features. For more information on ground water, see the FWQP Reference Sheets on ground water (ANR Publications 8083, 8084, 8085, and 8086).

WATERSHED FUNCTIONS

There are three processes within a watershed that can protect water quality if preserved: *water capture, water storage,* and *water release.* A number of circumstances that can interrupt the capture, storage, and beneficial release of water are beyond human control. For example, when warm rains melt snow over frozen ground, the resulting water cannot infiltrate and has no alternative but to run off. A number of steps are available to land managers, however, to preserve these processes.

Capture

Water capture is the process of water's transfer from the atmosphere into the soil. All moisture received from the atmosphere, whether in liquid or solid form, should have the maximum opportunity to enter the ground where it falls.

Land managers can affect the extent of water capture by making it easier for water to infiltrate the soil surface and percolate to greater depths.

Infiltration is the movement of moisture from the atmosphere into and through the soil surface. *Percolation* is the downward movement of water through the soil profile. Several factors affecting the infiltration rate are fixed, such as soil type (primarily texture and depth), topography, and climate, but you can influence infiltration rates by managing soil compaction, soil organic matter, and vegetative cover. The form and pattern of vegetation for any site can be managed to give water the maximum opportunity to penetrate the surface where it falls. This minimizes the overland flow that can otherwise cause erosion and transport pollutants into streams and waterways.

You can manage vegetative structure and the density of plant cover at or near the soil surface in such a way that almost all moisture that falls to the ground will enter the soil. Good infiltration rates are beneficially influenced by

- plant cover that reduces the physical impact of raindrops upon the soil surface, and thereby minimizes soil crusting
- plant cover that increases the roughness of the soil surface, thus decreasing the velocity of runoff water
- root systems that provide channels in the soil for water
- plant litter and organic matter on and incorporated into the soil surface to absorb moisture and help maintain soil structure
- plant cover that traps snow at or very near the soil surface (this will also make the soil freeze more slowly and enhance the water's chance to enter soil during winter months)

Some moisture is captured in the foliage of trees and shrubs. In areas of low precipitation where trees and shrubs dominate a site, these plants often catch snow and even some rain so that it evaporates or sublimates before it has a chance to reach and infiltrate the soil.

Healthy vegetative cover with its accompanying root mass can keep soil more permeable so moisture will more readily percolate into the soil profile for storage. Water often follows the paths of abandoned root channels and live roots into the soil. These paths may penetrate compacted soil layers or deeper horizons. Percolation also is aided by the activity of burrowing animals, insects, and earthworms.

Storage of Water in Soil

Once water is captured in the soil, it is stored between soil particles in the soil profile. Management practices can significantly affect storage capacity on any particular site. Nevertheless, keep in mind that the amount of moisture a given soil can hold depends on the soil's depth, texture, and structure. For example, the available water holding capacity of a clay loam is about 2 inches per foot of soil depth, versus about 1.4 inches per foot of soil depth for a sandy loam.

The kinds and amount of vegetation and the plant community structure can also greatly affect water storage on any particular site. A rangeland site can be dominated by shallow-rooted annual grasses, deep-rooted perennial grasses, shrubs, or trees, or a mixture of these. All of these plants use water at varying depths in the soil profile. A cropland site is typically dominated by a single plant species that draws water from a limited range of depths.

After a soil is saturated, additional water will either percolate deeply or run off the surface. Soil moisture is lost in three ways:

- through plants that grow on the site
- through percolation of excess water through the soil profile
- through direct evaporation from bare soil surfaces

Management practices that reduce evaporation at the soil surface by slowing the movement of air, shading the soil, and reducing temperatures can help conserve moisture.

Beneficial Release

Beneficial release occurs when water is released into ground water or out of the watershed without causing adverse environmental impacts. In this process, water moves through the soil profile to seeps, springs, and ultimately into the streams and rivers that are the water conduits from the uplands. The amount and rate of water released depend on two factors:

1. *Subsurface flow:* the water already in the soils of the uplands, riparian areas, and streambanks in excess of field capacity
2. *Overland flow:* precipitation that exceeds the soil's infiltration rate and flows over the soil surface

The form and amount of vegetation growing in riparian zones directly affect the flow rates of rivers and streams. Vegetation acts to protect streambanks and absorb energy from flowing water. A severe, rapid release of water will occur in straight channels with little resistance to water movement. The energy from the rapid release of water can then erode the streambanks, increasing the water's sediment load and diminishing the water's quality. Vegetation also affects the subsurface flow of water. Without vegetation to remove water from the soil profile by transpiration, the quantity of water from any precipitation that will be released to streamflow will increase.

Land management practices in every part of the watershed will affect the health of the entire watershed. All parts of a watershed are equally important. The upland zone captures and stores water while the riparian zone is the primary release mechanism for the watershed. Proper care of the upland and riparian zones keeps the watershed functioning properly. The ideal condition will keep most water where it falls, reduce runoff, and allow for moderate streamflows.

REFERENCES

Bedell, T. 1995. Rangeland water quality fact sheet No. 4: What is a watershed? http://agronomy.ucdavis.edu/calrng/h04.htm

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