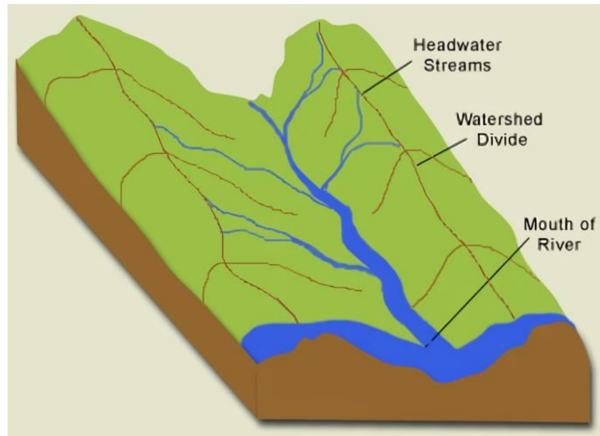
What is a watershed?

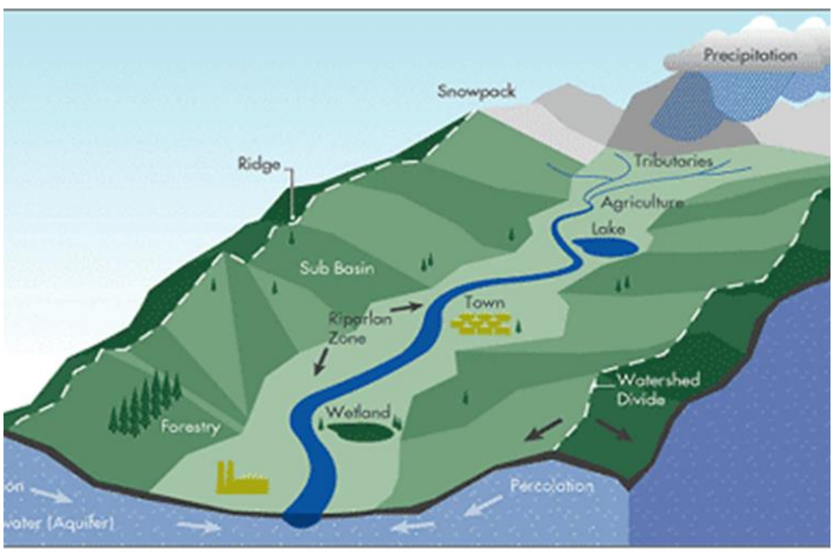
Easy, if you are standing on ground right now, just look down. We are all standing, in a watershed.

All land on earth is a watershed. Humans and their activities play an important and essential role in watersheds, yet few people understand them. Still fewer know how a watershed works or can describe the boundaries of the ones in which they live.

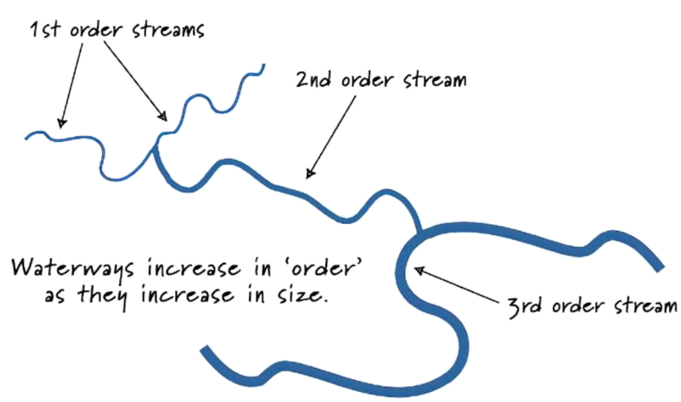
A watershed is often called a drainage basin. It is the land area drained by a network of channels, called tributaries, that increase in size as the amount of water, sediment, and dissolved materials they must carry increases. Each watershed is an interconnected land-water system that conveys water to its outlet—a larger stream, an inland lake, a wetland, an estuary, or the ocean. A watershed may be the drainage area surrounding a lake that has no surface outlet, or a river basin as large as that of the Columbia River. A puddle even has its own watershed. Within a large watershed, tributaries form smaller watersheds called sub-basins. Each tributary contributes to overall streamflow for the entire basin.



The corridor of vegetation next to and influencing the aquatic area is called the riparian area. The point where two watersheds meet is called a divide. Connecting the divide with the valley or lowland areas below are the hill slopes or uplands. Events in the uplands ultimately affect the capture of water on the surface of the land, storage, and movement of water below the surface, and release of water to riparian and aquatic areas. Each stream in a watershed is an everchanging open-water system. It carves through valleys, collects water and sediments, and conveys the surface runoff generated by rainfall, snowmelt, or groundwater discharge to the estuaries and oceans. The shape and pattern of a stream is a result of the land it is cutting and the sediment it must carry.



Stream orders In most cases, a watershed system is almost entirely hillsides, called uplands. Only about one percent of a watershed is stream channels. The smallest channels in a watershed have no tributaries and are called first-order streams. When two first-order streams join, they form a second order stream. When two second-order channels join, a third-order stream is formed, and so on. First- and second-order channels are often small, steep, or intermittent. Orders six or greater are larger rivers.



Channels change by erosion and deposition. Natural channels of rivers increase in size downstream as tributaries enter and add to the flow. A channel is neither straight nor uniform, yet its average size changes in a regular and progressive fashion. In upstream reaches, the channel tends to be steeper. Gradient decreases downstream as width and depth increase. The size of sediments tends to decrease, often from boulders in the hilly or mountainous upstream portions, to cobbles or gravels in middle reaches. More sand or silt are found downstream. In some cases, large floods cause new channels to form, leaving once-productive streams dry and barren.

Watershed Components

Watershed is the area of land that contributes water to a particular watercourse.

Divide marks the high point of land that separate one watershed from another.

Headwaters are the upper limits of the watershed.

Tributaries are smaller branches of watercourse that join together to make larger sections of the river.

Wetlands are permanently or seasonally inundated lands.

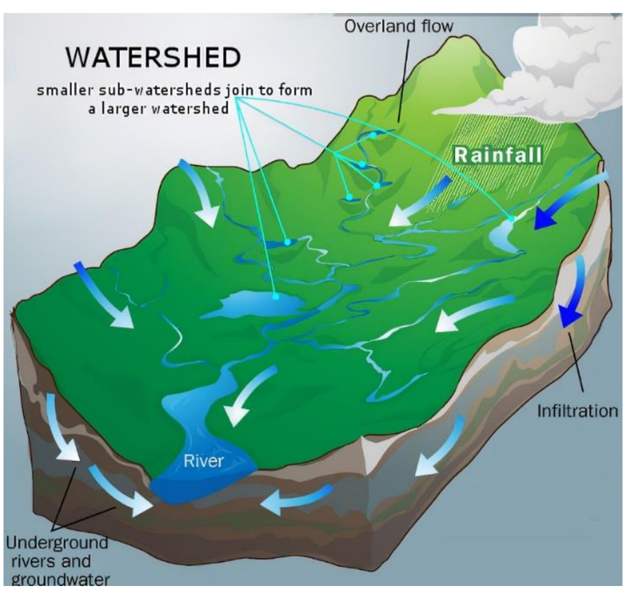
Channel is the normal area that the river occupies.

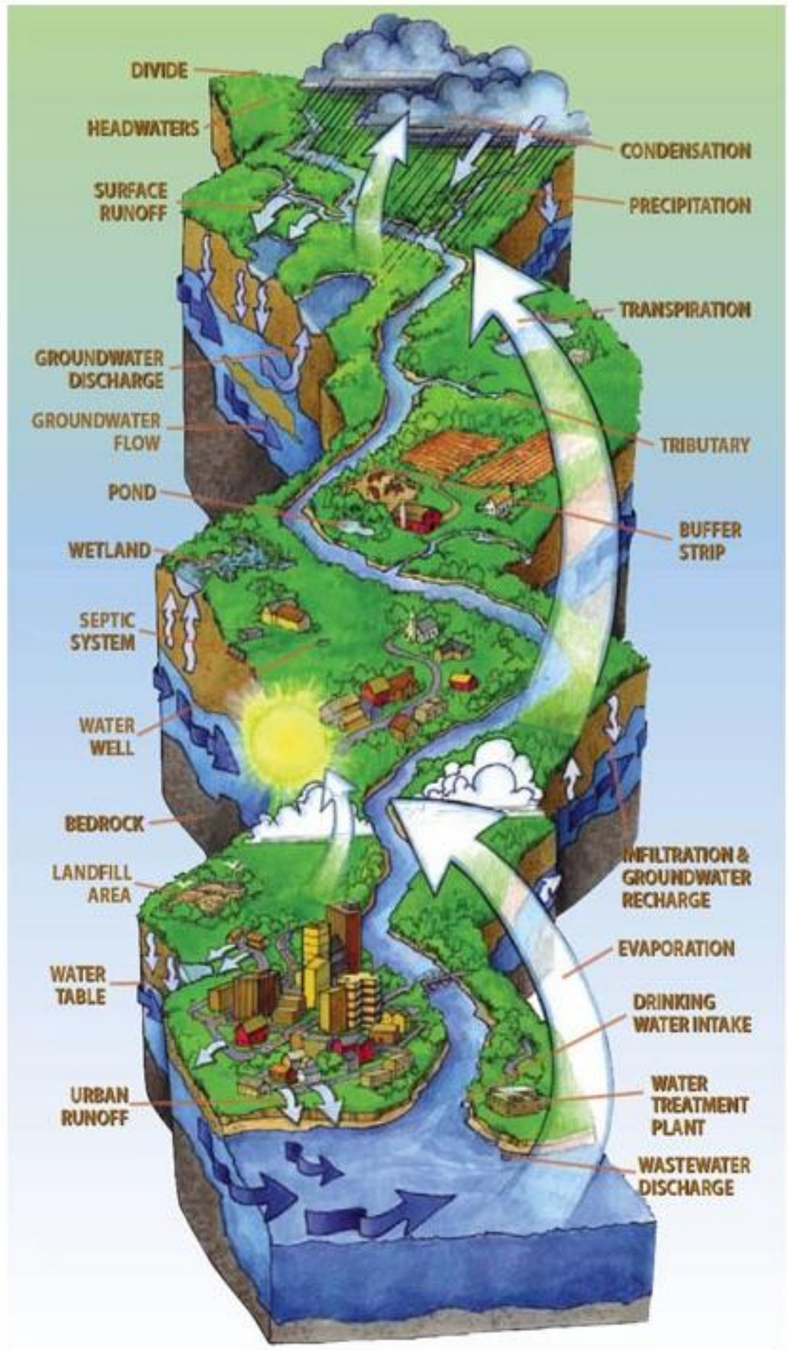
Floodplain is the area on either side of the watercourse that may be covered by water in times of high flow.

Confluence is where a branch of the watercourse joins the main channel.

Mouth marks the end of the watercourse at a body of water, usually a lake or the sea.

Groundwater exists in the spaces of bedrock or loose material, such as sand and gravel.





All watersheds have an aquatic area, a riparian area, and an upland area. Aquatic areas include standing waters like ponds, lakes, wetlands, bogs and running surface waters such as streams and rivers.

The word "watershed" is sometimes used interchangeably with drainage basin or catchment. Ridges and hills that separate two watersheds are called the drainage divide. The watershed consists of surface water--lakes, streams, reservoirs, and wetlands--and all the underlying groundwater. Larger watersheds contain many smaller watersheds. It all depends on the outflow point; all of the land that drains water to the outflow point is the watershed for that outflow location. Watersheds are important because the streamflow and the water quality of a river are affected by everything happening in the land area "above" the river-outflow point.

Streamflow types

Besides the ordering system previously described, streams may be classified by how much of the year they have flowing water.

- Perennial flow indicates a nearly year round flow (90 percent or more) in a well-defined channel. Most higher order streams are perennial.
- Intermittent flow generally occurs only during the wet season (50 percent of the time or less).
- Ephemeral flow generally occurs during and shortly after extreme precipitation or snowmelt conditions. Ephemeral channels are not well defined and are usually headwater or low order (1-2) streams.

Factors affecting watersheds

Climate

Land and water are linked directly by the water cycle. Solar energy drives this and other cycles in the watershed. Climate—the type of weather a region has over a long period—is the source of water. Water comes to the watershed in seasonal cycles, principally as rain or snow. In some areas, condensation and fog-drip contribute water. The seasonal pattern of precipitation and temperature variation control streamflow and water production. Some precipitation infiltrates the soil and percolates through porous rock into groundwater storage, which recharges areas called aquifers. Natural groundwater discharge, called baseflow, is the main contributor to streamflow during dry summer and fall months. Without baseflow, many streams would dry up.

Pumping water from an aquifer for industrial, irrigation, or domestic use reduces the aquifer’s volume. Unless withdrawals are modified or recharge increased, the aquifer will eventually be depleted. A drained aquifer can collapse from the settling of the overlying lands. Collapsed underground aquifers no longer have as much capacity to accept and hold water. Recharge is difficult, volume is less, and yields are considerably reduced. Springs once fed from the water table also dry up. Climate affects water loss from a watershed as well as provides water. In hot, dry, or windy weather, evaporation loss from bare soil and from water surfaces is high. The same climatic influences that increase evaporation also increase transpiration from plants. Transpiration draws on soil moisture from a greater depth than evaporation because plant roots may reach into an available moisture supply. Transpiration is greatest during the growing season and least during cold weather when most plants are relatively dormant. Wind also causes erosion, controls the accumulation of snow in sheltered places, and may be a significant factor in snowpack melting. Wind erosion can occur wherever wind is strong and constant, or where soil is unprotected by sufficient plant cover.

Soils and geology Soil, a thin layer of the earth’s crust, could be called the “skin” of a watershed. It is composed of mineral particles of all sizes and varying amounts of organic materials. It is formed from the breakdown of parent rocks into fine mineral particles. This occurs by:

- Freezing and thawing in winter,
- Heating expansion and cooling contraction in summer,

- Wind and water erosion,
- The grinding action of ice,
- Action of lichens and other plants.

Soils are categorized into 2 groups. **Residual** soils are those developed in place from underlying rock formations and surface plant cover. **Transported** soils include those transported by gravity, wind, or water.

Climate, particularly precipitation and temperature, strongly affects soil formation. Rainfall causes leaching—movement of dissolved particles through soil by water. Temperature affects both mechanical breakdown of rocks and breakdown of organic material. Soil bacteria, insects, and burrowing animals also play a part in the breakdown and mixing of soil components. Soil often determines which plants grow in a watershed, which in turn establish a protective vegetative cover. Plants also modify and develop soil. Plant roots create soil spaces and extract water and minerals in solution from their roots. Plant litter adds organic matter to soil. It also slows surface runoff and protects the soil surface from rainfall's beating and puddling effects. Soil depths and moisture-holding capacities are usually less on steep slopes, and plant growth rates are often slower.

Forage, timber, and water are all renewable resources. Water is renewed by cycles of climate. Forage and timber are renewed by growth in seasonal cycles. The availability of these watershed resources is dependent upon soil. Soil is, except over long periods, a nonrenewable resource. It may take more than a century to produce a centimeter of soil and thousands of years to produce enough soil to support a high yield, high-quality forest, range, or agricultural crop. Soil is the basic watershed resource. Careful management and protection is necessary to preserve its function and productivity.

Vegetation The variety of plant species and their growth and distribution patterns within a watershed are the result of differences in soil type, light, temperature, moisture, nutrient availability, and human activity. For example, temperatures on the north and south slopes of the same hill may vary considerably. Different light intensities may account for the temperature variation on either side of the hill. Temperature differences in turn affect the moisture levels on each of the slopes. Generally south-facing slopes are warmer and drier than north-facing slopes in the northern hemisphere. The plant species that are present directly affect the ability of a watershed to capture, store, and release water within that particular habitat. Branches of large conifers effectively intercept snow and rain. Some of the moisture in the precipitation will evaporate before it has a chance to reach the ground but the rest is slowed in its descent, lessening the impact to the soil's surface. Sagebrush and other arid land shrubs, on the other hand, are not as effective in slowing snow or rain. Yet in areas with less precipitation, this adaptation provides the greatest opportunity for moisture to infiltrate. Watersheds covered with dense grass cover help the soil capture water much more effectively than watersheds with sparse vegetation.

Fish and wildlife Each watershed has a diverse mix of wildlife species—mammals, birds, reptiles, amphibians, and invertebrates. Plant communities influence which species are found in a particular water shed. Plants, in some form or another, meet the basic habitat needs of food, water, shelter, or space for most all forms of wildlife. And, all wildlife species, large or small, become part of the interrelationships found within a watershed.

Some wildlife never leave their watershed residence while others move among several adjoining watersheds or even migrate hundreds or thousands of miles to live in a completely different watershed during different times of the year. Wildlife populations within a watershed may vary seasonally and annually. Migration, predation, wildlife management (like hunting seasons), or watershed management decisions (development, timber harvest, mining, recreation, agriculture) can all affect wildlife populations.

Wildlife perform a variety of functions within a watershed. Less commonly known but very important contributions include burrowing activities of animals like worms and mice. Their burrows allow moisture to penetrate deep into the soil, aiding the water storage capabilities of the watershed. Small rodents also collect and store nuts and seeds, many of which sprout and grow to provide more food and ground cover. Rodents are also an important part of many watershed food chains. Birds also help transport seeds. Dams built by beavers help increase water storage in the soil and their activities are often responsible for channel changes within a stream system.

Limited exclusively to the aquatic habitats found within a watershed, fish occupy a unique niche. Fish are part of complex aquatic food chains and, along with the aquatic organisms on which they feed, are indicators of water quality. A number of factors within the watershed control a stream's ability to produce fish food. When producers such as algae and diatoms are plentiful, the aquatic insects that feed upon them also thrive. They in turn are food for other aquatic invertebrates and fish. Overhanging streamside vegetation also contributes insects to the aquatic dinner plate.

Studies in recent years show considerable evidence that stream systems with migrating populations of salmon and trout are highly dependent on the nutrients provided by the decaying carcasses that remain after spawning.

Fish populations vary with the quantity and the quality of available water within a watershed. Streams that flow cold and clean throughout the year generally provide the conditions that salmon and trout need to be healthy and productive. Human management activities can affect the quantity and quality of water in streams.

Precipitation: The greatest factor controlling streamflow, by far, is the amount of precipitation that falls in the watershed as rain or snow. However, not all precipitation that falls in a watershed flows out, and a stream will often continue to flow where there is no direct runoff from recent precipitation.

Infiltration: When rain falls on dry ground, some of the water soaks in, or infiltrates the soil. Some water that infiltrates will remain in the shallow soil layer, where it will gradually move downhill, through the soil, and eventually enters the stream by seepage into the stream bank. Some of the water may infiltrate much deeper, recharging groundwater aquifers. Water may travel long distances or remain in storage for long periods before returning to the surface. The amount of water that will soak in over time depends on several characteristics of the watershed:

- **Soil characteristics:** Clay and rocky soils absorb less water at a slower rate than sandy soils. Soils absorbing less water results in more runoff overland into streams.
- **Soil saturation:** Like a wet sponge, soil already saturated from previous rainfall can't absorb much more ... thus more rainfall will become surface runoff.
- **Land cover:** Some land covers have a great impact on infiltration and rainfall runoff. Impervious surfaces, such as parking lots, roads, and developments, act as a "fast lane" for rainfall - right into storm drains that drain directly into streams. Flooding becomes more prevalent as the area of impervious surfaces increase.
- **Slope of the land:** Water falling on steeply-sloped land runs off more quickly than water falling on flat land.

Evaporation: Water from rainfall returns to the atmosphere largely through evaporation. The amount of evaporation depends on temperature, solar radiation, wind, atmospheric pressure, and other factors.

Transpiration/Evapotranspiration: The root systems of plants absorb water from the surrounding soil in various amounts. Most of this water moves through the plant and escapes into the atmosphere through the leaves. Transpiration is controlled by the same factors as evaporation, and by the characteristics and density of the vegetation. Vegetation slows runoff and allows water to seep into the ground.

Storage: Reservoirs store water and increase the amount of water that evaporates and infiltrates. The storage and release of water in reservoirs can have a significant effect on the streamflow patterns of the river below the dam.

Water use by people: Uses of a stream might range from a few homeowners and businesses pumping small amounts of water to irrigate their lawns to large amounts of water withdrawals for irrigation, industries, mining, and to supply populations with drinking water.

Management objectives

in a watershed A key watershed management objective is to maintain effective vegetative cover and soil characteristics that sustain high quality water supplies. Meeting this objective enhances the usefulness and productivity of the land for other purposes. If the soil is protected and maintained in good condition, then other renewable resources that depend on this most basic form of productivity can be supported.

Timber, forage, minerals, food, and wildlife represent important watershed management considerations. Problems arise when development and use of these resources conflict with the primary objectives of maintaining and protecting high quality water supplies and promoting watershed integrity.

Land ownership is the principal institutional control of a watershed. A private individual or public management agency may be free to apply whatever measures they believe necessary or desirable on their own land. They may regulate access and prevent use and development of associated resources. Many watersheds are in public or state ownership. Unless protected by specific legislation or agreement, most are used and developed to take advantage of all resources available for the general public benefit. It is in these multiple-use watersheds that management may face the most serious conflicts and challenges. Protecting the water resources of some of these watersheds may require limiting and balancing development to provide the greatest possible benefits with the least significant disruption of the water resource watershed protection, improvement, and education.

Summary

Rivers, upland areas, mountaintops, and flood-formed bottomlands with their associated riparian areas are all part of one system. All are integrated with each other. Hillside shape controls the rate of water flow. All living elements in the watershed interact with and modify the energy flow through the system. The unique combination of climatic conditions, soil types, topography, vegetative cover, and drainage system define the specific character of each watershed. Rivers do not stop at state lines or national boundaries. The effects of natural and human processes in a watershed are focused at its outlet, wherever it may be, even if a watershed crosses another state or country's borders. Each water shed is a part of a larger watershed whose downstream portion is affected by upstream influences. Everyone depends on the resources watersheds provide. As the human population continues to grow, the demand on those resources intensifies. Human uses of land and water resources affect the ecological dynamics of a functioning watershed system, altering natural habitats as well as the quantity and quality of its water supplies. Some changes are improvements. Others are not. It is up to the public at all local, regional, state, and national levels to meet the challenges of balanced, productive watershed management.