CENTRAL HARDWOOD NOTES

Factors Influencing Water Resources

Our Nation, as a whole, has an abundance of water with an average of 30 inches of precipitation each year. About 8.3 inches, or 1,200 billion gallons per day of this amount becomes streamflow. Only 55 percent of the average annual streamflow is generally available for use. Approximately 1,900 gallons per person per day or 420 billion gallons per day are used for domestic purposes, irrigation, and industrial uses. Demands are projected to increase at 2 percent per year. In addition, water is becoming more important for transportation and recreation. Considering that 80 percent of the Nation's valuable water supplies originate on forest and range lands, it is essential for resource managers to understand basic hydrologic relations and the impacts of management.

In the central hardwood region, average annual precipitation exceeds the national average and ranges from 30 inches in the northwest to nearly 50 inches in some southern areas. Average annual streamflow in the region varies from about 10 inches in the low rainfall areas to nearly 20 inches in the high rainfall areas. Groundwater supplies are abundant over most of the region and use is relatively low. Recreational benefits and uses of surface waters in the central hardwood region are important to many people.

Water Quality

Water quality refers to the physical, chemical, and biological characteristics of water. It is a product of climate, geology, physiography, vegetation, and human influences. If human influences are few, water quality is primarily related to the natural environment through which the water passes. Natural water quality varies considerably from place to place, depending on local factors, and it fluctuates due to seasonal and periodic events.

Forest ecosystems have the ability to stabilize natural water quality characteristics, and thus yield the highest quality water available for our use. In managing central hardwood forests, we must be careful not to let human activities adversely affect sediment, nutrient, and temperature levels of stream water. Basically, the effects of management relate to changes in the surface soil and vegetation.

The Water Cycle

Water is essentially a renewable resource, as are forests. It is renewable in that it passes through the endless moving process known as the "hydrological cycle." Most of the precipitation that falls in the central hardwood region is formed from water which evaporates from vegetation, lakes, rivers, and ground surfaces. A significant amount also originates as water vapor formed over the Gulf of Mexico, and is carried north by air currents. Precipitation may replenish soil moisture, move deep to groundwater reservoirs, or enter streams and move to the ocean. Less than 1 percent of the earth's water moves through the hydrologic cycle to supply the fresh water needs. The remaining 99 percent is in the oceans and polar ice caps.

Weather and climate are the primary factors that influence the distribution of precipitation and form and sustain lakes and rivers, create deserts, and produce floods and droughts. However, the distribution of water is also influenced by geology, soils, and vegetation, and their interactions with climate and weather.

Effects of Geological Features

Geologic erosion over millions of years has produced an organized stream system, which constantly changes from natural processes and human activities. In hilly or mountainous areas, the topographic divide between watersheds or basins is easy to establish, but in flat terrain it's extremely difficult to determine boundaries. Land forms have a significant role in the distribution and yield of water. Steep slopes provide greater stormflow yields at faster rates than gentle slopes. Relatively flat areas usually provide greater recharge to groundwater supplies. Topographic divides do not always represent the water divide since subsurface features may control subsurface water flow. Consequently, precipitation, pollution, disturbance, or use in one basin may affect streamflow or groundwater in another basin.

Effects of Forest Soils

Soils play an important role in determining the amounts and distribution, as well as the quality, of water coming from forested watersheds. Soils are largely the result of natural geologic weathering and erosion processes, but they can be greatly influenced by human activities. The amount and characteristics of the pore spaces are the primary factors affecting water movement and storage. The amount of pore space largely depends on soil texture, structure, and depth. Most forest soils have relatively deep litter and humus layers on the surface. The zone beneath these layers is the active zone for insects, worms, and small mammals and contains many large macropores. These upper soil horizons generally have very high infiltration rates and water storage capacities. Thus, most of the rain that falls infiltrates into these zones, and percolates to deeper horizons, the water table, and/or moves downslope through the macropores to stream channels with little or no erosion. Water movement in the deeper soil horizons is usually slowed because of higher clay content and smaller pores. Since the thickness or depth of soil varies widely in the central hardwood region, so does runoff.

The soil water deficit or difference between the available water-holding capacity and current water content of the soil is the primary factor that determines the amount of storm runoff. This deficit is created by water loss from the soil through evapotranspiration. Usually, the soil water deficit must be satisfied by rainfall before runoff occurs, even with very intense storms.

Effects of Forest Vegetation

The vegetative canopy and the litter layer protects the soil from erosion and recycles nutrients to maintain or enhance fertility. So silvicultural treatments have the greatest potential to change or manipulate water yield. As precipitation falls on forest vegetation, its velocity is reduced and part of it is intercepted by leaves, twigs, and stems. Some of the intercepted water flows down the stems (stemflow) to the ground. Canopy interception amounts to about 12 percent of annual rainfall,

but varies a lot by seasons, foliage changes, and storm characteristics. Some of the precipitation that passes through the forest canopy (throughfall) is intercepted by the litter layer, which protects the soil surface structure from raindrop impact and reduces evaporation losses. The remaining throughfall enters the soil. Most of the water that is intercepted by vegetation and litter is evaporated, but some of it may be used by plants. The vegetative canopy also withdraws a tremendous amount of water from the soil through transpiration and growth processes. A fully stocked central hardwood forest will use about three-fifths of the annual precipitation or 18 to 30 inches in these evapotranspiration processes. So manipulating the vegetative canopy can have a significant effect on water yield from a given watershed. For example, immediately after clearcutting, most of the vegetative interception and transpiration losses are eliminated, but evaporation from the soil surface increases slightly, especially as the litter decomposes. And runoff and deep percolation are increased.

The amount of increase in streamflow associated with silvicultural treatments varies with location of watershed, amount and distribution of rainfall, relative amount of vegetation removed, time since treatment, soil characteristics, and geological features. (A more detailed discussion of the effects of forest management practices on soils, water quality, and water yield is presented in Note 11.02 *Management Practices and Water Qualify.)*

References

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Edwin R. Lawson
University of Arkansas
Department of Forest Resources
Monticello, Arkansas

George B.
Department of Forestry
University of Kentucky
Lexington, Kentucky