THE ROLE OF FORESTRY IN HYDROLOGY

By

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Whether we mechanically control water or work with it through the natural processes, we must know something of the science of three geophysical groups. The first treats of the origin and distribution of water on the earth's surface and is known under the general term of hydrology. The second, climatology, is known and is measurable. The third is thescience of the development and properties of the soil. This paper deals with the latter.

We cannot change the geology of any locality, and climate can be only slightly modified, but we can alter the vegetation which directly affects the soil profiles and, therefore, deals with the properties of soil that are basic to watershed management. Even more important is the use of the soil profile as a physical system in understanding what happens to water when it falls on the land. Movement and storage of water in the soil profile are controlled by the volume, size, shape, and continuity of the soil pore spaces and soil texture. Hence, the structure of the soil which determines porosity is the basis for understanding soil hydrology or, we can say, land use hydrology. To build and/or maintain a favorable soil structure is one of the main objectives of forestland watershed management.

Throughout the eastern United States, forests are the dominant vegetation, on over 200,000,000 acres. They are, therefore, the only practical variable we have to soil management and thus to watershed management. Any land use practice that produces a marked change in the vegetation has an appreciable effect upon the soil. We influence infiltration and storage of water in the soil through our management of the forest cover.

A basic term, "forest hydrology", covers this relationship of vegetation, soil, and water. As a hypothesis we can say that for undisturbed forest conditions there has evolved over the centuries a natural favorable balance between rainfall and the sum of runoff, evaporation, transpiration, and water stored on the surface of the soil. All of these components of the water cycle can be measured either directly or indirectly. Hence, the circulating water capital for any watershed can be estimated and carried forward at any time as a water invoice. From this invoice, we can write the economy formula for any watershed.

We can use this formula also for a basis of determining the effects of different land use practices upon water, and the costs of restoration of hydrological condition to secure desired relationships.

The yield of water from these natural processes, especially under undisturbed conditions, is of high quality and perpetual quantity with a minimum cyclic hydrograph for any particular watershed. We literally duplicate these natural processes, for instance, in treating water for potable uses. Treatment provides aeration and filtration, while the application of engineering principles controls yield and provides storage.

The question, then, becomes one of individual watershed analysis to determine whether we can feasibly restore or maintain the natural conditions of forest hydrology within the time limits or use demands of mankind.

Restoration of a seriously depleted watershed soil, that is, where only the C or part of the B horizon remains, may require 50 years in this area. We have observed in Georgia where nearly complete soil profiles were restored in 35 years. The B horizon was yet to be consolidated with those of A and C. In contrast, it is estimated to require more than 1,000 years to secure similar results with the same treatment in the cold northern Rocky Mountain area. Rebuilding means the re-establishment of multitudes of bacteria, several fungi, hundreds of organisms, and many mammals. It may mean the mechanical introduction by contour trenches of water into case hardened C horizon soils. Such soils are known to make less than 3 inches of 60 inches of annual precipitation available for plant growth.

In our eastern environment, native species treated with sensitive silvicultural measures are optimum for maintaining or rebuilding favorable soil structure and fertility. Complete soil profiles are essential for interception, infiltration, and percolation of water and in providing a home for bacteria and biotic life associated with soil fertility.

Natural or rebuilt watersheds can be expected to yield an average of 1 cubic foot per second per square mile, with an optimum of 3 cubic feet per second. Initial costs of land treatment compare very favorably against the desalinization of sea water at less than $1.00 per thousand gallons. Quality water can be expected from watersheds in good condition throughout a wide range of storm intensities. In one instance, observed storms depositing 36 inches of precipitation in 8 days on watersheds in good condition caused no over-surface flows or deterioration of water quality. Stated another way, this same storm would have produced 76,000 cubic feet per second of stream flow under "worst possible hydrological condition" from one 40,000 acre drainage, whereas, the gauge measured a peak yield of only 8,300 cubic feet per second.

On the other hand, land use demands for urban development, road construction, or any other that concentrates human or animal populations negates forest hydrology's contribution.

The standard urban development completely seals off over 30 percent of the land surface from entry of the rain drops into the soil. Resultant accelerated surface flows are disproportionally excessive, polluted beyond natural filtration, and produce floodplain conditions below that palatable to even nature's aquatic flora.

Road construction and use has a very serious adverse effect upon the natural functioning of a watershed. Besides, producing large quantities of pollutant sediment, they too often cut through the vital circulatory system of the water function. Namely, roads tend to concentrate surface flows and interflows and where cut to bedrock intercept base flows. All of which are discharged onto the soil surface or into undersized stream channels. Modern use of roads casts doubt on the dependability of water quality downstream.

The demand concentration of people or animals for purposes of recreation, forage, or shelter beyond the capabilities of nature to maintain a complete soil profile with its soft A horizon creates a condition beyond the scope of forest hydrology.

Again on the side of forest hydrology are the co-existing benefits of commercial forest products, aesthetics, recreation--including hunting and fishing, and the rebuilding of soil fertility. For instance, greater economy can be derived from natural trout habitat which provides aquatic food, shelter, migration, and spawning gravels of a certain consistency in size and depths, as contrasted with hatchery-raised trout placed in quality water but without food or other natural assets. These natural trout habitats can yield $1,000 per mile of stream per year. Good watershed management is essential to protect and sustain such conditions. Then too, where time in restoration of depleted watersheds allows, we have the economic asset of working with nature through the biological sciences. The proper prescription, properly applied nudges nature on its way with only protection costs from fire and other damaging factors as an expense.

The scientific skills required to develop and maintain optimum forest hydrologic conditions include: meteorology, climatology, geology, ecology, soil science, physics, chemistry, mathematics, plant physiology, and silviculture. The intensity of analysis and planned treatment is directly related to the number of these scientific skills brought to bear on the problem areas.