111

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MOUNTAIN WATERSHEDS AND GREAT PLAINS AGRICULTURE

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The Great Plains is an area of great variations. The climate varies from place to place from humid to semiarid. It also varies from year to year between these extremes. One year may be as wet as Ohio and other year as dry as a desert. There is seldom a shortage of sunshine or wind, but a water shortage is chronic. Farming is a perpetual gamble upon the rains. Irrigation is one way to eliminate this gamble, and has been turned to wherever water is available. Because most of the Great Plains is an area of water shortage, not water production, irrigation is generally possible only along rivers which head into mountain watersheds. The bulk of the irrigated lands of the Plains lie along the Milk, Yellowstone, Big Horn, Powder, North Platte, South Platte, Rio Grande, and Arkansas Rivers. These streams derive the bulk of their flow from high mountain areas.

As we look over a Rocky Mountain watershed we soon realize that it is far from uniform, but actually consists of many different climatic, geologic, soil, and vegetation zones. The different characteristics of these zones affect flood peaks, sediment movement, and water yields. The goal of watershed management is to obtain the knowledge needed so that the land in each zone will be managed to minimize floods, reduce erosion, and produce maximum quantities of high quality water.

The lowermost zone in the foothills is an area of brushland or of scrubby trees, such as, oak, pinyon, and juniper. Precipitation is scanty and this is a zone of little water yield. However, because of shallow soils and violent storms, it is a flash flood producing area. When the plant cover in this zone is weakened by fire or too heavy grazing, floods occur more frequently and erosion rates increase. The problem here is to maintain and increase the density of the plant cover.

Above the brushland is a zone of Ponderosa pine and Douglas fir forests. Grass covered openings and parks are frequent. The more level areas were farmed by optimistic homesteaders and most of the accessible timber was cut during the early settlement. In general, old growth trees are now found only on the steeper slopes. In Colorado, the water yield from this land is from one-third to two-thirds acre-foot per acre of land surface. This zone is frequently a high producer of sediment because of gully erosion in old fields and along old roads. Hard thunderstorms are common and aggravate the effects of past poor land use. Because of the rather low precipitation there seems to be little hope of increasing the yield of water from this part of the watershed. Much can be done, however, to increase the quality of water originating here and to diminish the destructiveness of summer storm flows. Conservative grazing, gully control plantings and structures, and other measures to maintain and establish vegetation and stabilize soil are the necessary practices.

With increasing elevation we enter forests of aspen, lodgepole pine, spruce, and fir with which are intermixed grassland parks and sagebrush areas. The winter snow pack is heavy and water yields are high. Each acre of land produces one-half to one and one-half acre-feet of water. It is here that the forester has found possibilities for managing vegetation to increase streamflow.

The uppermost layer of the watershed complex is the treeless Alpine Area. Whipped by winds, these are areas of heavy snowfall and much of the snow is piled into deep drifts and some of it is blown into the spruce-fir forests which lie below. We have little information about the amount of water yielded from this zone, but it appears to be very large and in the magnitude of 1 to 2 acre-feet for each acre of stormswept lands. The gradual melting of the deep drifts undoubtedly prolongs summer streamflow. Little is known about the possibilities of management of these areas, and in view of their importance, research is badly needed.

In the Rockies, snow is the source of most of the water reaching the streams. The seasonal cycle of precipitation and runoff for a typical lodgepole pine, spruce, and fir watershed will show how forest cover influences the water yield from snow.

Each autumn the first snows begin to fall usually in small light storms. Most of this early snow is evaporated without adding appreciable moisture to the soil which is dry due to evaporation and use of water by plants during the preceding summer. As autumn progresses into winter, heavier snowfall occurs and an ever deeper mantle of snow is stored upon the ground's surface. From every storm the trees subtract their portion, holding it on their branches exposed to wind and sun so that much of it is evaporated before reaching the ground. The snow reaching the ground packs deeper and denser, until the warmer weather of early spring begins the melt period.

Until then, the soil under the snow blanket is still dry; the water from winter melting remains in the snow, making it more dense. As the melt rate increases, snow water enters the soil, replenishing the deficit caused by last summer's evaporation and plant use. Until that deficit is met, water does not flow through the soil and streamflow does not increase, but after the soil is soaked, the percolating melt water reaches the streams, building them to peak flows in early June.

When the snow is gone, streamflow declines in a long and flattening curve. The light summer rains add little to the stream because they are insufficient to overcome soil moisture deficiencies. In autumn and during winter, the stream maintains a minimum but almost constant flow fed by deep springs.

This brief resume of the mountain water cycle indicates two possibilities for increasing streamflow. One is to increase the snow pack by reducing forest density so that less snow will be held on tree branches. The other is to decrease the autumn soil moisture deficit so that less snowmelt water is required to prime the soil.

The interception of snow by plants increases with the density and height of plant cover. The amount of interception in forests of lodgepole pine, spruce, and fir can be decreased by the harvest of merchantable trees and by the thinning of dense young growth. Both of these practices are good timber management, and, when carried out by skilled foresters, can minimize soil movement and sedimentation. The cutting of all trees larger than 10 inches in diameter increased the snow pack by 30 per cent on cutover plots of lodgepole pine at the Fraser Experimental Forest. In another test, thinning of dense young lodgepole pine stands increased snow pack by 20 per cent. These are the maximum increases and occur in the years immediately after cutting. Lesser amounts of increase can be expected with the passing of time as trees grow and new trees come in to rebuild the forest canopy to its former density. It is not realistic to expect that all of the higher forest areas could be cut over to produce a 20 to 30 per cent increase in snow pack. An orderly harvesting and thinning program will only affect a comparatively small part of the total forest area in any given year. However, a reasonable estimate would be that a 5 per cent increase in snow pack is possible. This would be on a sustained basis--when it becomes possible to place the mountain forests under management.

Measures for decreasing the autumn soil moisture deficit are also worth considering. They are feasible only on the deeper soils because, on soils shallower than 2 feet, evaporation normally removes all available water before the end of the growing season and changes in plant cover can have little or no effect. An obvious method to minimize moisture deficit is to substitute shallow rooted for deep rooted vegetation. A test of this was made in Utah where it was found that herbaceous vegetation withdrew 4 inches less water from the soil than did more deeply rooted aspen trees.

While a great deal more knowledge is needed to properly manage forest vegetation for water yields, we do have enough information to know that such management will become increasingly important as water supplies become more critical. At present, there are formidable economic obstacles hampering management of watershed forests. The market for the products of Rocky Mountain forests is poor. Until there is a profitable market for small products, such as, ties, posts, poles, and pulpwood, there can be no large scale forest management for water yield unless it is subsidized by the general public or the water users themselves.

Economists can help the cause of watershed management by developing procedures for evaluating the water resource. What is water worth in an irrigation ditch? Some have said that without the water there would be no crops; therefore, the worth of water is equal to the total crop value. Yet this cannot be a fair index because water is only one of the essentials of crop production. Neither is it correct to say that water is only worth what the farmer pays for it. There isn't exactly a free market for water and often the user pays less than it costs to bring the water to his land.

Another socio-economic factor causing water difficulties and which will affect watershed management is the concentration of our population into large urban centers. Is it really economic to convey water long distances to even larger cities? Would it be better to encourage people to live closer to available water?

Such questions are important to the forester, and the answers to them will affect his work just as the irrigation farmer is affected by what happens on our forested watersheds.