MANAGEMENT AND USE OF FOREST AND RANGE LANDS

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What can forest and range management contribute to the control and use of soil and water? Or, in the terminology of this conference, what can they contribute to upstream engineering broadly defined to include the conservation of land and inland water resources and their products.

In attempting to answer these questions for forest and range lands, it is fully recognized that other lands, and primarily those cultivated for crops have an important place. But as background, let me indicate the area in the forest and range category, with which this discussion deals. It falls but little short of two-thirds of our total land area of somewhat less than two billion acres.

It is generally conceded that regulation of run-off, whether by natural or artificial storage, constitutes one of the fundamental aspects of control and use of water. It is commonly recognized also, that the most favorable streamflow is obtained when the earth mantle of the drainage basin has a high capacity to absorb precipitation.

Research is more and more conclusively establishing the fact that the capacity of this earth mantle to absorb water varies with the condition of the vegetation upon it, and that excessive run-off from the surface and accelerated erosion ordinarily follow overuse or destruction of the plant cover. Maximum yields of timber and forage and optimum conditions for wild life and recreation depend absolutely on the maintenance of an adequate plant cover. Thus it is that in the restoration and maintenance of optimum conditions for organic resources, the forester and range manager are also creating conditions favorable for regulated run-off and for water control and use.

It is not claimed that plant cover alone will control run-off adequately in all cases. The Mississippi River was in major flood stage when first seen by white men in 1541, long before there had been any cutting of timber or cultivation of land. We have proof, however, that floods have greatly increased in number and intensity since those early days. We have proof that natural factors favorable to absorption have been greatly reduced in many drainage basins of the United States as our natural resources have been exploited. We have an accumulation of evidence showing why and with what degree of intimacy the increase in floods and erosion and the increased depletion of forest and range cover are related.

There is a growing accumulation of factual data to show that good forest and range management will largely decrease the menace of floods and the costly waste of soil erosion.

Our research is showing that forest and range management reduce excessive erosion and run-off from the surface mainly because it maintains the interacting physical and biological conditions that help to get water into the ground. This process is influenced by (1) a porous soil, that permits percolation to the water table; (2) a supply of humus that prevents the clogging of soil passageways by fine particles of clay and silt, and that also absorbs some of the water; (3) a litter cover that protects the soil from mechanical action of rain and flowing water; and (4) the plant cover, that produces the litter, binds the soil with its roots, provides channels for water to pass through the surface soil, spreads and delays surface run-off, and intercepts and lessens the destructive impact of rainfall. With the wild life supported by the vegetation, which may influence run-off one way or the other, I will not attempt to deal.

Deplete or destroy this plant mantle by overuse, and litter and humus are not renewed; the impact of rain and the rush of water from melting snow are unopposed; roots no longer hold the soil; unobstructed run-off sweeps away the accumulated litter, humus, and topsoil; silt is impacted in the soil pores, practically halting infiltration; water rushes down the slope directly into the streams; absorption, infiltration, and percolation to underground storage are largely nonoperative.

The function and importance of litter in maintaining absorptive conditions in the soil is shown by laboratory tests in which 2 percent of silt in water reduced percolation into an unprotected soil by 90 percent. Field tests show that rainfall filtered through litter and humus causes no such stoppage; in one series of such tests, run-off from soil surfaces so protected was, at worse, 30 percent and, at best, 6 percent of that on bare soils. Even on compact soil with a 10 percent gradient, forest litter cut run-off to one-half and reduced soil loss to little more than 1 percent of that on bare soil.

The plant litter and roots not only protect the porosity of the soil; they are responsible for much of it. They supply the food and shelter for a teeming soil life which helps to incorporate organic matter into the soil and so insulate the soil particles from each other and accentuate natural soil cleavages and interstices through which water may pass. In this way a soil well-clothed with a vigorous grass, shrub or tree cover becomes porous and absorptive. To maintain or restore these conditions is a crucial objective of both forest and range management.

Investigations are also showing that plant growth shelters the soil and reduces evaporation. It holds the loose litter and humus from washing under torrential rains or sudden snowmelt. It slows up the rush of waters that the soil cannot absorb, and so prevents the formation of gullies which otherwise would gather and quickly discharge water from the

Slopes. With adequate forest cover, snow will remain on the ground from a few days to several weeks longer than in the open. In upper New York in March 1936, when heavy rainfall, deep snow, and warm winds combined to produce many floods and all snow was gone on the open fields, there was still 12 inches of snow in adjacent beech-maple forests.

The contrasts between what occurs when cover is reduced or stripped off and the results when vegetative cover is protected or restored through management is strikingly brought out in many tests of surface run-off and erosion in outdoor forest and range laboratories. Let me give examples of the effects of cultivation of watershed lands; of fires; and of unregulated timber cutting and grazing.

The severe Yazoo River flood in Mississippi in 1931-32 followed 27 inches of rainfall on the watershed, an appreciable part of which had been cleared. Sample plots showed that 62 percent of the rain ran off immediately from cultivated fields and 54 percent from abandoned fields, but in scrub oak forests only 2 percent ran off, and under an undisturbed oak forest only 0.5 percent. In Wisconsin an average of 3 percent of the total summer rainfall ran off beneath hardwood forests of varying density, and about 7 percent from wild pastures; whereas from cultivated hay fields the run-off was nearly 18 percent, and from fallow land 25 percent.

Protection against fire is a practically universal requisite in forest management. Fire – even a light fire – reduces the ground litter and plant understory and may materially accelerate erosion and surface run-off. A hot fire often destroys the entire plant cover, and consumes the litter as well as a large part of soil humus. Serious acceleration of washing, gullying, and silting ordinarily follows.

Forest Fires in an old-growth pine-hardwood forest in the southern Appalachians increased surface run-off on an average by 10 times over that of unburned forests of the same type, and as much as 32 times in individual storms.

In the Sierra pine region a 5-year record shows that surface run-off from repeatedly burned plots was from 31 to 463 times that from comparable unburned plots. The yearly erosion from the burned plots was 22 to 239 times that from the unburned.

During prolonged rains at Guthrie, Oklahoma, in 1930 the run-off from burned-over ground was nearly 28 thousand gallons of silt-laden water per acre, in contrast to a loss of 250 gallons per acre of clear water from the same soil and slope under unburned forest.

The form and extent of timber cutting also materially influences surface run-off and erosion. During March 1936, when some of the Tennessee tributaries reached flood stage, the maximum rate of discharge from a small drainage covered with hardwood forest was 18 cubic feet per second per square mile. From an adjoining clear cut drainage the maximum discharge was at a rate of 232 cubic feet, despite the fact that the basin had been partially reclothed with herbaceous cover.

One of the most common forms of poor range management is the attempt to graze more livestock than the range can carry. That range depletion inevitably follows has been more conclusively shown. Tests on Boise River watershed ranges in different stages of depletion and supporting different kinds of vegetation showed that typical bunchgrass virgin ranges, subjected to artificial rainfall, yielded only 0.4 percent surface run-off and but 6 pounds of soil per acre. Similar tests on overgrazed and depleted ranges averaged 45.4 percent run-off and 7,382 pounds of soil per acre. On the most severely depleted ranges, run-off from the equivalent of 1.80 inches of rainfall, applied as the rate of 1 inch in 16.6 minutes, amounted to 60.8 percent; and soil was removed at the rate of 15,280 pounds per acre, or 2,500 times more rapidly than from the well managed undepleted range.

This Idaho study substantiates the results of earlier research on range lands of the Wasatch Plateau where, during the period 1915 to 1929, restoration of the density of the range cover to 40 percent from 16, by regulated grazing, resulted in a 64-percent decrease in surface run-off from torrential storms and a 54-percent reduction in soil loss. During the past two years treatment of plots has been reversed, and already the run-off and erosion figures are varying the effectiveness of increased plant density.

Small scale results are substantiated by tests on drainage of several thousand acres.

The normal run-off from two forest and chaparral-covered watersheds in southern California was measured for seven years. One of the areas then burned over. In the next year, while the unburned area reacted normally, run-off increased 231 percent from the burned watershed and the maximum daily discharge increased 1,700 percent.

The disastrous flood of January 1, 1934, in Los Angeles County, California, corroborated the research findings on numerous experimental plots. About 12 inches of rain fell during 2 ½ days. From one drainage of 4,000 acres, nearly all of which burned a few weeks earlier, came a flood which destroyed 34 lives and caused damage estimated at $5,000,000. The maximum flood discharge from the burned basin reached 1,100 second-feet per square mile, and altogether about 67,000 cubic yards of eroded debris, per square mile of watershed were carried to the valley. From a nearby unburned canyon, with the same precipitation, the peak flow was at the rate of only 50 second-feet of water and the debris discharge was at the rate of 56 cubic yards per square mile of watershed. The run-off ration was, therefore, about 22 to 1 and the debris ration more than 1,100 to 1.

Results on large areas of poorly managed range lands parallel those from forest lands.

In northern Utah, beginning in 1923 and continuing to 1936, the steep Wasatch canyons have flooded with increasing frequency and severity.

A single canyon flooded four times in the summer of 1930, destroyed several homes, piled boulders weighing up to 200 tons on orchards and truck gardens, and caused several hundred thousand dollars damage to valley lands and improvements. Intensive examinations proved conclusively that the floods originated on unbelievably small upstream areas denuded by overgrazing. The valley sediments gave unmistakable geological evidence that no floods comparable to those of 1930 had occurred in the 20,000 years since ancient Lake Bonneville receded from the valley floor. The volume of debris from those recent floods exceeded all that produced during 20 centuries of normal erosion and deposition.

During the past few decades floods of this nature have occurred in such numbers throughout the West, in the torrential rainy season, that the local western newspapers have carried almost daily accounts of loss of life and property damage from walls of water and mudflows originating on depleted range lands. Between Salt Lake City and Ogden, for example, 15 canyons on the Wasatch front have flooded seriously in the last 15 years.

The primary justification fro research is human betterment. How then shall we best apply on forest and range lands for the highest human good such findings as those indicated, - and they are merely random selections from the rapidly growing number already available – together with other observational findings and the results of many years experience in actual forest and range management.

The application of such findings and experience in forest and range management has two great advantages. The first is the opportunity to attack the erosion and flood control problem at its sources, to prevent enormously destructive forces from starting rather than to attempt to control them after they have been unleashed.

The second advantage is that the vegetative cover, whether range or forest, is the only natural factor that man can materially modify. Such other factors as climate, geologic formation and topography must be taken as they are.

One important phase of our application should be, through land planning, to draw the best possible lines between lands which should be retained in forest and range and those which should remain in cultivation, and as far as possible to correct mistakes and rectify maladjustments of past trial and error, and to prevent repetition of mistakes and maladjustments.

Further destruction of forest and range watersheds could be stopped And in most cases satisfactory watershed conditions restored and maintained by fire protection and non-use. This, however, would needlessly deny all other uses for one. Watershed use is rightly multiple. It should yield usable supplies of water for industrial and domestic purposes, irrigation and navigation, and it should offer protection against floods rather than constant danger from them. But except for very limited areas, it should

Also include the production and use of timber, forage, wild life, and many other resources. It should provide essential recreational facilities. Permanent civilization depends upon the sustained production of these resources and services.

Continued full use of forest and range watershed land depends, however, upon satisfactory balance between destructive forces of erosion and the constructive processes of plant growth and soil formation. I do not mean that we should attempt to regain the exact balance of virgin forest or range for that would ignore many demands of human use; but a balance that will maintain for wise use all the basic resources of the land.

In the arid and semi-arid west the maximum yield of usable water is essential because water is the key to the entire industrial and social structure. The theory that on such watersheds water-consuming plant cover should be eliminated will not hold. We have ample evidence that disastrous floods and erosion result from denudation. Many watersheds are steep, soils relatively thin, and with torrential rains and heavy snows the erosion and flood potential is critically high. The small gain, if any, in usable water would never compensate for the flood and erosion problem created by denudation. Forest and range management in the semi-arid west must accept as a first consideration the necessity for protecting watersheds from erosion and rapid surface run-off.

In humid sections forest watershed management to increase total water yields is largely unnecessary. But efforts to decrease high peak flows and if possible increase low stream stages by all feasible forms of upstream engineering are a critical need.

More specific application of research findings and practical experience in forest management may for the purposes of this discussion be reduced to a few major operations: protection against fire, reforestation, and methods of cutting and cultural operations in timber stands to increase the quantity and quality of the product and also the effectiveness of erosion control and streamflow regulation.

On an average during the 5-year period (1926 to 1930), some 41-1/2 million acres of forest land were burned over annually in the United States. One reason for this excessive acreage is that 190 million acres, largely on important drainages, lack any organized protection. A primary requisite is that organized protection be extended to this area. Watershed requirements as well as those of timber production make it essential also that the standard of existing protection on approximately 320 million acres be raised as rapidly as possible.

Reforestation is a second major form of forest management. Any constructive program requires the rehabilitation of lands submarginal for agriculture. Such land is now under profitable cultivation or has been abandoned because erosion has removed the top soil or because productive capacity is naturally low. A portion may be suitable for pasture and some, with protection, will reforest naturally, but the remainder will require

Planting. This in aggregate might involve as much as 50 million acres. An additional area of at least 10 million acres of cut-over and burned-over forest land will not reforest naturally within a reasonable time and should be planted to re-establish a watershed cover as well as for other purposes.

Much of our remaining forest area is only partially productive for timber growing and ragged irregular stands are not fully satisfactorily meeting watershed requirements. Better methods of timber cutting and various forms of management are called for. For example, about 10 million acres of forest land were being cut over annually during the years immediately preceding the depression. Through a combination of cutting and fire, an average of 850,000 acres annually were practically devastated and made subject to erosion and rapid run-off. On only a small part of the remainder were systems of cutting followed that were wholly satisfactory either from the timber culture or watershed management standpoints. The total area needing more intensive management runs into hundreds of millions of acres.

Unfortunately, mismanagement is not confined to our forest lands. The natural plant-soil-water balance has been seriously disturbed on from 85 to 90 percent of the 728 million acres of range land. About 60 million acres of major water yielding importance and an additional 292 million acres of low water yielding capacity are contributing heavily to the silt burden of major streams and intensifying the problems of water use. Unsatisfactory conditions on an additional 237 million acres are aggravating the difficulties in local water economy.

By far the most important step needed to stop further destruction is the reduction of numbers of domestic livestock to a level which will start the range on the upgrade. This will require reduction of some 40 percent in present numbers. Systems of grazing worked out by research and experience which will promote the re-establishment and maintenance of the natural plant-soil-water balance by natural revegetation should supplement such reductions.

As on forest lands, extensive watershed range areas are so seriously depleted that artificial reseeding will be necessary. About 38 million acres need this treatment.

After segregating all the land on which grazing may be continued, an area of some 11-1/2 million acres will remain on which, because of its critical importance in erosion control and water conservation, grazing should not be permitted. The area is characterized by such conditions as steep slopes or loose soils or difficult growing conditions. Usually such large lands are submarginal for grazing so that nonuse involves no permanent waste or forage.

Engineering must play an extensive part in good forest and range management, and in the control and use of water.

Temporary works, such as silt-holding dams and drainage terraces, are needed in many instances to make possible the restoration of plant cover. Such structures as small reservoirs, retarding dams, the restoration of unwisely drained lakes and swamps, revetments, and other forms of bank control, spreading works, etc., should supplement what forest or range cover alone can supply in water and erosion control. Many of these will improve wild life environment, increase recreational facilities, and provide small water storages for irrigation and small hydro-electric developments. Even in the high rainfall country engineering projects such as drainage pits and terraces to improve on the best that nature can do in the conservation of water may be desirable.

Land ownership presents one of the most difficult problems in a coordinated program of forest and range management. This is because of the long standing American philosophy that all land, regardless of its character and productivity, should be privately owned. It is also because each owner has been and is still largely free to manage his land as he pleases, regardless of how this may affect either the public interest or his own. Since the private owner may not be able to take remedial action or may not be interested, various forms of State and Federal cooperation have been devised and applied. In this field a big undertaking still lies ahead. Furthermore, the possibility should not be entirely overlooked that the American public may become sufficiently aroused to take drastic action to insure the management needed in the public interest.

Even though everything is done to encourage and assist such a program on private land, areas will remain on which satisfactory results cannot be obtained under private ownership. These include lands of especially high public value for flood and erosion control, or where the cost of maintenance of plant cover and necessary engineering renders the land submarginal for private ownership, or areas in such stage of deterioration that individual enterprise cannot expect to rehabilitate them. Here State and federal ownership must step in. A start has already been made by retaining in Government ownership a large part of the public domain in the West and by land acquisition. The best information now available indicates that it will be necessary to increase State and Federal ownership of forest lands in the entire United States by approximately 150 million acres, and of western range lands by 125 million acres.

Last, but not least in any constructive program of forest and range management is the need for additional research on all phases of management. This need should not delay action along the many lines for which workable information is already available, but provide instead for increasingly intensive requirements of the future.

On the strictly watershed phase at least 25 major investigative installations or projects are required, each including and ranging down from watersheds of several thousand acres to small sample plots and laboratory tests, and designed to ascertain for its own peculiar set of conditions all of the facts of the cover-erosion-water relationship. To meet highly diversified conditions of cover, climate, soil, topography, Geological formation, and forest and range economy in the United States, at least 25 additional projects, less intensive in character, will also be required.

In order to obtain detailed information on existing conditions as a basis for appropriate planning and action, these projects must be supplemented by watershed surveys such as those provided in the recently approved Omnibus Flood Control Act.

The considerable progress already made on many phases of the watershed problem have not been overlooked and should not be minimized, even though time limitations have prevented more detailed reference in this very sketchy discussion of a future program.

Forest and range management constitute only one phase of upstream engineering. They must be integrated and correlated with all other phases. But taken alone they must deal with an enormous land and water resource and a variety of products and services. To carry out any program which measurably approaches our present and foreseeable future national requirements will challenge the best efforts of any scientific and professional groups, among which the forester and range manager, and the engineer, must take the leading part.