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Watershed Aspects of the New York Water Supply Problems[1]

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WE ARE INTERESTED in New York's watersheds, not only because they belong to one of the greatest surface water supply systems in the world but also because they furnish examples of all the varied watershed problems that are encountered in the eastern United States. On every drainage area there is to be found both private and public land. The land use ranges from highly improved dairy farms to state park and forest preserves, and these occur over a wide variety of topography and geology.

Greater New York requires about 800 million gallons of fresh water a day. Mid-summer uses have been as high as 1,400 million gallons a day. To supply this amount of water would require the average flow of one cubic foot per second per square mile from 2,160 square miles. For 800 million gallons per day, 1,200 square miles would be required. The combined area of all New York watersheds, excluding the East Branch development not yet completed, is only 1,250 square miles. During the summer and early fall months, July through October, New York streams yield on the average less than 1 cubic foot per second per square mile. Sometimes the daily average flow for an entire month has been one quarter of this amount, or less. The months of March and April produce the largest yield, sometimes as much as 40 percent of the entire annual runoff. Although the highest rainfall based on the 80-year record of the Croton area occurs during the months of July and August, these are the months of lowest amount of runoff.

Under these hydrologic conditions it is obvious that reservoirs must be employed capable of storing a 3- to 5-months' supply.

Any form of watershed management that would increase the amount of stream-flow only a small percent during the early summer would be of extremely great value. Whether or not any such increase can be brought about by watershed management techniques is a subject for considerable practical interest.

The Croton System

The watersheds now supplying the metropolitan area of New York City have benefited by the long and progressive history of forest conservation in the state. Interest in protection of the city water supply appears to have been a factor in the gradual increase in the amount of forest on the Croton watershed following the construction of the original Croton aqueduct in 1842. Within the present forests of the Croton watershed are to be found numerous old stone fences that once marked the boundaries of cultivated fields. Abandonment of these fields was in part a conscious effort to reduce erosion on the land areas furnishing the New York water supply. Some of the abandoned fields have grown back to trees naturally and some have been planted.

This change from cultivated land to forest on the Croton watershed was associated with the development of summer homes and country estates. Nevertheless, there was a clear-cut public opinion that the watershed should be protected by forests, and during this period many tree plantations were established on private estates within the Croton drainage.

Considerable land adjacent to the reservoirs was acquired by the city of New York at the time the reservoir sites were purchased. In 1917 extensive plantations of Scotch pine were established on these city-owned lands. One objective was to reduce the amount of hardwood litter getting into the reservoirs; however, this objective was not carried through completely because today most of the reservoir shore lines are still occupied by hardwood forests.

Today the entire Croton watershed has an excellent vegetative cover throughout. Such land as now remains in gardens, fields, and pastures is well maintained in a state of fertility and practically no serious erosion is encountered.

Cutting Not Permitted on City-Owned Land

Commercial cutting was not permitted on any of the municipally owned land within the Croton watershed. As a result, the 1917 plantations became exceedingly dense and developed evidence of stagnation and insect injury before sanitation cuttings were considered necessary to the health of the stands. Exemption of the city-owned lands from harvesting of wood products has been considered to be in the best interests of the watershed, although the policy has sometimes been questioned. For example, it has been suggested that a wide meadow strip of grass and herbaceous plants would be more suitable than trees for the protection of the reservoir shore lines.

Actually no one has the answer of how best to manage tree plantations established solely for watershed protection. It is reasonable to believe that, for such plantations, prescriptions should be made as to species composition and spacing, primarily to achieve restoration and maintenance of better soil condition. These recommendations might differ considerably from those usually followed on plantation establishment for the locality. Similarly, the subsequent management on the stands may call for special treatment.

On watersheds where the necessity exists for obtaining the greatest possible water yield, it is reasonable to believe that the total amount of transpiration draft should be kept to a minimum where this can be done through practical means. On forest lands this can be approached by maintaining prescribed stands as to composition, basal area, and age class, and by removing unneces-

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sary vegetation, such as dense streambank and shore-line vegetation.

Complete Closure Is Not Watershed Management

In any general consideration of the subject, the question frequently arises as to whether or not closure to other uses is always the best procedure for areas set aside for water production. Particularly where its previous history has greatly altered the original forest, judicious manipulation of the remaining stand will expedite and accelerate restoration of natural conditions and associated soil organic layers. The closure of a forest to other uses certainly does not in itself create a natural area.

Even in relatively undisturbed, natural forests complete closure may not be the best policy in the interest of water resources. For example, on soils where the normal wind-throw of overmature timber turns up quantities of subsoil with the exposed roots, the best solution would be the cutting of overmature forest trees prior to being wind-thrown. Still another example is that the decay of tree roots may be less favorable to water percolation and storage where the trees die naturally than where the stems are cut. Stream meanders and bank-cutting are often associated with natural forests where the gradual encroachment of vegetation restricts or changes the course of the stream.

There are, of course, always some areas with steep slopes and shallow soils that must not be disturbed in any way whatsoever, and many such areas are frequently encountered, particularly in mountainous country.

All the facts are not yet known as to the possibilities of stand management for both wood products and maximum usable water yields. For purposes of discussion the point may be raised that an alternate to complete closure of watersheds would be to grow and harvest wood products under careful supervision on productive sites, and to exempt from cutting poor sites of steep slopes and those of shallow soil that are difficult to harvest, or that naturally have a sparse cover. In harvesting wood products from watershed areas it is obvious that logging technics and the construction of roads must be so planned and prescribed that unnecessary soil erosion does not take place. Silvicultural practices must be followed that do not disrupt the normal biological activities within the soil itself. With the improved technics of mechanical logging that are available today, it should now be well within the realm of reality to remove wood products without serious disturbance to the forest floor.

Wood products have been harvested on the watersheds supplying water to the city of New Haven, Conn. Similarly, the commercial timber was removed from the watershed supplying the town of Glen Falls, N. Y. The real problem seems to be one of using reasonable care in protecting the water resource.

The Catskill System

The tremendous expansion in water needs by the metropolitan district of New York at the turn of the century called for further watershed developments in the Catskill Mountains. Here, a complex land-use pattern was encountered. The Catskill watersheds included highly improved farms and well-developed pasture lands. Land values were particularly high along the stream valleys, and the public acquisition of improved land appeared to be prohibitive. However, a considerable part of the mountain lands of the Catskills was acquired as a state park and forest preserve under legislation that precluded any further exploitation through cutting. This procedure is in keeping with the policy to maintain these preserves for recreation, this being considered to be their greatest usefulness to the people of the state. Thus, the forest preserve lands in the Catskills are excluded from further consideration in this paper.

Early records indicate that the original forests were made up of a birch-beech-maple association on the lower slopes and heavy admixtures of white pine and hemlocks on the upper slopes and ridges. Sufficient data are not available to draw any definite conclusions at this time as to the relative efficiency for watershed protection of the existing forest stands on the Catskill Mountains, as compared to other plant species or combinations of species and age classes. Information now available indicates that the fire-damaged forest, characterized first by gray birch, provides a less desirable litter and humus covering on the soil than did the original forest. Due to heavy cutting and repeated fires in the past, white pine and hemlock have largely disappeared. It is conceivable, however, that by the proper grouping of additional conifers on the upper slopes and ridges, it would be possible to influence the amount of snow accumulation during the winter months and to delay snow melt in the spring. At the present time, the last remaining snowbanks in the spring are those protected by the few clumps of hemlock that still exist. This is a subject that also calls for research, and further consideration after additional data become available.

Pasture Land Improvement Urgent

A large amount of the Catskill watersheds is in pasture. Much of the milk produced is shipped to New York City. For example, a land-use survey of the Schoharie watershed showed that about 44 percent, or 88,000 acres, are in grassland. Most all of this pasture is classified as being on steep or sloping land, and 80 percent showed moderate erosion. A portion is relatively unproductive, does not have a good sod covering, and is heavily trampled. From the point of view of watershed protection, this type of pasture land is definitely undesirable. The greatest objection to overgrazed and trampled pasture land in the Catskill region is that during the winter months the surface soil freezes solid to a considerable depth and becomes almost impermeable to water. At the time of spring snow melt this cement-like soil does not permit rapid infiltration or perco-

lation of water. Thawing takes place first in the surface few inches only, and this loosened soil is easily eroded. When spring rains occur, there is a great amount of storm water and snow melt that cannot enter the soil. It moves to the stream channels over the surface of the soil, and is the cause of spring floods and reservoir sedimentation. That this type of surface storm flow is definitely highly erosive is shown by the numerous gullies now present on the steeper, pastured slopes of the Catskill watershed.

In contrast to the heavily used pasture land, the soil under good forests does not freeze solid but permits the easy infiltration and percolation of water throughout the winter and spring months. Obvious changes in present land-use patterns are necessary in the interest of watershed protection. Good pastures should be retained, but steep and unproductive pastures should be eliminated. Fencing cattle off from steep slopes and from areas of thin soil is a definite step in watershed improvement.

Most of the specific details of pasture improvement through the use of fertilizers, seeding, regulation of seasonal grazing, and degree of stocking are rather well known by specialists in this field. The application of better technics to the steep pasture lands within the city watersheds can be encouraged through leadership and organization of the landowners to take advantage of services already available. Improvements that will provide better watershed protection will in every case mean greater profits to the landowners.

Public Assistance and Acquisition

There still remains a problem of designating what land not now in forest on the Catskill watersheds should be planted to trees in the interest of watershed protection. Certainly, unproductive pastures on steep, sloping land must be improved for infiltration and water storage. The actual area requiring planting to trees is not so great but that it can all be planted within a few years through the cooperation of public and private agencies. It is reasonable to believe that a certain amount of this unprofitable pasture land should be still acquired and administered under public ownership.

Technical advice and services in the field of forestry are available. At the present time New York has an organized state forestry program. Under the Forest Practices Act, district foresters and their assistants furnish cooperating landowners with advice on planting, marking, and selling wood products. Agencies concerned with forestry and land management direct their efforts toward promoting the best possible forestry and farming practices. The objective is to recommend good economic practices rather than any specific program of water-resource management. One reason for this is that the scientific principles of water-resource management are either not known or the knowledge has not been made available to those who are practicing forestry on the ground. Another reason is possibly that, in general, the private landowner is not cognizant of his public responsibility for water-resource conservation.

Problems for Consideration

One must conclude that forest conservation measures carried out in the past have definitely contributed to the development and protection of the New York watersheds. However, additional measures are needed at present because of new problems that are constantly arising. Generalizations are likely to be misleading, and recommendations must be expressed in terms of specific land areas and problems to be solved. Detailed land-use surveys and actual field examination of specific land-use conditions are a primary requisite. Consequently, this would be the first step in developing an overall program for the practical management of the New York watersheds.

From such information as is now available, the following watershed problems, given in order of their over-all priority, merit consideration in the administration of the drainage areas furnishing New York's water supply:

1.—Land-use adjustments directed toward reduction of erosion and storm runoff, increase in ground-water storage, and water yield.

a.—Elimination of problems caused by steep, unproductive, and overtrampled pastures within the Catskill system.

(1)—Through pasture improvement and pasture management.

(2)—Through fencing and restricted grazing.

(3)—Through fencing and planting to trees.

(4)—Through public acquisition and management.

b.—Public acquisition of strategic and critical areas other than pasture lands and their management in the interest of water resources.

(1)—For streambank protection and channel control.

(2)—For protection of lands now submarginal or unproductive under present management.

(3)—For control of steep slopes, areas of thin soils, and sparse cover.

2.—Harvesting of wood products on private lands. Improvement of harvesting technics so that wood products can be removed without damaging water values.

3.—Management of forest lands.

a.—Stand improvement directed toward creating increased infiltration and water storage.

b.—Stand management directed toward the accumulation of snow and delay of snow melt in the spring.

c.—Stand management directed toward reduction of transpiration draft by cutting or restricting growth of existing cover.