

FORESTS AND FLOODS

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649239610

Forests and Floods by B. G. Northrop

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Edited by Trieste Publishing Pty Ltd.
Cover @ 2017

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BY B. G. NORTHROP, LL.D.

[From Report of Secretary of Connecticut Board of Agriculture.]

HARTFORD, CONN.:
THE CASE, LOCKWOOD & BRAINARD CO., PRINTERS.
1885.

ters. They were attributed to the extensive use of tile drains. But in both 1883 and 1884 these floods occurred when the ground was frozen. The drains were therefore inoperative.

That so simple a cause as forest denudation should produce such disastrous results seems at first incredible. It is only when the vast areas contributing to a single river are considered, that the proof of the forest theory seems clear and convincing. Take the Ohio River for illustration. The area drained by it is 214,000 square miles, or twenty-two times as large as that which in Connecticut, Massachusetts, Vermont, and New Hampshire is drained by the Connecticut River, or an area more than forty-five times as large as that of the State of Connecticut, an area which includes portions of New York, Pennsylvania, Ohio, Indiana, Illinois, West Virginia, Virginia, North Carolina, Georgia, Alabama, Mississippi, Tennessee, and Kentucky. The length of the Ohio is about 1,000 miles, and that of its ten leading tributaries nearly 4,000, and that of the many minor affluents as much more. The smallest influences working over such immense regions, and ultimately combining in one stream, may enormously swell its volume.

How forests conserve the water supplies and lessen floods is an important question. I do not affirm that extensive denudation decreases the *total* rainfall of any *large* country; that is still an open question. But forests do influence the atmosphere as to temperature, humidity, and the distribution of rain. European foresters, after wide and varied observations in many countries, substantially agree in the conclusion that six per cent. more rain falls yearly in the forests than in the open fields; that, of the total rainfall, ten per cent. in the forest is caught by the leaves and reaches the earth gradually, and that the evaporation in the open country is five times as great as in the woodlands. The dense carpet of leaves in the forest creates an absorbent, sponge-like surface. This leaf-mold, usually several inches and sometimes several feet in depth, lessens the freezing of the ground, and absorbs and retains the rain and melting snows that thus gradually soak into the soil. Protected from the sun by the forests and dense underbrush and moss, the snow melts more slowly than in the open field. Decaying limbs and trunks of trees, bulging roots near the surface, and a thousand other obstacles, check the water on the hillsides till it can filter into the soil for the gradual feeding of the springs and rivers.

The roots of live trees have a remarkable power to penetrate into hard subsoil, and, by their mechanical action, lift or break it up, forming deep conduits for water, which thus penetrates through even hard-pan into more porous strata, or subterraneous reservoirs, insuring the permanence and regularity of the natural springs. When the forest is destroyed, this mechanical action of live roots ceases, and the orifices previously opened become obstructed. If the denuded lands are burned over, as often happens, consuming the leafy mold, the rainfall and melting snows rush down the hills as from a roof, washing away the soil and stripping the face of the mountains.

The investigations of the Forestry Division of the United States Agricultural Department, in reference to the diminution of forests and consequent inundation of rivers, are already very complete in regard to the State of Ohio, being based largely upon official data as given by counties. The forest area is given as it existed in 1853, 1870, and 1881, and shows a constant decrease in every county, and, what is specially significant, that decrease has been most rapid in the period since 1870. The number of acres in forest was—in 1853, 13,991,228; in 1870, 9,749,333; and in 1881, 4,732,092. The amount of clearing from 1870 to 1881 was 5,041,086 acres, or 799,192 acres more than the total area of woodland remaining in 1881. The total value of the lumber product of the State of Ohio for the census year ending May 31, 1880, was \$22,056,003, and the consumption of lumber is increasing to meet the demands of a growing population. At this rate another decade would clear all the forests of the State, and leave a large deficiency to be supplied from other States. The percentage of area in forest was in 1853, 55.27; in 1870, 38.51; and in 1881, 20.79. Hence Commissioner Loring, of the United States Agricultural Department, says: "The forest area of Ohio is already below the limit which is consistent with the highest salubrity of the atmosphere, as well as the greatest prosperity of the agricultural and commercial interests of the State." According to recent official reports, several of our States have less than the rule of the Duke of Burgundy requires: "One-third to the hunter, two-thirds to the husbandman." Vermont, Massachusetts, and Connecticut have less than a third of the farm-lands in forest; New York, twenty-two per cent.; New Jersey, twenty-four; Pennsylvania, twenty-nine; Delaware, twenty-six; Ohio, but twenty-

one. Originally, Ohio, eastern and southern Indiana, the northern portion of the Lake States, and the whole of the Eastern, Middle, and Southern States, except a large portion of Texas and a few prairies in the southwest, were well wooded. From North Carolina to Louisiana nearly six-tenths of the farm area is still wooded, and in ten States of the south and southwest the proportion is five-tenths or more. The last census shows that in nine of our States and Territories it is below ten per cent.; in five, between ten and twenty per cent., and in eight, from thirty to forty per cent. Yet the forest lands of the United States amount to less than one-fourth of the entire area. This proportion of wooded area is less than in eastern, northern, and central Europe, and is very unequally distributed. Norway has two-thirds of its area wooded; Sweden, six-tenths; Russia, nearly one-third; Germany and Austria, one-fourth. The countries on the Continent having less forest areas arranged in order of proportion from twenty-two down to five per cent., are Italy, France, Switzerland, Holland, Spain, and Portugal.

At the opening of its last session, the attention of Congress was called to the subject of Forestry, for the first time in any Presidential message. The last census, as well as recent floods, show this to be a question of national importance. For the single year, ending May 31, 1880, the total value of our lumber products alone was \$233,367,729.* The census maps are so prepared as to show the extent and character of the timber growth in the States and Territories. Says N. H. Eggleston, chief of the Forestry Division: "The census map of the western portion of West Virginia shows at a glance that every affluent of the Ohio river has been stripped of the forests through which it formerly flowed. The map of Pennsylvania shows the Alleghany and Monongahela flowing, through their long courses, almost unshaded by forests. The same may be said of other large tributaries of the Ohio. With such facts, can we doubt the cause of the devastating floods of the Ohio? It was, simply, that over this great river basin, embracing half a dozen States, the soil had been so far stripped of its trees, and its

* The chief of our National Forestry Division says: "The total value of *all* the annual products of our forests is not less than \$800,000,000, out-measuring the value of our great cereal crop, that of corn; more than that of our crops of hay, rye, oats, barley, buckwheat, potatoes, and tobacco, taken together, and ten times that of all our mines of gold and silver."

leafy covering, that it could no longer retain, even for a few days, the rainfall and dissolving snow, and so the combined waters of this great area slid down the hillsides, and into the river channels at once. If we would avoid destructive floods, and corresponding droughts, we must protect our forests. The cry of the flood is, "Restore your forests;" and the broken dams of the manufacturer, the desolate fields of the agriculturists, the checked channels of commerce, and the pitiful faces of the thousands who have become the victims of poverty and disease by reason of the floods, repeat the cry, "Restore your forests."

According to the last census, six per cent. of the land in Connecticut, included in farms, is reported as unimproved—that is, not cultivated, pastured, nor in woodland. This is a needless waste, for we have no lands on which trees of some kind cannot be grown. The practicability of reclaiming our waste lands is denied by some, and doubted by many. But the 10,000 acres of thriving forests on Cape Cod, planted thirty years ago, on sterile sands, the extensive and thrifty woodlands, similarly planted at Wood's Holl, show what may be done on the worst barrens of New England. The sand plains in Connecticut, and all along our Atlantic coast, were once well wooded. Sixty years ago, the dunes along Lake Michigan were covered with trees. But this reclamation of barrens has been carried on most extensively in France. Along the coast of the Bay of Biscay, the dunes, composed of minute silicious sand, stretched over a hundred miles. The prevailing and most violent winds, there, are from the west and southwest. Hence, at low tide, the sands were driven, as along an inclined plane, up the slopes, and thus formed those growing dunes ranging from 100 to 300 feet above the level of the sea, which, moving inland, created great desolation.

Nearly a century ago, Bremon tier published a memoir on the reclamation of sand dunes. Under the patronage of the French government, he there successfully introduced the planting of the maritime pine. Those plantations have been perseveringly continued from that time to the present, and now cover 100,000 acres in that single district. Not only has this wide area been reclaimed, and made productive soil, but a still greater extent of fertile land has been rescued from the destruction threatened by the advancing sand-hills. In speaking of the monument erected to Bremon tier, by the French government, in this now stately forest, Marsh says:

"He deserves to be reckoned among the greatest benefactors of the race."

In planting the dunes, a barrier along the shore was found necessary, at first, to protect the young trees from the rolling sands, which otherwise would bury them. A double line of paling was erected parallel to the shore, and a hundred meters from high-water mark, the second line being a hundred meters further inland. This paling is made of planks, sharpened at the lower end, and driven into the sand. Spaces of an inch between the planks allow sand enough to pass through to bank up equally on both sides, and relieve, somewhat, the force of the wind. As the paling is covered by the sands, the planks are raised, one at a time. A movable frame, with a long lever, mounted on runners, so that it can be slid along the top of the fence, and having pinchers, or a clamp and chain, is easily operated by one man.

The timber of this plantation has long been a source of profit, affording both resin and wood. France now draws an annual revenue of 180,000 francs from the resinous products of these forests. But in this case the greater profit comes from the consequent protection of the adjoining country from the encroaching sands, which had formerly sterilized fertile regions, and buried thriving villages. M. Samanos says that, "In all France, nearly one million acres (400,000 hectares) of desolate land, supposed to be doomed to everlasting sterility, have been reclaimed, and these savage deserts are now stocked with maritime pines, which will become for the country a fruitful source of wealth, and supply, some day, the wants of the whole of France." A liberal appropriation is now made annually for the continuance of this work.

Similar work has been done widely over Europe. On the Adriatic, Baltic, and Mediterranean, as well as the Biscayan coasts, the encroachments of the sea have been checked by forest plantations. Extensive plains, once sterile wastes, south of Berlin, about Odessa, north of the Black sea, and vast steppes in Russia, are now well wooded. The soil of the celebrated forest of Fontainebleau, in France, is comprised almost entirely of sand. Jules Claré, an eminent arborist, says: "The sand here forms ninety-eight per cent. of the earth, and it is almost without water. It would be a drifting desert, but for the trees artificially propagated upon it."

What has been done abroad, on the most unpromising beach sands, may surely be accomplished under the more favorable con-

ditions of our Atlantic barrens, though not by planting the same trees, or by the same methods. Sand wastes are, by no means, all alike. Trees which will grow luxuriantly on one, will die on another. The climate varies, as well as the soil. The soil of Cape Cod, and Nantucket, is well fitted for the maritime pine, where it has been amply tried. It grows well for a season or two, but is sure to winter-kill in a few years. It suffers from the severity of the winter, even in Holland and Germany. Sea spray, and saline constituents in the soil, or air, are fatal to some trees and favorable to others. A knowledge of the natural growths of each vicinity will favor adaptation to local conditions.

Though dry at the top, sand dunes, and most sand plains, are moist a little below the surface, by reason of retention of rain-water and capillary attraction. The latter cause depends upon the size of the grains of sand. The finer the grain, the greater is its capacity for receiving moisture, and the longer is the moisture retained. Many other facts might be cited, both from home and foreign lands, to prove the feasibility of reclaiming sterile lands. If one is to be commended who makes two blades of grass grow where but one grew before, how much more the farmer who makes forests thrive where nothing now grows.

The general influence of forests on climate is better known than their sanitary effect. Dr. Schadt of the University of Bonn says, "Epidemics unknown before, may, perhaps, be attributed to a climatic change, brought about by the destruction of forests." The Roman Campagna in ancient times seems to have been a populous region, and was the seat of numerous cities. But for centuries the danger of fevers and malaria have made this region almost uninhabitable during the summer. The Italian Government has recently undertaken to improve the sanitary condition of this district, especially by planting the Eucalyptus, but with what results remains to be seen.

Professor Huxley's special eulogy of Joseph Priestly is that "he laid the foundation of gas analysis, and discovered the complimentary action of animal and vegetable life upon the constituents of the atmosphere." The interdependence of men and trees is not yet duly appreciated. It is assumed that in view of the vastness of the atmosphere, it could not be sensibly affected by vegetation. But geology teaches that previous to the formation of the coal beds, the atmosphere was so charged with carbonic acid that man