

## PRESIDENT'S ADDRESS:

DEFORESTATION AND ITS EFFECTS AMONG THE HILLS OF  
SOUTHERN INDIANA.

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No region of America, east of the Rocky Mountains, was in the past more densely wooded than were the hills and valleys of southern Indiana. Some of the most magnificent specimens of the temperate latitude forest trees found a suitable habitat along the crests of the divides, and upon the valley slopes of the Ohio River and its tributaries. Very few unwooded areas were found among the hills of southern Indiana, and such as were present were not large.

The "flats" or "slash" lands, forming the watersheds between the Ohio and the Wabash and their tributaries in many parts of southeastern Indiana, were occupied largely by the sweet gum, or liquidamber, the black gum, beech, shell-bark hickory, black-jack and red oaks, red maple and hackberry.

On the gently-rolling land and among the hills the yellow poplar, white and chinquapin oaks, the black walnut, sugar maple, beech, hickory, buck-eye, black locust, linn or basswood, the white and blue ash, and on the still more precipitous and rocky ridges the chestnut oak and cedar, were found.

In the rich alluvial bottoms, and along the streams, in addition to many of the rolling land trees, were present in their greatest luxuriance the elm, the cottonwood and the sycamore. Many of these trees were among the giants in dimensions. There were yellow poplars from one hundred to one hundred and twenty-five feet in height, and from twenty to twenty-five or more feet in circumference. Sycamores grew along the larger streams and in the river bottoms, of such dimensions that their hollow trunks were sometimes used as rude dwellings and as stables.

White oaks and black walnuts grew to such size and in such profusion that were they to be had now, in their original numbers, their value would be twenty-fold greater than the present value of the land from which they were cut.

To clear the ground of such a forest growth, the pioneers had indeed a difficult task. After a generation of fierce fighting on the part of our fathers that they might overcome their then common enemy, the forest, it is not at all surprising that it is even yet difficult to bring the present generation to a proper realization of the benefits of the living forest. All appreciate the value of the timber, but very few of the people realize the benefits of the forest to the country at large; nor do they yet understand the methods by which forest lands may be made as profitable as cultivated areas. To cut away the trees, and to bring the land under cultivation, appears to be the great purpose of the majority of those still possessing a few acres of woodland. To such an extent has the work of deforestation been carried on, even among the hills of southern and southeastern Indiana, that less than ten per cent of the original forest areas are still left intact. Those portions of the original forests yet standing have in the greater number of instances not more than 30 per cent of their former number of trees.

Contrary to what might have been supposed, a larger per cent of the steep hill slopes has been cleared than the land of the more level regions. The slopes of the higher hill lands, such as are found in portions of Clark, Jefferson, Switzerland, Ohio, and Dearborn counties, and to an equal extent in the river counties to the southwest and in the adjoining State of Kentucky, have been almost entirely denuded of their forest growth. Here and there, however, on land that has become valueless for agricultural purposes, nature has begun to repair the general destruction, and a scattering growth of bushes and young trees has sprung up.

It is the purpose of this paper to treat of some of the questions, geological and meteorological, as well as economic, arising from the deforested conditions found in the hills of southern Indiana. Special study, however, has been made of the regions comprised in the basins of Fourteen Mile, Indian Kentucky, Indian and Laughery creeks and the smaller streams emptying into the Ohio River in Clark, Jefferson, Switzerland, Ohio, Dearborn and Ripley counties. What may be said of this general region is largely applicable likewise to other localities with approximately similar conditions.

One of the most striking effects of the deforestation of this region has been upon the "immediate run off" of the streams. As could have been predicted, the amount of this "immediate run off," for any given precipitation, has rapidly increased as the forests have disappeared. The volume

of the flood waters of the streams has year by year kept pace with the destruction of the wooded areas. This has been notably true of the volume of the different tributaries of Indian Kentucky Creek, which has come more immediately under my observation. Within the last ten years these streams have repeatedly had record-making floods.

It has been estimated that, upon all the lands of the earth, some 36,000 cubic miles of water fall per year, and that of this amount some 6,000 cubic miles finds its way into the sea by way of the rivers and streams. Thus the annual average run off from the lands is approximately 16 per cent. The average "immediate run off" of such streams as obtain their water supply from the hills referred to in this paper must have varied enormously with the change from the completely forested condition of the past to that of the present. Then, there was a universal leaf mulch, and a deep, porous soil, filled with roots and decaying vegetation. As compared to that, there is now a compact sod, a shallow and very compact clay or a rock surface. The average annual "immediate run off" from these streams today is at least 50 per cent greater than that from the same regions under the forested conditions of the past.

One of the most apparent consequences of the greatly increased "immediate run off" is the gradual lowering of the ground water level in all portions of the State and especially among the hills. As the ground water level is lowered the flow of springs and of wells is stopped, or very much reduced, in time of drouth. At no time in the history of southern Indiana and northern Kentucky have springs and wells so completely failed as has occurred during the season just past. Water for family use and for stock has in hundreds of instances, and during many weeks, been obtained from distances of one or two miles. The water supply in villages and small towns became very limited or gave out entirely. In many parts of the State, even at a distance from those portions having a rough topography, wells are being driven to greater and greater depths in the endeavor to obtain a permanent water supply for mills and factories, as well as for farm animals. These unfortunate conditions may properly be attributed in large part to the greater immediate run off of the rainfall resulting from deforested conditions.

That deforestation in general, and in the regions referred to in this paper in particular, causes a decrease in the total precipitation can hardly be doubted. The problem of the influence of forests on precipitation is one not easily solved, and is one which has long troubled investigators.

It appears to the writer that both theory, and the observation of the phenomena, substantiates the statement that deforestation greatly influences the rainfall.

It is not probable that the ordinary winter and spring precipitation is to any extent affected by the presence or absence of forest growth. That the summer and autumn rains are often greatly modified, on the other hand, can hardly be questioned.

In the first place, the presence of a heavy leaf mulch, and of the very porous and highly-absorbent soil of a forested area, is a sufficient guarantee that at the beginning of the hot season the soil shall be filled with moisture from the winter and spring rains. Under the present deforested conditions of the hill lands the immediate run off is so great, because of their compact and rocky surfaces, that it is at least questionable whether the ground is ever fully saturated, even at the beginning of the summer season. Moreover, if such a compact soil were saturated, capillary action would cause a very rapid evaporation during the first few weeks of warm weather, and hence greatly diminish the supply of ground water before midsummer.

Given, however, the soil and subsoil of a forested region thoroughly saturated with water at the opening of the hot season, the leaf and loose soil mulch effectively stops evaporation resulting from capillary action. The ground water then is largely conserved until drawn from the soil by means of the roots of the forest trees, and evaporated from the leaf surfaces later in the season, when the trees need the moisture for growth. It is a well-known fact that the evaporation from the leaf surfaces of the greater number of trees in a moist climate is very important. Carefully conducted experiments have shown that from the leaves of a birch tree of moderate size, from 600 to 900 pounds of moisture is evaporated in twenty-four hours, and that from a large elm there may be given to the atmosphere as much as several tons in the same period. The amount, however, varies very considerably with the atmospheric conditions. It is a fact of common observation that large trees, such as the oak, growing in cultivated fields, so completely take up the moisture from the earth that the corn or other crop fails to mature for a distance of many yards from them.

In a forested region the approach of a low barometric area, with its accompanying high temperature conditions, in accordance with the laws of vaporization, causes a corresponding increase of evaporation from the

foliage. Moreover, as the evaporation increases, in the same degree the temperature is modified, since the greater the amount of water changed into vapor the greater the quantity of heat absorbed in the process. Reducing the temperature increases the relative humidity of the atmosphere. Hence, in two ways the atmospheric conditions are made more favorable for a copious and general rainfall at the approach of low barometric areas during the hot season.

It has always been true, perhaps, that many thunder-storms and showers during the summer months, and particularly in July and August, give moisture to very limited areas. Careful observation during a number of years has convinced the writer that as the forests have disappeared the average territory covered by our summer thunder-storms has been gradually and greatly decreasing. Repeatedly during the last few hot seasons, and especially during the one just past, the arrival of a low barometric area caused the formation of a few thunder-clouds, but these, instead of increasing in volume and advancing so as to cover a larger and larger region, soon dwindled and disappeared. The failure of the present deforested areas to add to the sum total of the general atmospheric moisture, as the heated conditions of the low barometric area approached, and also the failure in the formation of vapor in the given locality, both served to decrease the rainfall of the thunder-storm. This was due, first, to the lack of a local vapor supply to add to that brought in by the winds from a distance, and which is very necessary for the formation of clouds in the hot season. Again, when the supply of moisture may have been sufficient to form a thunder-cloud, its advance was into a highly heated dry region with its low relative humidity. The absence of any considerable local evaporation, and the resulting high temperature caused the re-evaporation of the condensed moisture of the clouds and no precipitation followed.

The weather conditions of the deforested areas during the hot months are more and more nearly approaching those of the hot arid regions of the west, where a thunder-cloud formed under favorable conditions very frequently disappears because of re-evaporation as it advances into a territory more highly heated, and of a lower relative humidity.

In another way also the presence of forests tends to add to, and their absence to diminish, the precipitation of the summer months, and that is in causing secondary showers after the main storm is over. The enormous leaf surface, covered with moisture by the rain just passed.

causes a very rapid evaporation to take place almost immediately. Hence, during the hot months, a number of secondary showers quite often followed a thunder-storm under forested conditions. The old weather adage that "Fog rising from the hills will soon give water to the mills," seldom failed of fulfillment. The benefits derived from the more gently falling showers following the hard downpour of the thunder-storm in filling the soil of the cultivated fields and pasture lands can hardly be estimated. It is the moisture from these rains that adds very greatly to the ground water, especially on the firmer earth surfaces.

Again, if it be true, as now appears from records kept during the last ten years, that the summer rainfall of the trans-Mississippi states, particularly Oklahoma, Kansas and Nebraska, be increasing, it would uphold the theory just advanced. In contrast with the naked prairie of the past, which had a large immediate run off, the plowed lands of today are a much better absorber of moisture, and would increase very much the ground water supply. The early summer cultivation of extensive cornfields would tend to conserve this moisture, until the rank growth of corn or other cultivated vegetation, with its extensive leaf surface, would add greatly to the evaporating surface. This would increase the local atmospheric moisture, especially during July and August. Hence, if the above theory be true, there should be ordinarily an ever-increasing rainfall during those months year by year, just in proportion to the area of original prairie land put under cultivation. If trees were more extensively planted, the results in increased rainfall should be marked to the same degree.

In résumé, we may say that theory upholds, and observation substantiates the statement, that deforestation greatly increases the immediate run off, and as greatly decreases the ground-water supply of a given region. It is equally true that the absence of forests seriously decreases the evaporation, and the amount of vapor in the atmosphere, during the hot months. Again, the absence of evaporation permits of higher local temperatures on the approach of low barometric areas and hence the relative humidity of the atmosphere must be lower. All tend toward the reduction of the rainfall during the late summer months, when of all times it is most needed for the growth and maturing of vegetation.

Furthermore, we believe that it can be shown that deforestation has a tendency in a region of rough topography, such as is found among the hills of southern Indiana, to localize the hot season rainfall, and to produce conditions approximating those of the so-called "cloudbursts" of the

Rocky Mountain regions of the West. A case in point occurred during the past summer in the latter part of July over an area of some six or eight square miles along the divide between the basins of Indian Kentucky and Indian creeks and their tributaries, in eastern Jefferson and western Switzerland counties of this State. The rainfall in this case was unprecedented for the region. On one border of the given area a government rain gauge, kept by J. R. Shaw, Jr., was filled to the brim, the measurement amounting to three and one-half inches, and then ran over for an unknown period. Afterward the gauge was emptied and received one and one-half inches more, making at the least five inches, and probably much more, in the period of two hours during which the rain fell. Other and more reliable measurements in locations more nearly the center of the storm area were made and a precipitation of at least ten inches in the two-hour period were recorded.

The conditions producing this exceptional and very destructive rain-storm were as follows: The region to the west and southwest of the storm-swept region is one of the roughest topographically in southern Indiana. The whole area for ten or twelve miles in this direction forms the basin of Indian Kentucky Creek and tributaries, and the hills rise in many instances 400 to 450 feet above the valleys, and the slopes are very steep. From the whole basin the forests have been almost entirely removed. On the day referred to the temperature was unusually high, some thermometers within the area registering 102 degrees in the shade. There was no movement of the air until early in the afternoon, when a gentle southwest wind arose, and this caused the highly-heated air of the whole region to move northeastward. The valley of Brushy-fork Creek, one of the principal tributaries of Indian Kentucky Creek, became the center of the air movement. About three in the afternoon a cloud began to form above the divide and around the head of the valley of Brushy-fork Creek. The highly-heated air ascended very rapidly on reaching the divide, and the consequent rapid cooling of the air by expansion caused an equally rapid condensation of the moisture of the air. The cloud increased in volume with very great swiftness, and the rain fell in torrents, first over a very limited area and then over a wider region. The center of the storm, however, instead of moving, as is usually the case, remained almost stationary for a period of two hours. During this time the winds from almost the entire surrounding region moved slowly towards the now enlarged area of precipitation. There were few if any clouds outside of

the six or eight square miles covered by the storm, but the hot air from the proximity, on reaching this area of rapidly rising atmosphere, constantly added its moisture to that being condensed, with the result that for two hours the downpour continued. This very unusual precipitation proved exceedingly disastrous to the soil of the cultivated fields, and to the roads and bridges as well as to property of all kinds along Brushy-fork Creek and the larger tributaries of Indian Creek. Both of these streams were several feet above any previous record. Where a few moments before there were dry, rocky creek beds, now became a wild flood from six to ten feet in depth and from 300 to 500 feet wide. Buildings were carried away that had seldom or never been touched by previous floods.

In the opinion of the writer this cloudburst, which in truth it was, was caused by the intense heating of the deforested region of very rough topography to the southwest, followed by the gentle movement of great volumes of heated air in a northeasterly direction, until in its passage over the divide it rapidly ascended. Becoming cooled in its ascent, the enormous quantity of moisture held in the highly-heated atmosphere rapidly condensed, and the unprecedented rainfall for that region followed. It may be years before conditions of temperature, moisture and winds would unite to produce another such storm in the same locality, yet the probabilities are that in the future such rainfalls will become increasingly frequent somewhere in such deforested areas of rough topography.

From observations in the Rocky Mountains of Colorado and Wyoming, the cloudbursts of those regions are formed under essentially similar conditions, so far as the absence of forests and areas of highly-heated air are concerned. In the mountains, however, these storms may be more intense, and more frequent, because of the greater height of the divides and the almost entire absence of vegetation or even of any considerable mantle of soil.

Observation of the hill region of southern Indiana compels one to believe that as the forest growth has disappeared such storms have become more prevalent. Excessive rainfall occurs over limited areas, while drouth conditions prevail over the surrounding country. In the one place of rainfall the destruction caused by the flood may be even more disastrous than the continued drouth over the nearby territory.

The effect of forest destruction upon streams has often been described and need not be dwelt upon in this paper at any length. In the area



of hill lands of southern Indiana there can be no reasonable doubt that as the trees have been removed there have been greater and greater floods; and now as the forests have almost entirely disappeared the floods have become exceedingly destructive. Dwelling houses that had stood above the highest waters of the streams for half a century have, within the last decade, since the higher prices for timber have caused the more rapid disappearance of the trees, been inundated repeatedly and many of them carried away. Bottom lands that twenty years ago had a deep and fertile soil are now almost worthless. The flood waters have carried away the greater part of the tillable earth and left in its place stones and gravel. In other places the alluvium of the bottoms has been covered by material from the hills. Thousands of acres of such land, which a few years ago was the most fertile and valuable in the State, are now undesirable.

Hand in hand with the flooded conditions and consequent destruction caused by the larger streams has gone the loss of soil by erosion from the deforested hill lands. It is no exaggeration to say that, from the greater number of hill farms placed under cultivation a quarter of a century ago, there has been removed on the average a foot of soil, and from many slopes there has been taken three or four times as much. Tens of thousands of acres of the steeper hillsides have been denuded of their soil covering and are at present valueless for ordinary agricultural purposes. How to prevent this denudation is the most serious problem that the hill farmer has to solve. In many cases a single heavy rain in February or March, when the departing frost has left the ground in its least compact condition, has been known to remove from a whole slope an average of four or five inches of the soil. Fields that before the rain were considered good farming land were left so covered with rocks, and with so little soil, that they were practically abandoned. Farmers among the hill lands are realizing more and more that a loss of soil is the most serious of property losses, since a damage of this character cannot be repaired except by the ordinary processes of nature, which require scores and even hundreds of years. Farm after farm in southern Indiana, considered very valuable thirty years ago, is practically deserted today. The population of this region first occupied the hills, and considered the soils of the flats and divides very undesirable. For many years now, however, the tide of movement of the people has been from the hills to the flat or gently rolling

lands. As a result the population and wealth of many of the hill counties have been gradually and greatly diminishing.

Many of the streams, flowing down steep beds in their short courses from the divides to the Ohio, at one time furnished valuable water power. They are now useless. Were it possible to control such streams as Fourteen Mile, Indian Kentucky, Indian and Laughery creeks and many others in Clark, Jefferson, Switzerland, Ohio, Dearborn, Ripley and other counties in southern Indiana, very valuable water power could be obtained. Under the present condition of floods and drouths, however, they are valueless as a source of power. Streams that thirty years ago furnished abundant power for mills during ten months of the twelve now are even without flowing water for almost half the time.

The alternate floods and drouths have had a serious effect also upon the animal life of these streams. The great volume of muddy and rapidly-flowing water sweeps thousands of the smaller fish from their proper habitats into larger pools, where they become a prey to their own kind. On the other hand, drying up of the pools of almost every small and of very many of the larger streams causes the destruction of the young of our most valuable game and food fishes as well as of minnows and of crayfish upon which the more highly-prized fishes feed. In the flooded streams following the unusual freshets of March and April of the present year bass and other species of fish ascended the smaller streams almost to their very sources for the purpose of spawning. The severe drouth of the late summer and autumn months dried up the pools and caused the death of such quantities of the young fish and other animal life that the odor of their decaying bodies was very offensive to persons dwelling along the streams near the pools. It would be quite within the truth to say that several wagon loads of minnows and the young of our food fishes thus perished this season in the tributaries of Big and Indian Kentucky creeks in Jefferson County alone. Some of the young bass were removed to larger pools, but thousands upon thousands were destroyed. It would seem almost useless to restock our streams with bass and other valuable food and game fishes if the periodic floods and drouths are to continue and to grow in magnitude and severity.

The points already discussed represent but a part of the evils resulting from deforestation among the hills and valleys of our southern counties. We need not speak of the more manifest economic phases of the subject, such as the failure of the timber and the fuel supply, and the

higher prices resulting. Enough has been said to convince all that the only hope for the future prosperity of great areas of our State lies in reforestation. In the first place, reforestation should be urged upon the present land owners. Many an acre of untillable soil could be planted in black locust, catalpa, black walnut or shell-bark hickory with good prospect of speedy returns upon the investment. Wealthy men, interested in the preservation of game or fish, should be encouraged by favorable laws, or otherwise, to purchase large tracts of the hill lands of the State, and to plant them in timber.

Our State has already made a good, although very small, beginning in forestry. In the writer's opinion it would be the highest economy for the commonwealth to purchase and reforest tens of thousands of acres of her rougher hill lands along the Ohio and other streams. These lands are almost valueless for agricultural purposes. Covered with a growth of our most useful trees, they would in time return a rich revenue to the State; they would again become covered with soil; the present unsightly and unprofitable gullied fields and yellow clay points would disappear; the loose soil and leaf mulch resulting would again absorb great quantities of moisture, reduce the immediate run off, and hence diminish the volume of the flooded streams. At the same time the ground water supply would be greatly augmented; our late summer rains would be more numerous and more copious; wells and springs would be more permanent and give larger volumes, and our most severe drouths, destructive to all life, prevented.

The probabilities are, however, that private enterprise alone will never restore the forests to our hills as fully as the best interests of the people demand, hence the State and Nation must be called upon to take a leading part in reforestation.

