FOREST DESTRUCTION AND THE EROSION OF ARABLE LANDS.

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The work of the elements in eroding or eating away the surface of the United States affords a study for the scientists which is of extreme interest and importance. So many are the causes of erosion and so varied are its effects, however, that a series of volumes would be needed to describe the effect of air and water merely on the different soils, in the various climates, and at the various altitudes.

Perhaps the most familiar effects of earth erosion are in the West, in such regions as the Arizona desert, where the crumbling away of the surface has revealed the petrified forests. The remarkable formation in the Bad Lands of Dakota and Nebraska and the picturesque of the famous Garden of the Gods in Colorado are due almost entirely to the wearing away of the softer formation exposing the curious shapes formed by the more solid composition. Much of this erosion is due to the extremely dry climate and high temperature, which have caused the earth to become remarkably friable. Here and there can also be seen the effect of water upon the soil, but a really wonderful result of the power of water is in what is now the famous Salton Sink, into which the detritus from millions of acres of the States of Arizona and Utah has been carried and deposited by the action of the Colorado River, the original surface of the sink being covered in some spots to a depth of no less than 200 feet.

Erosion caused by a river or creek, however, is seldom beneficial. In the case of the Colorado, the material carried down in flood contains so many fertile ingredients that it has reclaimed a large area of the Southwestern desert, making it fit for cultivation by irrigation. In this respect the conditions resemble the annual inundation of the valley of the Nile with its renewal of the fertility of the soil.

In many other portions of the United States, however, the result of erosion by water has brought literal destruction to very large areas of farm land and of territory available for agriculture by reason of its advantages of climate and soil. In spite of the enormous extent of cultivated lands in the various portions of the country and the many tracts which can be made available by the farmer in the East as well as the West, this destruction has already assumed such large proportions that it has seriously affected our most important industry. While evidences of the injury done by erosion can be found in New England and in many parts of the Middle States, possibly the Southern States present the most notable illustrations. This is due to several conditions, such as the topography, the

character of the soil, the size and number of the streams and the volume of water which they carry, especially in the flood season. A considerable area of the South is composed of the flat, level land adjoining the seacoast. The descent of the rivers from the mountains where they have their source to the coastal plains is so abrupt that experts of the Geological Sur-

and other detritus, much of which is held in solution. Unfortunately this material is unlike what is carried by the flood waters of the Colorado and the Nile; for it usually covers the land to such a depth that the soil is worthless for agricultural purposes. This distribution of alluvial material is one of the most serious destructive effects of erosion. Every year large areas of the valleys in the Piedmont section, as well as of the lands of the coastal plain, are inundated by the high waters, and this deposit left upon their surface. The direct erosion caused by the flood water, however, is another great injury to agriculture. The soil of the Piedmont region consists largely of clay and loam, the upper stratum of which is so soft and loose that the contact of water causes it to dissolve just as a pile of sand will be disintegrated by a small jet of liquid. It is this quality of soil which is noted for its crop production. Upon the "red lands," as they are called, of the Carolinas and Georgia is raised a large proportion of the cotton crop, some of the planters averaging nearly two bales of cotton to the acre. This land is also adapted for the growing of fruit, as is shown by the great peach orchards in the red lands of central Georgia. Much of it is included in the older plantations which have been cultivated for over a half century. It is in this country, however, that erosion from water has done great injury; for many of the plantations are situated in the foothill country where the land is sufficiently rolling to permit a rapid flow of water.

The erosion even of a small rivulet is of such an extent as to seem almost incredible. The writer has measured ravines and gullies in the plantation districts of South Carolina which were actually 50 feet in depth, yet only two or three feet wide at the top. The drainage water cut through the soft surface like a knife, and with no hard clay or rock to stop its course, had eaten its way into the earth. With such a formation, it is not strange that one can see fields of 50 acres or more which have been abandoned because so creviced by the water. But even greater damage has been done to plantation and

other bottom lands in the valleys through which flow the mountain rivers. Such may be the force of the flood torrent that it will carry away the entire earth crust, washing it down to the rock itself. As these bottom farms are usually extremely fertile and produce large crops of corn and cotton, the loss to the farmer is very great.

The engineering work which has been done in Europe and other countries shows that much of this destruction of farm land in the United States can be avoided, if only methods are adopted to confine or limit the flow of water. The fact is that America is

Brush Dams Which Are Now Being Introduced in the West to Hold Back the Mountain Torrents.

vey who have been investigating the Appalachian region estimate that nearly 3,000,000 horse-power could be secured from the principal water courses—more than enough to operate all of the industries of the South at the present time.

This figure illustrates the volume and force of the water in the Southern rivers. During the flood season, when the rivers are swollen by the melting snows in the mountains or by heavy rains, and the flow of water is many times greater than at other periods, some of the streams become literal torrents and carry down their course an enormous amount of sand, gravel,

A Hill Once Wooded, from Which the Earth Has Been Washed by Storms Because It Was Unprotected.

An Example of the Destruction of Farmland by Erosion. A Field Washed Out, Caused by Failure to Ditch.

very far behind such countries as Switzerland, Italy, and France, where systems have been employed which have averted much of the erosion that formerly prevailed in the mountainous sections. The investigations by the experts of the Geological Survey as well as the United States Forest Service proves beyond question that the floods are due largely to the indiscriminate cutting of timber along the head waters of the southern streams. It is needless to say that the industry has been so wasteful that entire tracts of woodland forming the watersheds of some of the principal southern rivers have been stripped of their trees, so that the country is practically denuded of forest growth. The result of this is that the bare watersheds do not hold the rainfall and melted snow, the water flowing directly into the river channels and thus forming floods. The forest cover, as it might be called, really acts like an enormous sponge, absorbing the precipitation of moisture, which gradually drains off. The work of the timberman, however, as already stated, has so stripped many of the watersheds that this sponge has been destroyed. An investigation of floods in North and South Carolina shows that the worst ones have been in watercourses from which the woodland has been thus removed. The history of the Southern States also proves that the connection between great floods and the destruction of the forests is very close; for prior to the inroads made by the timberman in the Appalachian region, the volume of water coming down the rivers during the so-called

How Farm Lands Are Ruined by Erosion Caused by Freshets. The Fertile Bottom Land Is Here Covered by Flood Sand.

Alluvial Bottom Which Has Been Destroyed by Flooding. The Small Area in the Center Shows the Condition of the Bottom Before the Floods Came.

flood season averaged far less in volume than it has in recent years.

As already intimated, the work which has been done in European countries to prevent land erosion of this character indicates what can be accomplished by the United States. As is well known, southern France is extremely mountainous. It has been stated that more than one-half of the Alpine rivers are within the borders of the French republic. It is a fact that there are nearly 1,500 brooks and mountain streams which are considered dangerous, owing to the force of their flood currents and the volume of water. They have endangered nearly a million acres of fertile land on the hillsides. Since 1860, however, the French government has been planting the lands near the shores of these streams with suitable trees, and up to the present time about 250,000 acres have been forested, with the result that the floods have been considerably checked, and a large portion of the area referred to protected from further possibility of damage. The work is considered so important, however, that about \$50,000,000 will be expended before it is completed; for a half million acres of lands are to be reforested.

Switzerland affords the best object lesson. The protection of cantons and other settlements from the mountain streams has been prosecuted for over six centuries, although systematic forestry has only been in vogue about fifty years. Considering the size of the country and its population, Switzerland has accomplished really great results, for it has reforested nearly 20,000 acres of land around the sources of its mountain streams at a cost of about \$1,000,000. While the conditions are such that it is impossible to prevent torrents in the flood season, the flow of water has been

considerably lessened by the erection of dams and other diversion works, and thus an extensive area of cultivated country has been protected from further damage of this kind. Conditions in Italy, however, are quite similar to those in some portions of the South. One-third of its surface is unproductive at the present time, a large proportion of this consisting of sloping country, from which the earth has been washed away down to the bare rock by the unrestrained mountain rivers. It may be added that the great floods which periodically occur in China have been traced to the fact that this is one of the few countries which thus far have taken no steps to preserve or renew the forests. As a result, some of the mountain ranges, forming a source of its greater streams, have been stripped of every tree, and the precipitation from rainfall and snowfall drains directly into the water courses, thus forming the floods which have become famed for their extent and the disaster which they have produced.

This description of the situation in the Southern States can be applied to many other portions of the country where the conditions are similar. The necessity for restoring the forests at the headwaters of western rivers has been realized to such an extent that some of the most important work of the Forest Service has been to plant watersheds denuded by the timberman. This is really the main solution of the problem in the South, and unless steps are taken to regulate the rivers in the manner referred to, the tracts of worthless land caused by erosion will be greatly increased in the near future, since year by year the damage by freshet is greater throughout the Piedmont section as well as the coastal plain.

A Scene Which Shows How the Earth is Washed from the Surface Where It is Not Protected by Trees.

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