Dust Bowl: Causes and Effects

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In the 1930's and again in the 1950's portions of the Great Plains, especially the southern Plains, have been termed the "Dust Bowl." The Great Plains extend in a broad belt nearly from the Mississippi River to the Rocky Mountains and from the Gulf of Mexico into the prairie provinces of Canada. The Columbia River Plains are also subject to considerable wind erosion. Recently this area has been termed "Little Dust Bowl." Other regions affected by substantial wind erosion are the Colorado Basin and some parts of the Pacific Southwest, the muck and sandy soils around the Great Lakes, and the sands of the Gulf and Atlantic seaboards. By far the greatest damage from wind erosion has been in the Great Plains. This paper will refer primarily to this region.

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MUCH can be learned about causes of dust storms from lessons of the past. Wind erosion has been a common occurrence on the Plains since white man first came into this area and probably even before.

There is abundant evidence that dust storms occurred before cultivation of the soil began. The following extracts from official weather records at Dodge City, Kansas, indicate the presence of dust storms in that region more than 60 years ago:

April 8, 1890: At 10 a.m. the dust in the air was so dense that objects could not be distinguished 100 yards off. No one who could possibly remain indoors was on the street."

August 13, 1892: The wind raised such a cloud of dust that it was impossible to see over 150 feet ahead."

April 6, 1893: The dust was blinding and was deposited so thickly on office furniture that everything looked as though it were covered by a layer of dirt prepared for a hotbed."

May 15, 1894: The dust caused by high wind was terrible."

These storms occurred at the time when virtually no land in the southwest had been broken from virgin sod (6). Some of the dust was ashes of burnt grass, but there is some indication that much of it was surface soil.

There is considerable evidence too that wind erosion became even more serious after the virgin lands were broken and planted to cultivated crops. One notable example of accelerated wind erosion occurred in Colby District, Kansas, during the years 1910 to 1914. About 65,000 acres were affected by severe blowing in that area (4). Surface soil down to plow depth was removed from some fields. This occurred on hardland soils which today are considered to be more resistant to wind erosion than sandy soils. The sandy soils south and west of that region had not been broken at that time.

Wind Erosion Every Year

Some wind erosion has taken place in sections of the Plains almost every year since settlement was completed. The period of most extensive and severe erosion occurred in the 1930's. At one time or another during that period the entire Plains region was affected. Many fields lost as much as 12 inches of top soil. Some sandy land was converted to sand dunes. Many farmers abandoned their farms and left the Plains.

A more tranquil weather and above-normal rainfall ensued in 1940 and continued till the end of the decade. Some dust storms occurred in the 1940's but they were local and mild compared with the earlier ones. Many settlers came to the Plains and occupied farms abandoned in the 1930's or settled and broke new land on the drier and sandier fringes of the old "dust bowl."

About four million acres of the remaining grassland were plowed up in the southern Great Plains between 1942 and 1952 (3). A considerably smaller acreage of

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This paper is a joint contribution from the U. S. D. A., Agricultural Research Service, Soil and Water Conservation Research Branch and the Department of Agronomy, Kansas Agricultural Experiment Station, Manhattan, Kansas, Contribution No. 573. This paper was part of a theme on the Dust Bowl presented at the annual meeting of the Soil Conservation Society of America, Tulsa, Oklahoma, October 16, 1956.

grassland was broken in the northern Great Plains. Most of this sod land was not suited for permanent cultivation for it is situated either in areas normally too dry for cultivation or too sandy to resist strong winds.

Severe and extensive drought and dust storms returned to the Plains in the early 1950's and continued into 1956. The extent of the area subject to accelerated wind erosion was greater in 1956 than it has ever been in the history of the Plains. The Soil Conservation Service estimates that about 14 million acres not suited for permanent cultivation are now being cultivated on the Great Plains (7). Nearly all of this land is subject to severe wind erosion. They advise that it should be converted to permanent grassland as soon as possible.

Causes of Dust Storms

The basic causes of wind erosion are few and simple. Wherever (1) the soil is loose, finely divided, and dry, (2) the soil surface is smooth and bare, and (3) the wind is strong, erosion may be expected.

By the same token, wherever (a) the soil is compacted, kept moist, or made up of stable aggregates or clods large enough to resist the force of wind, (b) the soil surface is roughened or covered by vegetation or vegetative residue, or (c) the wind near the ground is somehow reduced, erosion may be curtailed or eliminated. These general conditions form the basis for effective wind-erosion control.

Denudation—the Major Cause

Of the major causes of accelerated wind erosion on the Plains, the most important has been the depletion or destruction of vegetation or vegetative residue on the land. Drought at times has reduced or stopped the vegetative growth, but drought alone has not been the cause of severe wind erosion. Some erosion occurred when the land was covered with natural vegetation but the amounts were small compared with those occurring after man began to deplete and destroy the vegetative cover. In the earliest days of white man's settlement of the Plains, destruction of vegetative cover by prairie fires was the main cause of severe erosion of soil by wind.

A quotation from the *Kansas Free State*, Lawrence, Kansas, January 31, 1855, is given to illustrate this point: *"The strong south winds that we experience here are our greatest annoyance. They frequently last for several days, and are loaded with a black dust from the burnt prairie which penetrates every corner of our houses and makes everyone who is exposed to it as sooty as a collier. This annoyance, however, will not be so great when the surrounding country is brought under cultivation and the prairies cease to be burned."*

Evidently some of the early settlers failed to perceive that destruction or removal of vegetative cover from the surface of the land—by fire or any other means—is the basic cause of dust storms.

Later, depletion of grass by overgrazing supplemented and superseded the burning as the major cause of dust storms. Many areas of the range were overstocked by 1885. Having only the grazing rights and no title to the land, the cattlemen were strongly tempted to graze all the grass possible. Dust storms became a serious consequence in the 1890's.

Plowing of grasslands without knowledge of or regard to the ultimate consequences became the major cause of subsequent dust storms. Homesteaders gained title to the land replacing the cattlemen. They plowed up the sod and planted grain. Between 1910 and 1920, for example, 10 million acres of grassland were put under the plow in North Dakota alone. The cycle of wet years and World War I accelerated the break-up of the sod. Farm tractors

Sorghum stubble in this photo was flattened by an unusually strong wind on February 19, 1954, near Tribune, Kansas. Such a wind is likely to occur only once in 15 to 20 years. Note the soil erosion.

gave further impetus to so-called "dry farming" on the Plains.

In this early period of agricultural history there seemed to be absolutely no recognition of the importance of vegetation and vegetative residue for protection of the soil against wind and water erosion. The plow and the disk and drag harrows developed in and adapted to more humid regions were the principal tillage implements. Vegetative residues were buried and the soil surface was left smooth, loose and fine. This set the stage for serious dust storms in the 1930's.

A survey of the portions of the Southern Great Plains during that period showed that cultivated and idle land suffered more than three times as much wind erosion as pasture land (5). Pastures on the whole were eroded and in poor condition, but not nearly so much as idle and cultivated land.

Climatic Factors

Extended periods of drought and high wind-velocity have contributed to the severity of wind erosion. Great variations in precipitation and wind velocity exist on the Plains. These variations are governed by the normal probability law. The general frequency of occurrence of periods of high wind and low precipitation can be predicted from past records for any given location, but unfortunately the time when these periods will occur cannot.

It is essential therefore to establish soil conservation practices that will be effective against wind erosion wherever it may occur. Emergency measures adopted after wind erosion has started never have been entirely effective in preventing damage to crops and soil.

Due to great climatic extremes, occasionally some wind erosion will occur even under the best land management. The amount of vegetation or well-anchored crop residue required for adequate protection against a wind velocity which will occur on the average of once every 10 years is far more than can be grown even in wet years.

Wind Flattens Stubble

The occurrence of unusually high wind on February 19, 1954, in eastern Colorado, western Kansas, and the panhandle areas of Oklahoma and Texas is a good example. This wind was strong enough to blow standing wheat stubble out of the ground and to blow out or flatten much of the untilled sorghum stubble. The wind piled up loose soil in ditches and other depressions and in fields where some crop residue still remained. These loose drifts were moved even by gentle winds. The effects of that one high wind on soil erodibility no doubt were carried well into 1955.

Such a wind is likely to occur, on the average, only once in about 20 years. When it occurs and the soil is dry, some erosion is bound to take place regardless of how well a vegetative cover is managed.

The amount of erosion on February 19, 1954, and subsequent days was far less on fields that had some vegetative cover than on those that had little or none. Vegetative cover was paramount in importance in reducing and in some cases eliminating erosion (2). Soil cloddiness was of secondary importance. On the whole the sandy soils had neither the vegetative cover nor the degree of cloddiness necessary to resist the wind and were therefore much more affected than the hardlands.

Damage to Soil

In their native condition, most of the Plains soils were characteristically loose and finely granulated at the surface. Alternate wetting and drying and freezing and thawing tended to break soil clods into finer aggregates. Effects of weather were greatest at the soil surface but diminished rapidly with depth and virtually ceased at a depth of about three to four inches.

Under natural conditions, grass usually protected the fine surface material from erosion by wind. As soon as the grass was destroyed or the sod broken and the soil surface was left bare, the fine surface soil was blown readily by the wind.

A recent study showed that some newly broken hardland (loessal) soils of the Plains were more than twice as erodible by wind as the land broken about 20 years previously (1). The binding action of native grass roots apparently was insignificant or lasted only for a short period after breaking.

Less Productive Subsoil

The highly erodible surface soil is now gone from many of these old cultivated fields, exposing a more clayey and more wind-resistant, though less productive, subsoil.

In this study about 9 inches of surface soil was gone from the old cultivated fields. Little of this soil was trapped in nearby grasslands. Most of it was carried out of the area in the form of dust.

Climatic factors remaining the same, the rate of soil removal from the old cultivated land is expected to be considerably lower in the future than it has been in the past. This conclusion is based on the fact that the surface soil of the old cultivated land is now more clayey, more cloddy, and therefore more wind-resistant than it was soon after breaking.

The above condititon is a typical example of non-selective removal of soil by wind. This type of removal is associated with loessal soils believed to be deposited from the atmosphere throughout past geologic eras. The composition of these soils is predominantly very fine sand, silt and clay—all removable by wind in the same manner they were brought in. The abrasive action of saltation is sufficient to break down soil aggregates to dust which can be transported great distances by wind.

Great deposits of loess exist on the Plains. These represent a great land resource—ironically a product of wind

erosion that has occurred elsewhere. Apparently there was a long period of build-up of these grassland soils due to trapping of dust that was blown in from some distant areas. These deposits show the great importance of wind as a geologic mover of dust.

There is another type of removal that is far more injurious, though somewhat less extensive, on the Plains. It is known as selective removal. It occurs on soils developed from glacial till, residual material, mountain outwash, and sandy soils of any origin.

On these soils, the wind acts like a fanning mill on grain. It removes only the fine and light materials. This sorting action over a period of years has made these soils progressively coarser in texture at the surface. Some of these soils have become covered with sand dunes. This process is apparently proceeding in exactly the same way in some relatively small areas in the United States as it did in some parts of the Old World—parts that were once fertile plains but have since been changed to sandy wastes.

The damage to soils subjected to selective removal by wind has been far more serious than is reflected in crop yields. Considerable increases in sandiness have made these soils even more erodible than they were originally. Such changes generally are beyond human repair.

The Problem of Sandy Soils

Greatest wind erosion problems are usually on sandy soils. These have lost from 10 to 75 percent of their original content of silt, clay, and organic matter in the surface layer since they were broken from virgin sod. If exploitation of these lands for production of erosion-susceptible crops continues and if the rate of change in texture is the same in the future as it was in the past, a great proportion of these soils will change to sand dunes in a relatively short period of time. The rate of change actually is expected to accelerate because the sandier a soil the more erodible it becomes.

The cheapest method of solving the problem might be to take the worst of these lands out of cultivation and seed them permanently to grass. Other more productive sandy lands must remain covered with cultivated vegetation or vegetative residue at all times.

Re-vegetation of sandy areas, however, will take care of only a small part of the whole wind-erosion problem. New and better techniques must be adopted if serious erosion of our soils by wind is to be prevented.

Summary

To summarize, dust storms are almost certain to occur within periods of prolonged drought and extreme wind velocity. But they do not have to be as severe as they have been in the recent past.

With new techniques of maintaining soil cloddiness, vegetative cover, surface barriers and roughness, erosion can be controlled as when the soil was protected by native grasses. Today some soils are more erodible than they were when first brought out of sod and some are less erodible. Some lands must be put back to grass or they will be abandoned and remain a threat to better lands around them.

The greatest need today is not the knowledge of how to conserve the soil (although more knowledge is required) but the determination and willingness to leave the land in as good or better condition than it was found.

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Poor stand of wheat (foreground) failed to protect soil from wind erosion. Crop residue cover (upper left) trapped more soil than it lost.

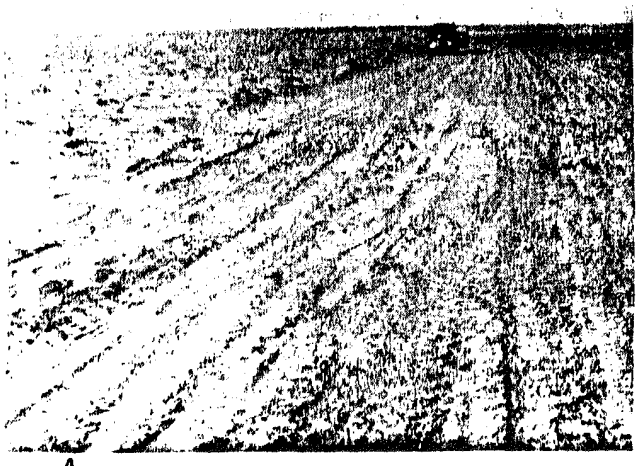

Photo 283 Lemon

Good growth of fall wheat on loam soil near Sublette, Kansas, pulled through the severe windstorm of February 19, 1954, and went on to maturity.

Photo 284 Lemon