Particulate Loads Caused by Wind Erosion in the Great Plains

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Dust is always present in the air, but when wind erosion occurs, both the flux of soil particles into the air and the particulate concentration increase by orders of magnitude. Previous research[1] indicated that median duststorm concentration was 4.85 mg/m^3 and median annual hours with duststorms was 45 in the Great Plains during the 1950's. Of the total soil moved by wind, the suspended particulates probably represent 10% or less.[2,3]

The literature contains little information on wind erosion as a cause of atmospheric particulates. In this paper we estimate the annual flux of suspended particulates caused by wind erosion at specific locations in the Great Plains and, finally, over the entire Great Plains.

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Particulate Flux past Locations

Previous research related dust concentrations to visibility and demonstrated that these relationships could be used to estimate particulate concentrations during duststorms.[1,4] To calculate the horizontal particulate flux, the product of assumed windspeed and dust concentration profiles was integrated over the lowest mile of the atmosphere; reported windspeed and visibility measurements were used to determine the magnitudes of the assumed profiles. Using this procedure, we calculated the horizontal flux for every dusty hour at 37 Great Plains locations in the 1950's and at 12 Southern Great Plains locations in the first 7 years of the 1960's.

Among the locations, those in the driest area of the Central Great Plains supplied most soil to the atmospheric particulate load (Figure 1). Changes in dust passage were consistent between adjacent locations, and the least erosive areas in the eastern and mountainous western portions of the Great Plains had the lowest total dust passage. Varying precipitation caused average dust passage to fluctuate widely from year to year.

Reprinted from **APCA JOURNAL**, *Vol. 25, No. 8, August 1975*

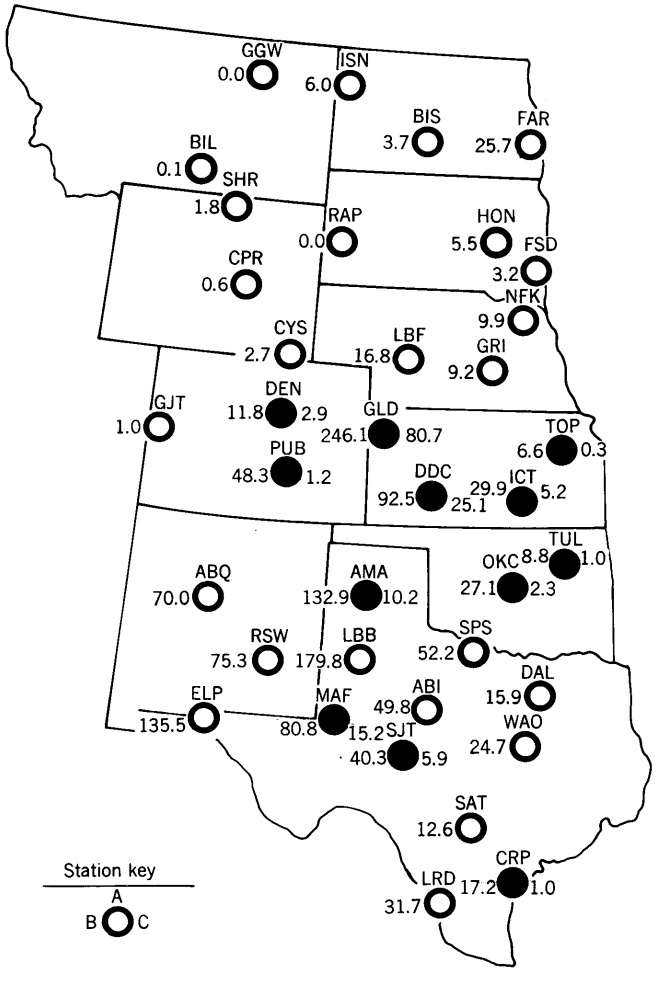

Figure 1. Plot of 37 Great Plains locations showing station abbreviation (A), average annual dust passage in thousands of tons per vertical square mile for the 1950's (B), and 1960's at 12 Southern Plains stations (C) (solid circles).

Total Particulate Load

An estimate of the amount of particulates carried by the wind during duststorms in the Great Plains can be obtained by assuming each of the 37 locations makes a representative sample of an equal, upwind area (165 × 165 miles square) and that all the dust originated in the upwind area. This assumption appears reasonable because the average duration of duststorms in the 1950's was 6.6 hr, and whole days of blowing dust were rare.[1]

Using the average dust passage of 40,000 tons/vertical mi^2/yr, we get 244 million tons of dust suspended annually in the 1950's. Based on the variation in dust passage, annual amounts of dust suspended by wind erosion ranged from 37 to 551 million tons in 1958 and 1954, respectively. Because the 12 Southern Great Plains locations were representative of all locations during low-to-moderate periods of wind erosion, we estimate that suspended dust in the 1960's averaged 77 million tons annually.

Most particles suspended by wind erosion are relatively large; thus, the amount of dust entering the atmosphere should correspond roughly to the amount of dust deposition. From 1964 through 1966, Smith, *et al.*[5] measured dust deposition at 5 rural locations ranging from Nebraska to Texas and reported 488 lb/acre/yr being deposited on the surface. Using our procedure, we calculated 428 lb/acre/yr leaving the surface during the same period. The nearness of these calculated loads tends to support the validity of the method we used to estimate the load of particulates put into the atmosphere by wind erosion.

Discussion and Conclusions

Whether or not the suspended particulates caused by wind erosion are important depends on one's viewpoint.

As a long-range mover of sediment, wind erosion is relatively unimportant.[6,7] However, the pollution hazard posed by erodible soils containing large amounts of pesticides, fertilizers, or radioactive materials still needs further research.[8,9]

As a cause of total mass of particulates in the atmosphere, wind erosion is important. Results of this study suggest particulate mass from wind erosion in the United States exceeds the combined output from all other primary sources (both natural and anthropogenic), which emit about 35.2 million tons of particles annually.[10]

As a cause of high particulate concentrations, wind erosion is also important. Based on the duration and concentrations of duststorms,[1] it is doubtful that any of the Great Plains States can meet the criteria on maximum 24-hr concentrations outlined in the National Ambient Air Quality Standards, particularly if particle size continues to be disregarded in the Standards.

As a direct hazard to health, the coarse particulates moved in duststorms rank relatively low compared with other airborne pollutants, and Corn[11] has pointed out the need for emission standards to consider particle size (in addition to total mass) to obtain desirable community effects.

To combat air pollution associated with wind erosion, States can take two approaches: (a) establish standards as a function of land use, or (b) establish uniform requirements regardless of location. This study demonstrated that climate causes wide variations in air pollution from wind erosion. Thus, an approach that encourages proper land use will probably be most effective.

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