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Causes and Implications of Record Windblown Dust Conditions during 1981 in Illinois

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INTRODUCTION

Parts of Illinois experienced severe and frequent dust storms during the spring of 1981, reminiscent of conditions in the 1930's. In portions of central Illinois, the frequency of days with blowing dust (visibility less than 5/8 mile) exceeded prior high values of this Century, setting new all-time records. Windblown dust reaching the dust storm level has largely been a spring season phenomenon, obviously related to agricultural practices interacting with a certain mix of critical weather conditions such as the high winds common to the spring combined with untypical dry conditions. Other known factors affecting the amount of wind erosion are soil types, field size, and vegetative cover (Woodrow and Siddoway, 1965).

In the spring of 1981, Illinois was entering the second year of a moderate drought that had begun in the spring of 1980 (Changnon, 1981). This drought, as defined by persistent precipitation deficiencies, was concentrated in the southern third of Illinois. The driest 12-month period in the drought area, defined by the period of April 1980 through March 1981, had a precipitation deficiency ranking as a once in 7-year event. However, the area of frequent blowing dust in the spring of 1981 was located to the north of the 1980-1981 drought area. There were initial suspicions that the severe dust in central Illinois originated in the southern Illinois drought area.

This study of the 1981 blowing dust conditions has been made because of its record-breaking proportions and its serious impacts. As revealed by the headlines and photographs in Figure 1, the conditions were sufficiently severe to bring widespread attention and great concern over losses of Illinois' valuable soil. Visibility problems were sufficiently bad to produce several traffic accidents in central Illinois, and the windblown dust became a pollutant that infiltrated businesses and homes in central Illinois.

Atmospheric scientists were also concerned on at least two accounts: one was the record or extreme event nature of the situation (and hence its causes), and the other was the fact that large volumes of dust affect atmospheric quality and precipitation quality. An earlier study (Siebel and Semonin, 1981) postulated that the windblown dust in the 1953-1955 drought had a major effect on the acidity of rainfall. The 1980-1981 dust conditions offered an opportunity to examine their hypothesis.

The key questions about the record blowing dust conditions of 1981 were these.

1) Was the dust largely a result of unusual weather conditions (extremely dry, extremely windy, or both)?
2) Was the dust largely due to the cumulative effects of current farming practices?
3) Were the 1981 dust storms a herald of growing wind erosion problems?
4) What are the implications of the findings for agriculture?

It was important in answering these questions to discern whether the types of weather conditions in 1980-1981 were singularly anomalous or possibly indicative of a tendency to more windy or drier winters and springs. The climate of Illinois is constantly fluctuating on time scales of 5 to 500 years. Unusual extremes occur at random and these are short fluctuations appearing on long-term trends that usually last over several decades. The parallel issue is whether the dust

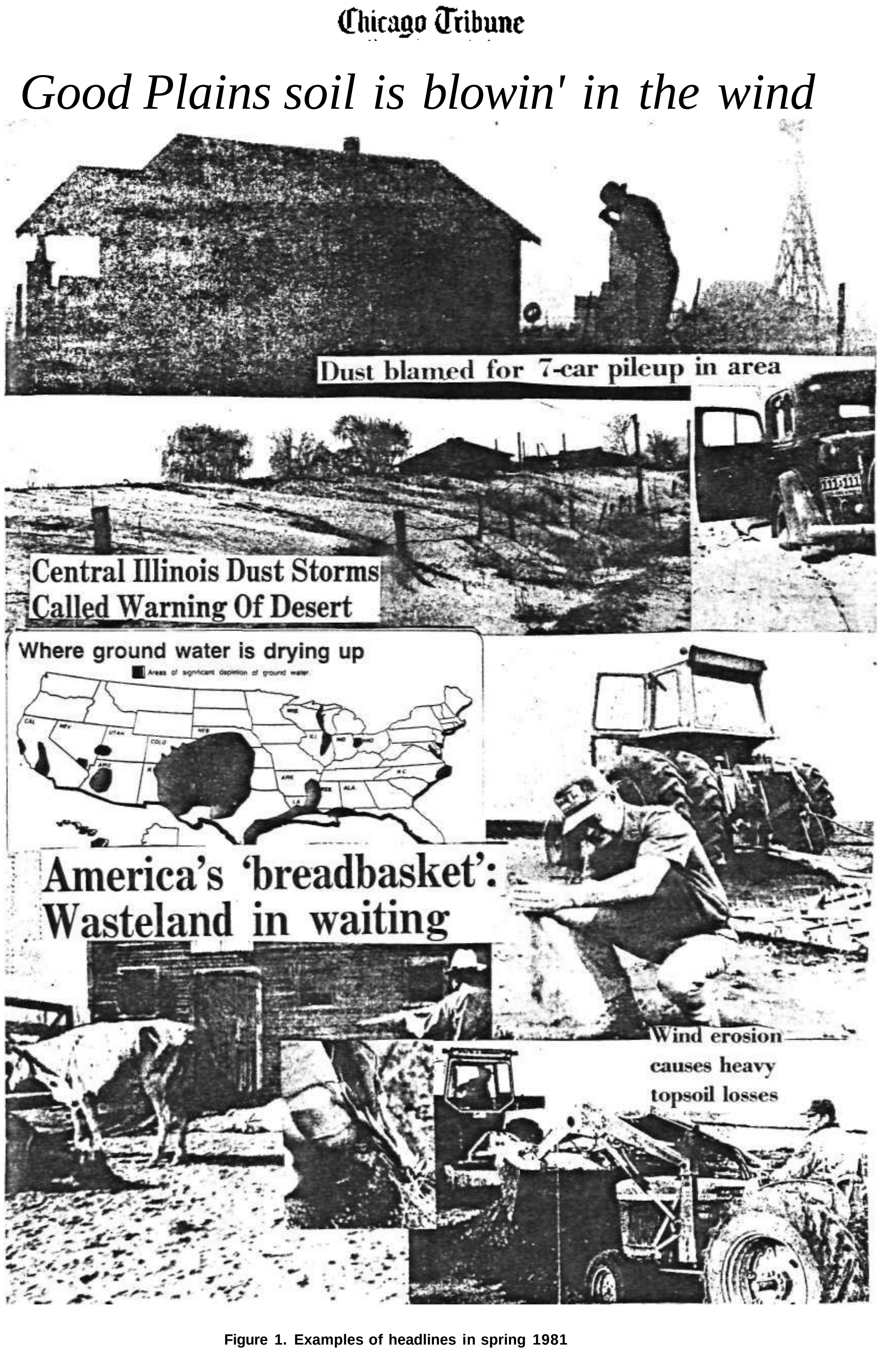


Figure 1. Examples of headlines in spring 1981

problem in 1981 was a culmination of effects on soils relating to recent trends in farming practices that would produce conditions more amenable to wind erosion.

Data Sources

Data used in this study came from several sources. The weather data, including that on winds, precipitation, and temperature, came from three types of weather stations operated by the National Weather Service (NWS) and Federal Aviation Agency (FAA) in Illinois. These included the NWS first order stations in Chicago, Rockford, Moline, Peoria, Springfield, and St. Louis; and the FAA stations at Bloomington, Decatur, Champaign, Danville, Quincy, Mt. Vernon, and Terre Haute. Data from these two types of stations, where trained weather observers are on duty and make hourly observations, should be extremely accurate and able to define windblown dust conditions. Windblown dust typically persists for only a few hours during a day.

The third data set came from NWS cooperative substations where volunteer observers normally measure only daily temperatures and rainfall; hence their observations of blowing dust are often casual and they are potentially of lesser accuracy. However, data from 45 quality substations were investigated and utilized where possible. Data on 1981 soil moisture conditions and farm practices were obtained from the weekly "Illinois Weather and Crop Reports" of the Illinois Crop Reporting Services. The Water Survey's weather and soil moisture data for Urbana were also used Blowing dust is defined as the condition when the horizontal visibility is reduced to 5/8 of a mile or less.

The Dust Conditions in 1981

The frequency of days with blowing dust during 1981, all within the spring (March-May), are shown in Figure 2. Most locales in northwestern, western, and southern Illinois experienced one day with blowing dust. The pattern based on the point frequencies shows the zone of 2 or more dust days defined in the central, east, and northeast crop reporting districts. The 1981 maximum of 7 blowing dust days was found at Champaign-Urbana with the state's higher frequencies in the central and east districts. The pattern reveals most of the dust in this maximum had to originate from that area alone and was not a product of dust blowing in from the drought area of southern Illinois. Otherwise, values would have been much higher in southern Illinois. Therefore, the explanation for the central-eastern Illinois maximum has to lie with relatively rare conditions in that area. These could include anomalous weather conditions, particularly sensitive soil types, farm practices, or a combination of all of these.

The dates of blowing dust are shown in Table 1. The stations reporting dust are also shown, along with the times of the dust if known. Examination of the dates and the locations reveals two general periods of frequent activity. The first period of frequent dust days was 31 March through 8 April. In this 9-day period, blowing dust was reported on 6 days. A less well-defined period of blowing dust occurred again in late April (23 April), and extended into early May. In 14 days there were 6 days with dust.

Another important observation that can be made from Table 1 relates to these two distinct periods. The first period, 31 March-8 April, was one having a fairly extensive spread of dust conditions with 5 or more stations reporting dust on 5 of the 6 dust days. The six dates of dust later in the spring were defined by more localized conditions. A third important observation from the information presented in Table 1 is that most events were largely concentrated in the late afternoon and early evening. This typically is the daily period of highest temperatures and wind speeds. This reveals the importance of the weather factors.

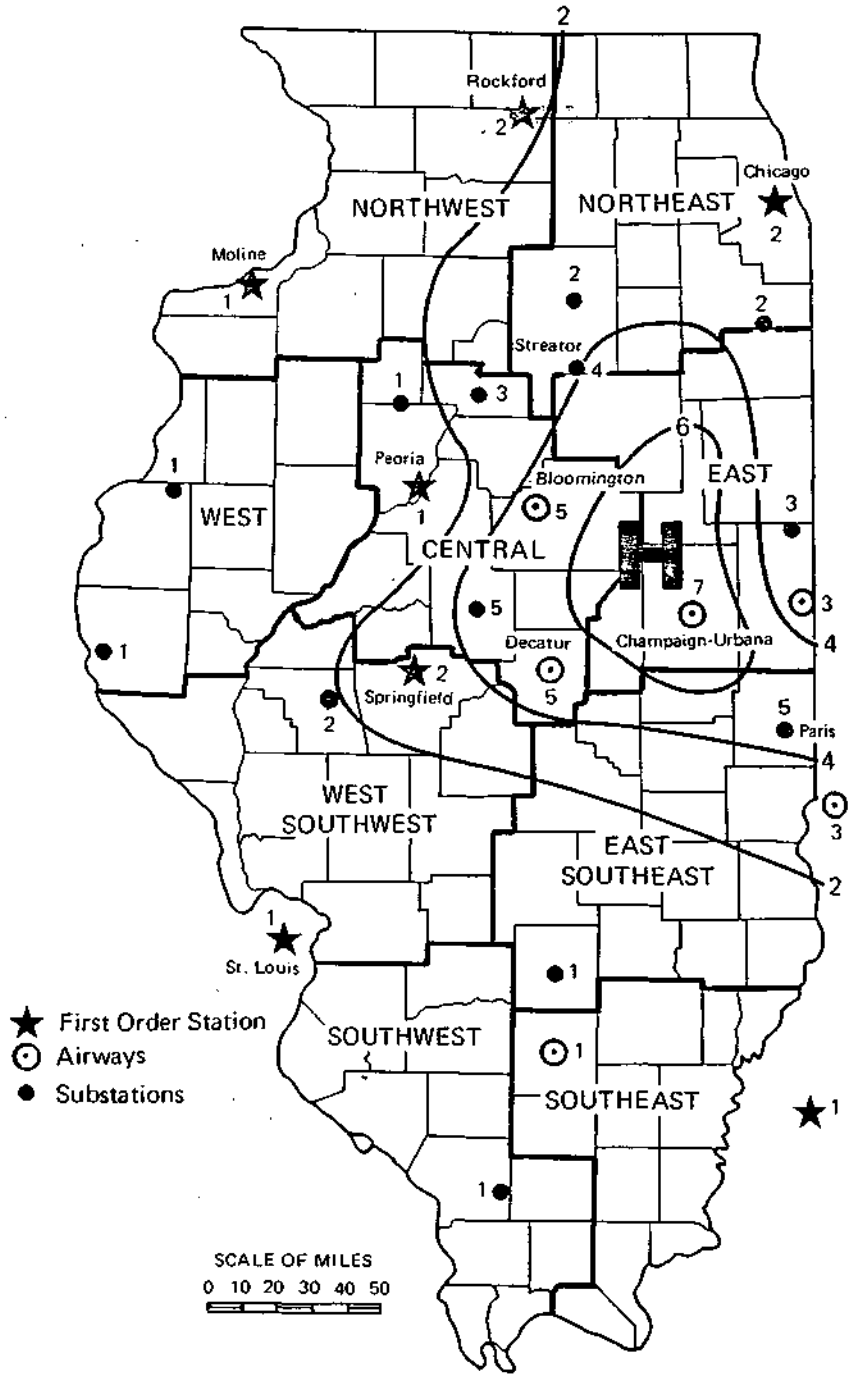


Figure 2. Number of days with windblown dust in 1981

Table 1. Dates of Blowing Dust in Illinois in 1981

Date	*Locales (and time if known)**
3/31	Danville (eve), Urbana (15-18), Peoria, Decatur (14-18), Princeville, Streator
4/1	Urbana (15-17), Hoopeston, Lacon, Ottawa, Streator
4/3	St. Louis, Peoria, Moline, Chicago, Urbana (14-15), Decatur (13)
4/5	Bloomington (14)
4/7	Urbana (16-20), Springfield, Chicago, Bloomington (17-24), Decatur (16-18), Hoopeston, Lincoln, Sidell, Streator, Chebanse
4/8	Danville (15), Terre Haute (16), Bloomington (01), Chebanse, Hoopeston, Lincoln, Sidell, Urbana (14-15)
4/2 3	Terre Haute (13), Decatur (14-18)
4/26	Urbana
4/28	Danville (18-20), Urbana (17-18)
4/30	Decatur (17)
5/3	Bloomington (16-22)
5/6	Quincy (18), Bloomington (17-24)

* 18 = 1800 or 6 p.m. Local Standard Time

HISTORICAL EVALUATION OF 1981 CONDITIONS

It was important to assess the 1981 dust conditions in a historical perspective. This was done by comparing the frequency of dust days in 1981 against those since the turn of the Century (when records began at most stations).

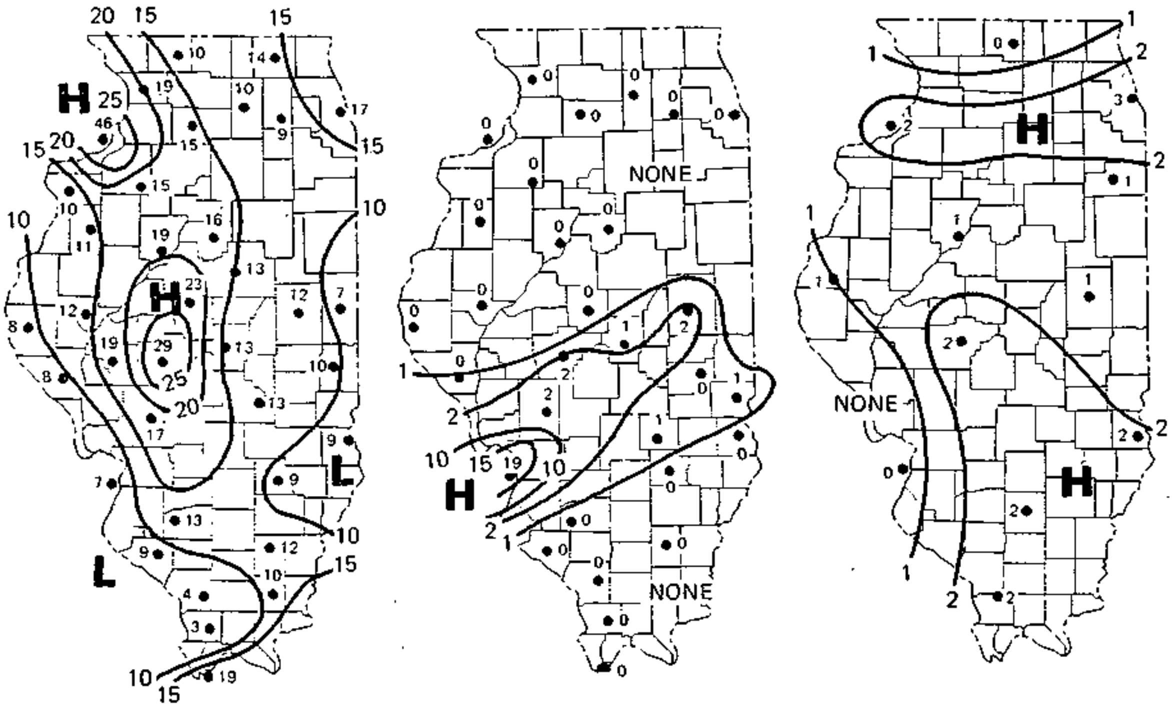
Patterns of Dust Days

Figure 3 presents patterns of dust days based on three past Illinois droughts, since there is a considerable expectation that blowing dust conditions are largely related to droughts. The first of these is for the 5-year period (1933-1937), a period of the worst droughts in Illinois (Huff and Changnon, 1963). The 1933-1937 pattern shows values ranging from less than 10 dust days to 46 days at Moline.

The second most severe drought in Illinois was one centered in south central Illinois during the early 50's. The frequency of dust days in Illinois based on that 5-year drought period, 1952-1956, is shown in Figure 3b. St. Louis had a maximum value with 19 dust days, but most Illinois stations in the drought area had only 1 or 2 days of blowing dust in this 5-year period.

The third drought analyzed was a recent one but only a moderate one occurring in southern Illinois during 1976-1977. The patterns based on the dust days in this 2-year dry period are shown in Figure 3c. Here, one finds values ranging from 0 up to 3 days (at Chicago) with the major high frequency area in southern Illinois.

The important conclusion from the three patterns (Figure 3) is that the maximum incidence of dust days occurred where the drought intensities were most severe within Illinois. Also, comparison of the earlier patterns with that for 1981 (Figure 2) shows that the 1981 values in east central Illinois were exceptionally high, particularly since it was only one year. The 1981 values in east-central Illinois exceeded those of the 1952-1956 and 1976-1977 droughts, and almost matched those of the 5-year drought of the 1930's.



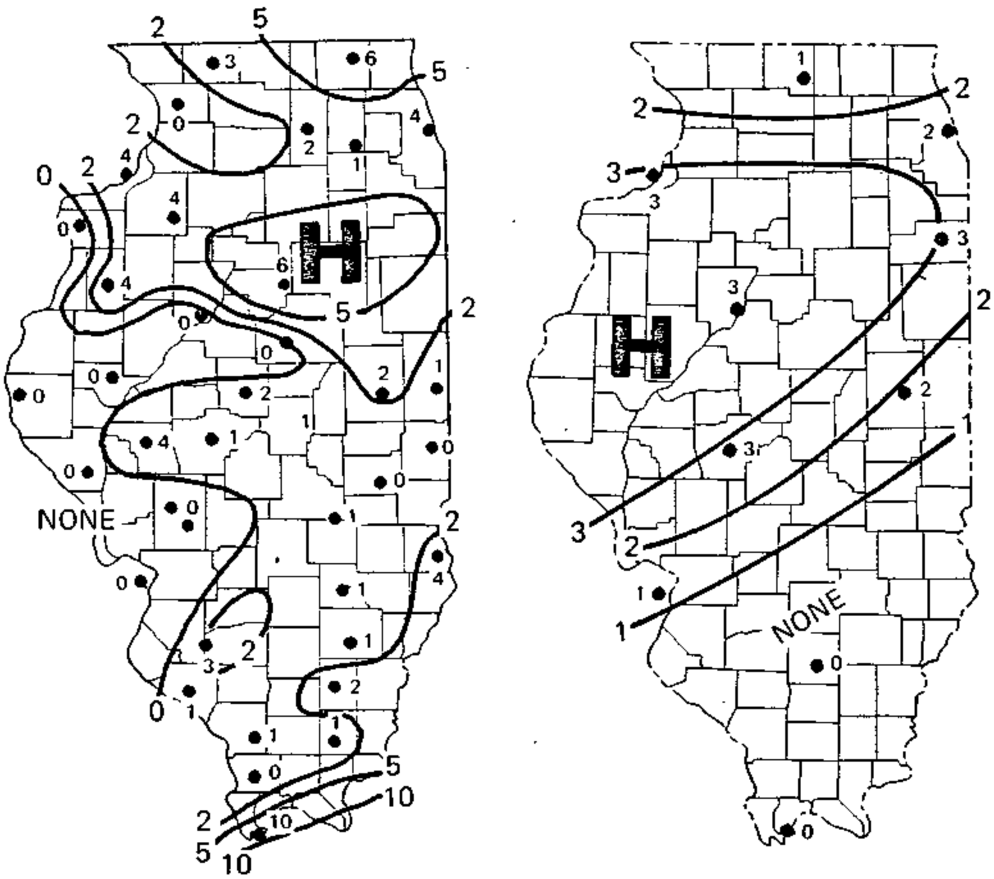
a. 1933-37 (5 years) b. 1952-56 (5 years) c. 1976-77 (2 years)

Figure 3. Number of days with windblown dust in 3 prior drought periods

The historical analysis also considered two other periods for a comparative assessment. A 30-year period, 1901-1930, with 5 moderate 12-month droughts (1910-11, 1913-14, 1920-21, 1922-23, and 1924-25) in Illinois, is shown in Figure 4a. The pattern based on the point values shows occurrences ranging from 0 days in western Illinois (no days with blowing dust in the 30 years) up to 4, 5, or 6 days in other parts of the state. Thus, parts of east central Illinois had more dust days in 1981 than occurred in the entire 30-year period that began in 1901.

A drought-free period of 19 years duration is shown in Figure 4b. This 1957-1975 period shows relatively few dust day incidences with none in the southern third of Illinois and a maximum of 3 found in the central and western parts of the state.

These various periods of drought and non-drought, and the 1981 conditions, were further analyzed as shown in Table 2. The lowest and highest station values in Illinois in each period are shown (most periods including the droughts had places in Illinois with 0, or no, dust days). A statewide mean value based on the stations with data are shown. Since the lengths of these periods varied from 1 year (1981) up to 30 years, the state means were normalized for comparison purposes to "point averages for 5 years." These 5-year averages are also shown in Table 2, and differences between them are informative. For example, multiplication of the 2.8 days, as a statewide mean in 1981, produces a 5-year value equivalent to 14 dust days. This is comparable to the 1933-1937 drought period with 13.3. It is also well in excess of the 1952-1956 drought value of 1.0. Importantly, the long non-drought period (1957-1975) had a very low 5-year point average and values greatly different from that in most drought years. However, it was greater than the



a. 1901-30 (30 years) b. 1957-75 (19 years)

Figure 4. Number of days with windblown dust in a long period with droughts and a drought-free period

Table 2. Number of Blowing Dust Days **for 1981** and Selected Historical Periods

Period	*Number of years*	*Station values lowest*	*Station values highest*	*Statewide point average*	*Statewide point average per 5 years*
1901-30*	30	0	10(Cairo)	2.0	0.3
1933-37*	5	3	46(Moline)	13.3	13.3
1952-56*	5	0	19(St. Louis)	1.0	1.0
1957-75	19	0	3(Springfield Peoria)	2.3	0.5
1976-77*	2	0	3(Chicago)	1.4	. 7.0
1981*	1	1	8(Urbana)	2.8	14.0

* Droughts

Table 3. Spring Season (March-May) Frequencies of Days with Blowing Dust in 1981 and in the Drought Years of the 1930's

Stations	*1933*	*1934*	*1935*	*1936*	*1937*	*1938*	*1981*	*Other years with dust day values equal to or higher than 1981 and since 1938 (1939-80)*
Chicago	0	2	6	6	0	0	2	1979, 1976
Urbana	0	3	3	2	2	0	7	None
Springfield	0	6	11	2	3	4	1	1977, 1975, 1967, 1962, 1954, 1945, 1941, 1939
Moline	1	10	11	5	3	1	1	1979, 1977, 1972, 1970, 1964, 1962, 1950, 1946, 1945, 1943, 1940, 1939
Peoria	0	5	8	1	1	1	1	1976, 1975, 1947, 1942, 1940, 1939
St. Louis	0	1	2	0	1	2	1	1971, 1965, 1956, 1955, 1954, 1953, 1947

value for 1901-1930 when five droughts occurred. The values in Table 2 reveal the extremeness of the conditions experienced in 1981. This is further shown by comparing the pattern and values for 1981 (Figure 2) with those in the past severe drought periods (Figure 3). The analysis of the patterns and the values in Table 2 indicates that the conditions in 1981 were singular, record or near record, frequencies of blowing dust conditions in east central Illinois.

Spring Season Comparisons

Further assessment of the abnormality of 1981 was pursued by a comparison of the spring 1981 conditions with those in prior springs. Table 3 is an analysis of the spring season (March-May) frequencies of days of blowing dust for the seven years in the severe drought of the 1930's. These are based on point data from 6 stations with quality historical records. Also shown in Table 3 are "other years with dust day values equal to or higher than that in 1981 (that have occurred since the drought ended in 1938)." Comparison of the 1981 value at Chicago (2 dust days) reveals it tied the 1934 spring value but did not match the 1935 or 1936 values of 6 blowing dust days. However, the Chicago value of 2 days of blowing dust in 1981 was as high as that achieved since 1936, except for values in 1979 (2 days) and 1976 (2 days). Thus, the two spring days of blowing dust at Chicago 1981 tied for the third highest of this Century.

The Urbana 1981 value of 7 is the record highest for the spring season, more than double those of any spring in the 1930's. The values at the four other first order stations in Illinois (Springfield, Moline, Peoria, and St. Louis) were all only 1 day in 1981. However, a value of 1 day per spring is in itself a fairly high value, as can be noted by their spring values in the 1930's and by the infrequent number of years since 1938 when a value of one dust day, or more, was experienced. For example, in the period of 1939-1980 (42 years) Springfield has had only 8 years when one or more blowing dust days occurred. Thus, the values of one spring dust day at these four first order stations were not records but were "well above average."

It is also notable in Table 3 that the five first order stations (Urbana excluded) had earlier high values in at least one year in the 1970's (i.e., Peoria had 1 or more dust days in 1976 and 1975). Comparison of the number of years shown as equaling or exceeding the 1981 value in the

Table 4. Decadal Frequencies of Blowing Dust Days at Six Illinois Stations

	STL	*P'IA*	*SPI*	*CHI*	*MLI*	*URB*	TOTAL.	*Decade rank*
1901-10	0	0	1	1	0	0	2	7
1911-20	0	0	0	1	0	0	1	8
1921-30	0	0	0	2	4	2	8	6
1931-40	.7	25	35	19	59	14	159	1
1941-50	5	7	12	10	16	5	55	2
1951-60	20	0	0	1	0	3	24	3
1961-70	3	2	3	3	4	1	16	5
1971-80	1	2	3	5	4	2	17	4
(1981	1	1	2	2	1	7	14)	

1938-1980 period indicates a resurgence of blowing dust conditions in the 70's, with more incidences in the 1970's than in the 1960's at most first order stations.

Possible Trends

The potential of trends in the dust day frequencies was examined. Basically, the incidences of blowing dust days are so infrequent that detection of trends is difficult. As has been shown, the incidences of blowing dust days are largely tied to drought conditions which have been indiscriminately distributed throughout the Century.

The decadal number of dust days at six Illinois stations with quality historical records for the 1901-1981 period are shown in Table 4. The impact of the droughts of the 1930's, 1940's, and 1950's is further revealed. The total dust day values, and their ranks, reveal that these 3 decades, in chronological order, are the leading 3 decades of the 8 decades in this Century. This suggests an upward trend to the 1930's maximum, followed by a decrease, or downward trend. However, the two most recent decades, 1961-1970 and 1971-1980, rank as fourth and fifth highest and with largely non-drought conditions during them (only two minor droughts, 1976-1977 and 1980-1981). Since the precipitation of these two periods also averaged higher than that of the early three decades of the 20th Century, the differences in dust days between the 1901-1930 period (with 5 droughts) and the 1961-1980 period presumably related more to differences in farm practices than weather conditions. One would conclude that since 1901 there has been an upward trend in dust day events in Illinois, although the major droughts in the middle part of the Century overlay the trend.

The 1981 values are also included in Table 4 to show the general relevance of the 1-year totals against the decades of the past. The 1981 values at the six stations almost match those of the two immediately prior decades, and exceed those of the first three decades of this Century. The blowing dust days are, in general, increasing but their incidence is heavily controlled by major drought situations. In assessing the significance of dust in 1981 it is important to realize that there is a slight upward trend with time, but that 1981 stands as an anomalous event. The critical weather-related questions then relate to the degree of severity (or lack thereof) of the weather conditions in 1980-1981 since the other major one-year extremes of the past have been during periods of extreme dryness with much windblown dust, often from external sources south and west of Illinois.

WEATHER AND CLIMATE CONDITIONS

Precipitation Conditions in 1980-1981

The investigation of the weather factors related to the 1981 severe dust conditions concerned the precipitation, soil moisture, wind, and temperature conditions. This section describes the seasonal and monthly precipitation conditions prior to and during the windblown dust periods. The three crop reporting districts in Illinois with the most severe dust conditions (Figure 2) were the northeast, central, and east districts. The area mean precipitation in these three districts for the fall of 1980, winter 1980-1981, March 1981, and April 1981 are shown in Table 5. Shown are the total precipitation values and their departures from normal. Also shown are the number of times, during the largely non-drought 1957-1979 period, when precipitation values lower than those in 1980-1981 occurred, as well as the two most recent years with values lower than those in 1981. These values are used to help interpret the significance of the 1980-1981 conditions in light of those in the last 23 years when reasonably similar agricultural practices have been employed.

Inspection of the precipitation departures reveals that in the two worst areas, the central and east districts, the precipitation in both the fall and winter was somewhat below normal. The greatest negative departures in both fall and winter were found in the east district where dust was worst. The winter season precipitation in the east district of 4.23 inches was 1.4 inches below normal or only 65% of the normal value. As shown in Table 5, only 5 winters in the prior 23 years had lower values, but these included recent dry winters of 1979-1980 and 1976-1977. Thus, in the six months prior to the onset of the dust conditions in March 1981, the precipitation in the central and east districts was below normal but not at an exceptionally low level and with recent years having comparable or greater departures. Thus, the 1980-1981 antecedent precipitation conditions were not extreme nor unique events.

Table 5. Monthly and Seasonal Precipitation in Prime Dust Areas

Districts	*Total precipitation, inches*	*Departure from normal, inches*	*Number of times in 1957-1979 (23 years) period with lower values*	*Two most recent years with lower values than 1981*
		Fall (Sept.-Nov.) 1980		
NE*	9.88	+1.85	16	1979, 1976
C*	7.32	–1.12	10	1979, 1978
E*	7.01	-1.16	6	1979, 1978
		Winter (Dec. 1980-Feb. 1981)		
NE	4.77	-0.42	10	1979-80, 1977-78
C	4.80	-0.75	8	1979-80, 1977-78
E	4.23	-1.47	5	1979-80, 1976-77
		March 1981		
NE	0.62	-2.00	1	1958
C	1.06	-1.71	1	1958
E	0.63	-2.08	0	none in 1957-80
		April 1981		
NE	5.38	+1.57	17	1979, 1978
C	5.91	+1.67	19	1979, 1978
E	6.73	+2.60	21	1979, 1978

* NE = Northeast, C = Central, E = East

Table 6. Other Springs with High Dust Day Frequencies in Illinois during 1901-1981, and Associated Precipitation Conditions

	Districts where dust was bad	*Winter and spring mean precipitation departures (inches) around normal for districts of bad dust**	
		Winter	*Spring*
1934	NW,_C, E	-3.0,-3.2,-3.3	-6.0,-6.2,-5.9
1935	NE, NW, W, C	-0.3,-0.2,-1.5,-1.3	+2.0,+2.1,+4.5,+4.7
1936	NW, NE	-0.9,-1.1	-4.5,-5.0
1937	NW, W, C	+1.8,+2.2,+2.7	-0.7,-2.2,-2.4
1953	WSW, SW, ESE	-1.2,-2.4,-1.7	-0.6,-0.1,+0.2
1954	WSW, SE, ESE	-2.4,-2.2,-2.7	-4.8,-4.2,-5.0
1955	SW, ESE	+0.4,-0.2	-0.3,-0.7
1977	WSW, ESE, SE	-2.3,-3.5,-5.4	+1.5,-1.5,-0.7
1981	C, E	-0.8,-1.5	+3.1,+1.5

* These are for the districts in the order shown in left column: Thus, in 1981, the C (central) district precipitation in the winter was -0.8 inches (below normal), and the spring value was 3.1 inches above normal.

The March 1981 rain values shown in Table 5, however, reveal that it was an anomalous event. District precipitation values were ail much below normal and were either the driest or second driest since 1957. The 0.63 inch average for the east district was more than 2 inches below normal and was the driest in the area since 1957. Clearly, March 1981 was a near record dry event following moderately dry fall and winter seasons. The April 1981 rainfall conditions in the three dust areas were all much above normal rainfall.

An important aspect for evaluating the record dust conditions in 1981 is to compare the spring 1981 antecedent precipitation conditions with those in other prior years of major dust activity. Table 6 identifies, for prior major dust years, the districts where the dust frequencies were exceptionally high. First, inspect the 1981 conditions. Here, the central and east districts are shown along with departures of their winter and spring precipitation values. Interestingly, the spring values of 1981 were above normal due to the wet April and May which overwhelmed the deficiencies in March, a problem with seasonal precipitation analyses. Nevertheless, a comparison of the departures in 1981 with those shown for other spring seasons when bad dust conditions existed is informative. The winter 1981 departures (—0.8 and —1.5 inches) rank as less severe than most. There are 25 winter departures and 12 were greater (more below normal) than those in 1981; this reveals that the antecedent conditions for 1981 were not extreme events. Most other cases of bad spring dust conditions, other than 1937 and 1955, were preceded by winters with greater below normal departures of precipitation than were experienced in 1981. Only 1935 had spring rain totals heavier than in 1981; all other spring rains were lower.

From this climatological assessment, it can be concluded that the winter prior to the 1981 ' dust situation was only moderately dry, and that the spring was not excessively dry. The 1980-1981 seasonal precipitation conditions were certainly not extreme nor anomalous. Dry yes, extreme no. From a precipitation standpoint, there have been recent years, including the 1977-1978 winter-spring and the 1979-1980 winter-spring with conditions drier than those of 1981. However, neither of those years had an unusually dry March. Thus, if the weather conditions in 1981 were a major influence on the dust conditions, they had to relate to the rather unique conditions in March, and not so much to prior seasonal conditions.

Table 7. Soil Moisture Conditions across Illinois, as Assessed by Farmers in Spring 1981

Status of soil moisture	Percent of state by given date in 1981 3/23	4/6	4/13	4/20	4/27	5/4	5/11
Short	87	99	86	33	12	15	15
Adequate	13	1	14	62	78	65	76
Surplus	0	0	0	5	10	20	9

Urbana 4/14 = 60% of plant available moisture in top 7 feet
4/24 = 67% of plant available moisture (amount in top 16 inches had decreased)
5/1 = 53% of plant available moisture, most located in upper 2 feet

Soil Moisture

The soil moisture conditions evaluated qualitatively by Illinois farmers are summarized for the spring of 1981 in Table 7. Cooperating farmers report to the Illinois Crop Reporting Service on a weekly basis indicating whether their soil moisture is short, adequate, or surplus. Their reports are used to develop a statewide estimate of conditions on a weekly basis.

The percentages of Illinois reported with short, adequate, or surplus soil moisture during the spring of 1981 are shown in Table 7. On 23 March 87% of Illinois was reported as being short on soil moisture with 13% adequate and none surplus. By 6 April 99% of the state was listed as short. These conditions reflect the extreme dryness during March. The initiation of rainfall after the first week in April brought a rapid increase in soil moisture, and by 27 April only 12% of the farmers in the state were identified as having short soil moisture with 78% adequate, and 10% with surplus soil moisture.

Also listed in Table 7 are comments based on soil moisture measurements begun by the State Water Survey at Champaign-Urbana in the spring. On 14 April the soil column comprising the upper 7 feet showed 60% of the plant available moisture available, and by 24 April it had increased to 67%, although the amount in the top 16 inches had decreased. On 1 May the plant available moisture in the top 7 feet of soil was decreased to 53% with most of it in the upper 2 feet.

The information in Table 7 reveals that during the spring of 1981, there was a major depletion of moisture in the upper 6 to 7 feet of soil, at least in Champaign-Urbana which was in the center of the dust area. Even though it rained considerably at Champaign-Urbana in the period of 9 April through 28 April (see Table 11), the moisture still did not replenish the soil moisture deficit by the end of April.

The Champaign-Urbana soil moisture profiles suggest two critical processes. First, the unseasonably high temperatures (which will be discussed later, see Tables 10 and 11) coupled with the deficient soil moisture distribution and the normally high spring winds indicate that large amounts of water from the rains in mid to late April (and early May) were being evaporated. Secondly, considerable percolation of water down to the deeper soil horizons to replace the deficient moisture was in process. The first period of dust days, as shown in Table 1, came at the end of a moderately dry fall-winter and a very dry March. The second period of dust days during late April and early May came at a period when the rains stopped for about 8 days and when temperatures were above normal. Most important is the fact shown by the soil moisture conditions in Urbana; the relatively heavy mid-April rains largely evaporated and percolated downwards. They did not bring the upper soil layers to saturation.

Table 8. Peak Gusts with Blowing Dust Conditions

	Speed, knots, 1981 days	*Speed, knots, on dust days in prior years, 1941-1980*
Moline	26	24, 19
Springfield	37	42, 29, 30,45, 40
Chicago	23, 37	46
Peoria	34	46, 33
Urbana	38,45, 30, 40,46, 44,49, 55	not available
Danville	30,30,30,25,25	not available
Terre Haute	32	not available
Bloomington	35, 40, 35, 30, 30	not available
Decatur	40,37,35,32,20	not available
St. Louis	27	31,38,20,25,47,31,40 33, 22, 30,45, 35,40,48 30
	Mean = 34.5	Mean = 34.9 knots
	Range = 20 to 55	Range = 19 to 49

Wind Conditions

A comparable climatological question existed about the magnitude of the wind speeds associated with the 1981 dust events, and how the 1981 winds compared with those in prior years, so as to assess the normality of the 1981 conditions. Table 8 presents the peak speeds recorded during the blowing dust conditions in 1981 at several stations. Also listed are wind speeds for dust days that occurred in prior years. In 1981 there were speeds from 30 separate places and days with the speeds ranging from 20 up to 55 knots. The mean was 34.5 knots. There were 25 daily values from blowing dust events before 1981, and they indicated a range of from 19 to 49 knots and a mean of 34.9 knots: The two means are almost identical, indicating that the winds which produced the dust events in 1981 were not particularly different from those in prior years.

Another analysis to evaluate the wind conditions in 1981 related to the frequency of high wind days. Changnon (1980) made an analysis of high wind events in Illinois and determined the average and extreme number of days of high winds for many stations.

Table 9 shows these frequencies for four substations in the high dust frequency area of 1981, and for the five long-term first order stations in Illinois (lower part of Table 9). For the four substations one finds the historical average and the 1-year maximum value of spring days with 40 mph or higher winds. For comparison, the number of days in 1981 with winds of this speed are shown. All came with dust. For example, at Urbana there were 3 days in which the winds exceeded 40 mph and all were with dust. This is more than the average number of days with ≥ 40 mph in spring (with or without dust) but well below the maximum at Urbana of 9 days in spring. The differences shown for the other 3 substations indicate that there we're not abnormally large numbers of high wind days.

In the lower part of Table 9, the data for the 5 first-order stations including the average number of days in spring with winds of 40 mph or higher are shown. Also shown are the total number of such high wind days in 1981, and the high wind number in 1981 with blowing dust. This reveals that the number of 1981 high wind days was not abnormally high or low, and that only a small number of the high wind days in 1981 actually were associated with dust.

Table 9. Frequency of Spring High Wind Days*

	Substations: Historical	1981 Number of days
Urbana	Average = 1.7 days	3 days (all with dust)
	Maximum = 9 days	
Danville	Average = 1.6	0
	Maximum = 11	
Bloomington	Average = 1.4	2 days (both with dust)
	Maximum = 9	
Decatur	Average = 2.0	2 days (both with dust)
	Maximum = 6	

First Order Station	Spring average days	1981 total days	1981 (with dust)
Chicago	2.0	2	1
Moline	2.7	2	0
Springfield	6.4	4	1
St. Louis	1.7	3	0
Peoria	1.1	2	0

* Days with gust > 40 mph.

Table 10. Seasonal and Monthly Temperature Conditions in the Prime Dust Area of 1981

	Fall (Sept.-Nov. 1980)		Winter (Dec. '80-Feb. '81)		March 1981		April 1981	
District	Mean temp in °F	Departure from normal °F	Mean temp in °F	Departure from normal °F	Mean temp in °F	Departure from normal °F	Mean temp in °F	Departure from normal °F
Northeast	51.1	-2.0	25.6	-0.2	37.9	+1.8	52.6	+3.2
Central	53.8	-0.8	28.4	+0.2	40.9	+2.0	57.0	+4.4
East	53.0	-1.3	27.4	-0.8	40.4	+1.8	55.3	+3.5

The conclusions derived from the data in Tables 8 and 9 are that winds in 1981 were not exceptionally greater than winds with dust in prior years, nor was the number of days with high winds exceptionally large in 1981. Thus, high winds in the spring of 1981 were not anomalous events.

Temperature Conditions

Table 10 presents the seasonal and monthly temperature conditions in the prime dust areas of Illinois in 1981. Shown are the antecedent conditions for fall and winter and those during March and April 1981. Basically, these reveal that the temperatures in the fall of 1980 (which was moderately dry) were slightly below normal. The winter temperatures were very near normal. The March 1981 temperatures were considerably above normal, 1.8 to 2.0°F, and the April temperatures were much above normal, 3 to 5°F.

Since prior research has shown that wind-produced soil erosion was related to the frequency of freeze-thaw cycles (Bateman and Hinesly, 1967), the frequency at Urbana in the center of the peak dust activity was determined. Unfortunately, data for shallow soil layers were not available, but other data were examined to get an estimate. Freeze-thaw cycles are defined as excursions in the daily temperatures from above freezing to below freezing, or the return, during a one day or longer period. The Urbana air temperature data for the winter of 1980-1981 show that there were 72 such events (height 5 feet above the ground). Hershfield (1979) did a historical study of such events and this indicated that the frequency in central Illinois was 71 freeze-thaw cycles per winter on the average. Thus, the 1980-1981 frequency based on air temperatures was normal. The Urbana soil temperatures at the 4-inch depth showed 10 freeze-thaw cycles in the 1980-1981 winter. This is one more than normal based on the past 10 years.

Meteorological Analysis of Individual Dust Days

After a rainless period throughout central Illinois from 5 March to 29 March, widespread moderate rainfall occurred on 29-30 March. Most portions of central and northern Illinois received between 0.2 and 0.6 inch on 29-30 March. However, the first major day of windblown dust in 1981 occurred on the following day, 31 March. The pattern of dust on that day is shown in Figure 5, revealing a large area of dust stretching from Princeville in north central Illinois southeastward into central and eastern Illinois.

On the next day, 1 April, blowing dust was reported in the same general area of Illinois (Figure 5), with no dust on the following day. April third marked the third out of four days with extensive areas of blowing dust in central and northern Illinois.

The sequence of blowing dust conditions was stopped temporarily by widespread light to moderate rains in Illinois on 4 April. Most of the central and northern portions of the state received between 0.1 and 0.5 inches with a few locales receiving up to 1 inch in this 1-day respite. However, two days later, extensive blowing dust conditions appeared again, producing the extensive pattern of blowing dust shown for 7 April. All of central, eastern, and northeastern Illinois were covered by blowing dust on that day and on the next day, 8 April.

Blowing dust conditions then disappeared with the beginning of a sequence of rain days on 9 April. Widespread rainfalls occurred across Illinois on six successive days, 9-14 April, with more rains again on 16-17 April, 19-20 April, and 22-24 April.

1981 Weather Summary

As shown in Tables 5 and 10, the fall and winter preceding the spring of 1981 and its extreme dust conditions had deficient precipitation, although not exceptionally dry, and near normal temperatures. It is important to realize that the summer conditions, prior to the fall of 1980, in central Illinois were warm and dry, particularly in July.

Table 11 presents the weekly temperature and rainfall values at Urbana, which is in the center of the dust area, for the March-May 1981 period. These weekly values have been expressed as departures from normal to get a sense of the week-to-week differences. Inspection of the weekly values shows interesting weather sequences. Above normal temperatures persisted throughout most of March and through 18 April; only the week of 15-21 March had temperatures averaging below normal. Furthermore, the positive temperature departures from 22 March through 18 April were exceptionally large, ranging from 6 to 14 degrees.

The weekly rainfall departures shown in Table 11 reveal persistent dry conditions from early March through early April. This was followed by a wet week, 5-11 April, and then another

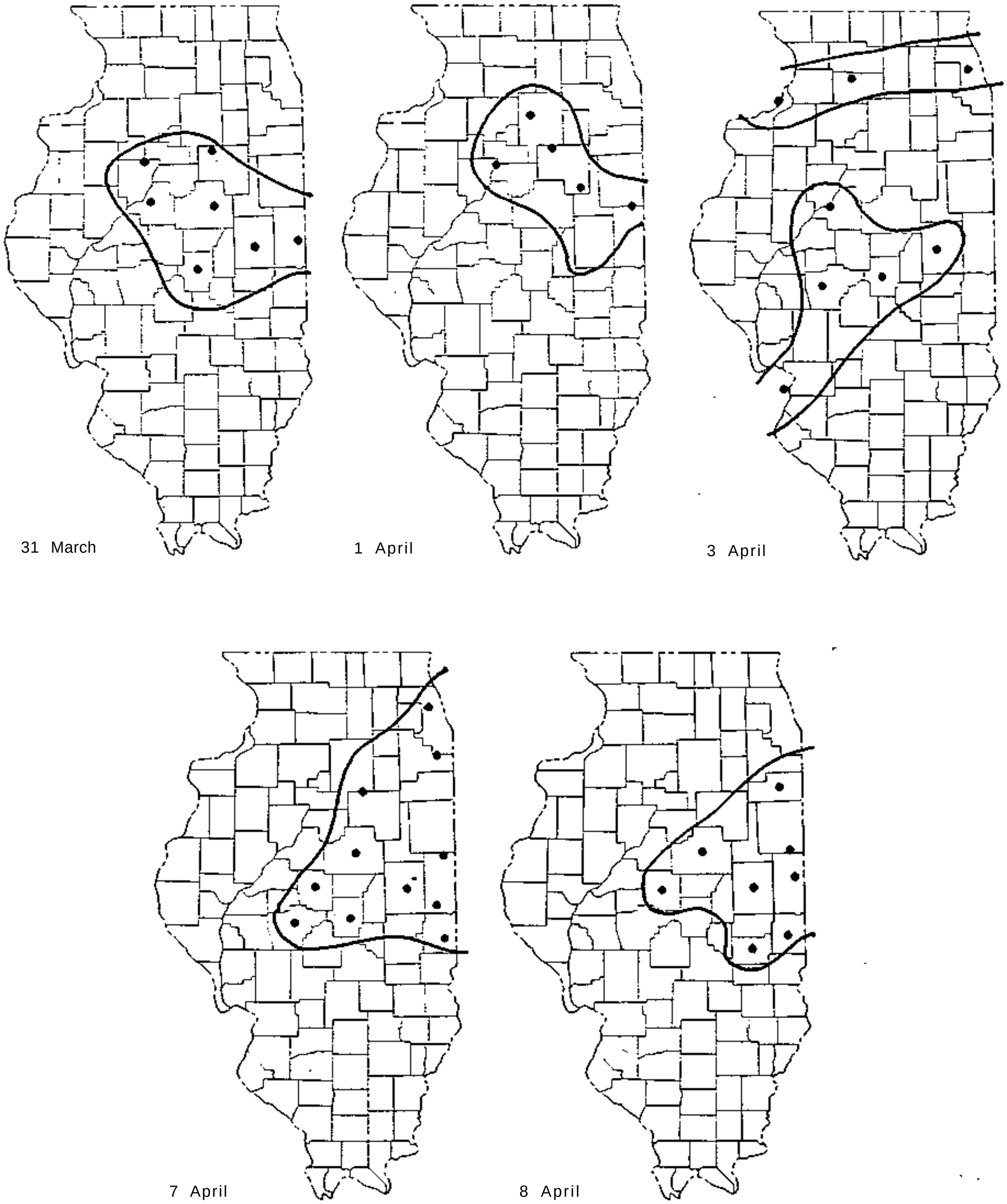


Figure 5. Areas of blowing dust reported on selected days in 1981

Table 11. Weekly Mean Temperature and Total Rainfall Departures at Urbana in 1981

		Average temperature, °F	*Rainfall, inches*
March 1-7	=	+ 2.2	-0.9
March 8-14	=	+ 0.7	-0.71
March 15-21	=	- 4.0	-0.67
March 22-28	=	+ 6.0	-0.73
March 29-April 4	=	+14.0	-0.06
April 5-11	=	+ 6.1	+1.03
April 12-18	=	+ 7.4	-0.30
April 19-25	=	- 4.0	+0.37
April 26-May 2	=	+4.1	-0.15
May 3-9	=	- 2.0	+0.03
May 10-16	=	- 8.3	+2.01
May 17-23	=	- 3.1	+0.29
May 24-30	=	+ 2.0	-1.01

week with a negative departure. Thus, persistent dry and warm conditions were antecedent to the major outbreak of windblown dust during the 31 March - 8 April period.

The second outbreak of less widespread severe dust conditions in late April and early May came in a period of deficient precipitation and warm conditions. In particular, the week of 26 April—2 May was very warm and dry.

In essence, the combination of these spring and antecedent temperature and precipitation conditions produced the low soil moisture conditions at the start of the plowing period for the growing season of 1981. Swanson and Jones (1966) have estimated that in only 20% of the years does this area enter the growing season with its soil moisture below saturation.

ANALYSIS OF SOILS AND FARM PRACTICES

The purpose of this study has been to determine the cause/s of the record high frequencies of blowing dust conditions in central and eastern Illinois in 1981. Various weather conditions have been examined and the values related to normal and other extreme events of the Century. Obviously, the occurrence of the blowing dust conditions in spring establishes the fact that farm practices, visualized as spring tillage, fertilizing, and planting, are major factors in the incidence of blowing dust. Such soil-breaking activities loosen the soil particles, and soil types can play an important role in the erosion potential of an area.

Soils

A study by Bateman and Hinesly (1967) evaluated the benefits and disbenefits of fall plowing and spring tillage. Their results furnish insight about how soils and farm practices interact to allow wind erosion. Although water erosion is the most serious problem for soils in Illinois, there are years when tilled soils produce a serious wind erosion problem. The wind erosion may occur in the fall and winter (with fall plowing) but it is usually a spring season phenomenon (Bateman and Hinesly, 1967).

Research has shown that dry soil particles or aggregates of fine to medium sand grain size are readily set in motion by winds with speeds of 13 to 15 mph at 1 foot above a smooth soil surface (USDA, 1961). High winds are required to dislodge and put in motion particles of greater or smaller size. Particles smaller than the fine grain sand size have a greater cohesion and do not protrude sufficiently high above the layer at the soil surface to be moved. Particles and soil aggregates larger than the medium sand grain are not as readily moved by the wind because their surface area (per unit weight of particle) presented to the force of wind decreases as the particle size increases. Hence there is an optimum soil particle size for wind erosion.

Because of the wind differential between the upper and lower portions of the wind-erodible particle, the wind makes the particle roll and spin until the pressure difference between its top and bottom becomes great enough to overcome the gravity. Once the air pressure or force exceeds the force of gravity, the erodible particles of up to 0.02 inch in diameter may rise or jump the vertical distance of a foot or more. As they move across a soil surface in a short series of bounces, they cause other dust particles to rise which otherwise would be resistant to erosion. The small particles then become suspended in the air for many miles before they settle out. The larger particles may be bombarded by the erodible particles and become sufficiently small through abrasive action to become erodible. The winter processes of rapid freezing, thawing, wetting, and drying of fall plowed soils aid in the pulverization of large clods. These weather processes also often set the stage for severe wind erosion in the spring. However, in the winter of 1981, these periods of freezing and thawing were not frequent and were near average.

Since a particle about half the size of a wheat kernel is the dividing point between the larger erodible and the non-erodible soil grains, soil scientists have determined which soils are more erodible than others.

In the Bateman-Hinesly (1967) study, information was presented on the erodible particle sizes with Drummer silty clay loam, a typical soil found in central and eastern Illinois, the area of high windblown dust. When these soils are fall plowed, the study found that after planting in the spring, 54% of the total dry sample weight of the soil was in erodible size particles. Of the fields that were not fall plowed but were spring plowed, the research showed that after planting 38% were of erodible sizes. Obviously, fall and/or spring plowing have a considerable effect on the erodibility of these silty clay loams.

Bateman and Hinesly (1967) state that "wind erosion is not an uncommon sight where expansive areas of dark-colored prairie soils are fall plowed." They identified that these soils, through plowing, have many soil particles susceptible to erosion, and the problem is markedly worsened by fall plowing. The central and east crop reporting districts lead all others in the amount of fall plowing (I11. Agr. Energy Advisory Committee, 1975). The 1974-1975 values indicate 90% of all corn acreage in the east district was fall plowed and 72% of all acres in the central district was fall plowed. The highest values in other districts include 61% in the west-southwest, and 57% in the east-southeast. Most of the state's farmers who deep plowed, ≥ 10 inches, were in central and eastern Illinois also. Importantly, a very large percent of the particles associated with the soils common to central Illinois soil are in erodible sizes.

Important to an understanding of what occurred in 1981 are further findings of the Bateman-Hinesly study. They state, "Once wind erosion begins, it can continue at wind velocities very much lower than the velocity required to initiate soil movement. Rains may temporarily stop wind erosion, but most of the erodible particles are water stable and movement begins again as soon as the soil surface becomes dry." This appears to have been a very important factor in the 7 and 8 April dust cases (Figure 5), and in the resumption of blowing dust in late April and May after considerable rainfall had occurred but when planting had begun in earnest.

It is important, for obtaining an understanding of the 1981 situation and for future planning to minimize wind erosion, to realize that the silt loams, which are the common soils of central Illinois, are likely among those most subject to wind erosion. These soils experience less crusting by rainfall, and they produce a great number of water-stable particles of erodible size. Further, they are often fall plowed to obtain a better seed bed, and this adds to the windblown erosion potential.

Comparison of the pattern of Illinois soil types (Wascher et al., 1967) with.that of blowing dust days in 1981 (Figure 2) revealed an amazing similarity. The two areas of great dust frequency (central and east-central crop districts) are largely occupied (75%) by a group of similar soils. The characteristics of these soils are: 1) dark colored prairie soil; 2) deep subsoil of medium texture and moderate permeability; 3) nearly level topography; and 4) high to very high productivity ratings. This type is among the best soil in Illinois, and the soils in the extreme dust area are classed as the C, H, and R soil associations by Wascher et al. (1967). They occupy 17.3% of Illinois.

However, these associations are very similar to the "K" soil association in western and northwestern crop districts, areas which did not have excessive windblown dust in 1981. This K soil area comprises another 13.9% of Illinois. Importantly, then, the west (W) and northwest (NW) districts could serve as "controls" for investigating regional differences and for discerning the causes of the excessive dust in the central (C) and east (E) districts. The W and NW districts do have lesser amounts of the highly erodible soils (about 45% vs 75% in the C and E). They also experienced much less fall plowing in 1974-1975 than did the central and east districts (I11. Agr. Energy Advisory Committee, 1975).

Comparison of 1981 conditions in the C and E with those in the W and NW revealed: similar planting rates; identical spring weather conditions (dry warm March, wet warm April); and comparable temperature conditions (fall, winter, and spring of 1980-1981). However, the weather in the NW and W districts differed in that they had normal to above normal precipitation in the summer of 1980, fall 1980, and winter of 1980-1981. This indicates that the subsoil moisture levels at the start of the 1981 plowing season (March) were likely much higher in the W and NW than those in the C and E districts.

This suggests that with today's farm practices in these prairie soils, the amount of windblown soil erosion is very dependent on the soil moisture conditions, not only that near the surface but in total depth (6 ft) of the soil column. After dry cold seasons, the spring rains are used to recharge the deeper soil levels in these permeable soils, leaving the upper levels less than saturated, drying rapidly, and very susceptible to wind erosion.

Farm Practices

Given this knowledge of the predominance of very erodible soils in central Illinois, and the effect of tillage on them, it is interesting to review the farm practices during 1981. The Illinois Weather and Crop Report for 23 March 1981, stated that "excellent weather for field work existed through most of March which allowed farmers to begin field tillage earlier than normal over most of Illinois." This is established by the statistics presented in Table 12, as obtained from the weekly "Illinois Weather and Crop Reports."

The status of plowing for corn and the planting of corn, on a weekly basis, is shown in Table 12 for 1981, for the previous year (1980), and for the average of the past 5 years (1976-1980). For example, on 23 March, 83% of the corn plowing had been completed, as compared to 69% completed on that date in 1980, and an average of 65%. This much faster rate of completion

Table 12. Rate of Spring Plowing and Planting for Corn in Spring 1981 in Illinois

(Percent completed on given dates)

Plowing for Corn

	3/23	*4/6*	*4/13*		
1981	83	92	94		
1980	69	72	78		
Average (past 5 years)	65	70	75		
	Planting for Corn				
	4/13	*4/20*	*4/27*	*5/4*	*5/11*
1981	1	3	5	18	48
1980	0	0	10	45	84
Average	1	4	13	34	57

of plowing existed on through 13 April, remaining 20% above average. This of course was a result of the extremely dry and warm conditions in March (Table 11). In essence, the greater amount of earlier completion of tillage by late March, coupled with the drier and warmer than usual conditions, and the normal wind conditions apparently set the stage for the excessive amount of wind-blown dust in the 31 March — 8 April period where the most erodible soils predominated in Illinois.

The rate of *planting* of corn in 1981 (Table 12) reveals a different story. By 27 April, which is the time that the second period of blowing dust began, the planting of corn was behind schedule. As shown in Table 11 and Table 5, conditions had been extremely wet in mid-April which had effectively put corn planting much behind the average rate. Nevertheless, the soil moisture data (Table 7) indicated that the soils down to 7 feet were still relatively dry in April, such that much of the above normal rainfall in April was either evaporating or percolating downward through this deep and dry soil layer.

The delayed corn planting extended into early May with rapid expansion in May as shown by the jump from 18 to 48% between 4 May and 11 May. Again, there was considerable field work during the late April-early May period. This helps account for the second series of wind-blown days recorded in the 23 April — 6 May period (Table 1).

Since wind erosion is a function of soil type (surface soil aggregation or cloddiness), vegetative cover, shape of soil surface, and field size (in addition to weather factors), it is appropriate to also examine these factors for recent changes. It is well recognized that by 1981 there were fewer hedge rows and fence rows with grass than there were 10, 20, or 30 years ago in central Illinois. Between-field cover helps reduce wind speed and the loss of cover in recent years has increased the potential for wind erosion. Furthermore, there has been a tendency to larger farms and fields, and larger fields without vegetative cover futher increase wind erosion potential.

In summary, the central and eastern Illinois areas where the record blowing dust conditions existed in 1981 were where:

.1) Soils with relatively many wind erodible particles predominate (the prairie soils)
2) There is extensive fall plowing
3) There are few fence or hedge rows
4) Abnormally dry and warm March conditions allowed extensive early spring plowing

CONCLUSIONS

A reconstruction of the spring 1981 conditions, along with the antecedent fall and winter conditions, is relevant to understanding the immediate causes of the dust occurrences in 1981. The fall and winter preceding March 1981 had moderately below normal precipitation with near normal temperatures.-Illinois entered the growing season of 1981 with nonsaturated soils, a condition that occurs in one out of five years, on the average. The antecedent weather conditions were not record or extreme events. March, however, was an exceptionally dry and warm month, one of the driest on record. The central and eastern portions of the state had had considerable 1980 fall plowing because fall was dry also. Then the unusual opportunity afforded by the dry and warm March conditions, particularly in the latter half of March, brought extensive spring plowing and fertilizing. Three straight weeks of very warm and dry conditions from mid-March until the second week of April resulted in considerable tillage at a time of normally high winds of early spring. This was associated with the first series of six days with blowing dust in central, eastern, and parts of northern Illinois.

This early unusual weather was followed by a wet and warm period from 9 April through 25 April with many days of moderate rainfall. The rainfall went in three directions: some ran off, above normal amounts were likely evaporated due to the higher than normal temperatures, and the dry soils consumed much of the water. Dryness extended to more than 7 feet, so that much of the rainfall entering the soil percolated rapidly downward leaving the surface dry.

By the latter part of April, after 3 to 4 inches of rain in the 2-week period, the near surface soils were still relatively dry, and a few days of above normal temperatures without rainfall allowed the surface to dry again. Large numbers of farmers who had waited impatiently to plant their corn got into the fields in the last week of April and the first week of May attempting to get the delayed corn planting done. This second burst of field activity, occurring in soils that were still not saturated, led to the second period of blowing dust days during late April and early May. However, the extent of the dust on these days was not as great as in the early period.

Thus in analyzing the causes for the blowing dust days in 1981 one can point to an interaction of agricultural practices and moderately unusual dry weather. *The fall plowing and spring tillage (which was done early due to favorable March weather conditions) of the highly erodible prairie soils in central and eastern Illinois was clearly a major factor.* The below normal fall, winter, and early spring rainfall conditions resulted in deficient soil moisture to great depths, and spring rains that fell did not leave the upper erodible soil layers wet very long. Above normal temperatures aided and abetted the evaporation of surface moisture. Winds were not extreme, only normal for spring, but spring is the period of greatest wind speeds.

Contrasting these case study results against efforts to predict the wind erosion potential reveals the importance of using a predictive approach that employs seasonal values rather than annual values. The predictive approach of Bondy et al. (1981) using crop stage calculations is a step in the right direction, but the criticality of the soil moisture situation in the 1981 erosion case indicates the need to incorporate moisture indices in predictive approaches.

The above explanation for 1981 appears reasonable and defensible, but does not answer which factors were critical to the record outbreaks of blowing dust.

Hence, an evaluation of the relative importance of the two causes of the blowing dust in 1981 (farming practices and weather conditions) was conducted. The weather-related factors identified as relevant to the outbreak of dust in the spring of 1981 involved a sequence of 1) a moderately dry fall 1980, 2) a moderately dry winter, and 3) a warm and very dry March. Since these events (which produced deficient soil moisture and allowed fall plowing and early tillage)

Table 13. Normality of Critical Weather Conditions in 1980-1981
and in Similar Prior Years at Urbana during 1889-1981

Year	*Fall precipitation*	*Winter precipitation*	*March precipitation*	*March temperature*	*Number of blowing dust days in spring*
1981	Below*	Below	Below	Above*	7
1958	Below	Below	Below	Below	0
1957	Below	Below	Below	Near*	0
1956	Above	Below	Below	Near	1
1954	Below	Below	Below	Near	1
1941	Below	Below	Below	Below	0
1936	Near	Below	Below	Above	2
1910	Near	Below	Below	Above	0
1905	Below	Below	Below	Above	0
1895	Below	Below	Below	Near	0

* Below indicates below normal (lowest third of the 93 values); Near is near normal (central third of 93 values); Above is above normal (upper third of the 93 values).

appear to be the key weather factors, one can look to past years of similar weather and to their ensuing blowing dust occurrences.

Examination of the Urbana historical weather data for 1889-1981 revealed nine past seasons very similar to that in 1980-1981. Urbana is in the center of the blowing dust area of 1981 (Figure 2). The existence of ten similar seasons (Table 13) in 92 years (10%) indicates it is not a rare weather sequence. The years of occurrence (Table 13) show a very uneven temporal distribution. The most recent similar year was 1958, 23 years ago, and the 1958 weather sequence lacked the above normal temperatures in March.

Also shown in Table 13 are the number of dust days at Urbana in the spring seasons (March-May) in each year. Importantly, if, in these nine earlier years of weather very similar to that in 1980-1981, there were not severe (frequent) dust conditions in east-central Illinois, one can more clearly assess the relative importance of current farm practices to the 1981 dust outbreak. The lack of dust days in six of the nine earlier years suggests that the record dust conditions in 1981 were largely a result of current farm practices. Since the 1980-1981 weather contions and farm practices elsewhere in western and northern Illinois were similar to those in central and eastern Illinois, this further suggests that the dark colored silt-loam soils prevalent in the east-central area are a factor because they are much more susceptible to wind erosion with today's farm practices than soils elsewhere in Illinois.

The 1981 dust frequency was anomalous but the magnitude and the sequence of weather conditions in 1980-1981 were not rare anomalous events. Nor was 1980-1981 a part of a major state drought like all other record-breaking dust day incidences. For example, most other areas of the state set their dust day records in the spring during the droughts of the 1930's or the early 1950's. These were also periods when extensive droughts existed in states to the west and southwest of Illinois and many of the dust days in Illinois were a result of the long-range transport of dust particles. In the 1981 drought, the study of the individual dust days shows that east and central Illinois were the source, or origin of the windblown dust. No other spring period dating back to 1900 shows this type of localized dust phenomenon. The 1901-1981 period reflects an upward trend in dust day frequencies with the 1957-1975 drought-free period averaging, per unit time, more dust days than the 1901-1930 period which had five moderate droughts. This trend, with fewer recent dry conditions, further supports a conclusion that modern farm practices are the principal cause of the recent increase in blown dust conditions.

When abnormally dry cold season (October-March) conditions occur, then extensive blowing dust conditions such as those in 1981 are apt to occur. The 1981 differences between the excessive dust frequencies in central and eastern Illinois, and the low frequencies in western and northwestern Illinois (with similar planting activities, soils, and March-April weather) suggest the drier fall and winter in the central and east, leading to depleted soil moisture, was also an important factor.

If one deems the windblown soil erosion to be a serious problem, and if Illinois is moving back into a climate regime like that of 1890-1955 with more frequent drier fall-winter-spring sequences (two moderate droughts, 1976-1977 and 1980-1981), then future farm practices may need to be reconsidered. The 1967 recommendations of Bateman and Hinesly deserve repeating. They state, "The obvious solution to many of our soil-management problems is to leave the previous crop residues on the soil surface as long as possible. One of the major benefits of minimum tillage systems is that the residues protect the soil against the weather until planting time."

For those farmers who have adopted the practice of fall plowing as a means of applying fertilizer, Bateman and Hinesly recommend the use of a chisel plow for incorporating the fertilizer and increasing surface water storage on sloping soils, which also allows the retention of some residues on the soil surface to control water and wind erosion. Also large fields, many without hedge rows or grassy fence rows, are a part of the growing wind erosion problem.

In summary, the unusual but not record 1980-1981 weather conditions allowed for the record frequencies of blowing dust conditions. However, similar weather sequences in prior years did not result in such extreme wind erosion; hence, current farm practices used in Illinois' highly erodible soil areas during drier than normal non-growing seasons will likely lead to wind erosion at levels not previously experienced. The type of weather sequences conducive to record-breaking blowing dust frequencies is not frequent, but wind erosion of a lesser nature will occur in years less extremely dry but with deficient cold-season precipitation. Conservation tillage practices would help reduce this problem. Use of long-range climate predictions to detect, before fall, the advent of a dry winter and spring sequence would also allow decisions about whether to fall plow or to use conservation tillage.

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