A Geographic Investigation of Selected Historical Winter Weather Patterns in Eastern South Dakota, November 1959-April 1978

Douglas Edward O’Neill

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A GEOGRAPHIC INVESTIGATION OF SELECTED
HISTORICAL WINTER WEATHER PATTERNS
IN EASTERN SOUTH DAKOTA
NOVEMBER 1959-APRIL 1978

By

DOUGLAS EDWARD O'NEILL

A thesis submitted
in partial fulfillment of the requirements
for the degree Master of Science,
Major in Geography,
South Dakota State University
1979
A GEOGRAPHIC INVESTIGATION OF SELECTED HISTORICAL WINTER WEATHER PATTERNS IN EASTERN SOUTH DAKOTA NOVEMBER 1959-APRIL 1978

This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable for meeting the thesis requirements for the degree. Acceptance of this thesis does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Thesis Advisor
Roger K. Sandness

Head, Geography Dept
Dr. Edward P. Hogan
ACKNOWLEDGEMENTS

I am indebted to several individuals for their assistance, but would like to give special thanks to Kathy Fimple, Denny Martin, and Keith Courier.

Most of all I would like to thank my wife, Demetra, who kept me going and gave me encouragement and help when I needed it. To Heather, my 2 year old daughter, a special thanks for being well-behaved.

Finally, my gratitude goes out to all the faculty of the Geography Department at South Dakota State University, particularly Dr. Edward P. Hogan, Department Head, and Roger K. Sandness, my advisor, for their encouragement, insight and patience.

Douglas Edward O'Neill
Pierre, January, 1979
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CHAPTER I

INTRODUCTION

1.1 Aim of Study Problem

The State of South Dakota was given the dubious distinction of being called the "Blizzard State" by its' early settlers. This label is still commonly accepted by its present day citizens.¹ Employing a historical perspective on the geography of winter snowstorms in South Dakota, the "Blizzard State" hypothesis can be investigated in a scientific manner.

In the past it seems only snowstorms and winters with heavy snow accumulations were recorded as being significant events in the history and geography books of winter weather in South Dakota.² Today the same holds true; however, public exposure to commentary on the significance of these storms is through the media of television and newspapers. With the effects of only selected snowstorms being studied, a gap in the understanding of the geographical implications of snowstorms over the longer periods

¹South Dakota: Hazard Vulnerability Analysis (Division of Civil Defense, South Dakota Department of Military and Veterans Affairs, 1976), p.79.

of time associated with climate has developed. The objective of this thesis is to help close this gap. For a look at winters in South Dakota, a study was done on winter snowfalls which is defined as "the amount of snow that falls in a single storm or in a given period." This study examines the winter snowfalls and snowstorms for a 19 year period. The aim of this study is to determine if a trend or reoccurrence of snowfall pattern with severe winter snowstorms exists in eastern South Dakota. Although the study covers only a portion of the state using seven select cities, it illustrates an important facet of a South Dakota winter.

1.2 Choice of Setting, Purposes and Time

This study centers on winter snowfall and storms in eastern South Dakota. The main purpose of this study is to determine the snowfall patterns and their movements from 1959 through 1978 in eastern South Dakota. The specific 19 year period was selected due to the initiation of the publication of Storm Data, a monthly document printed by National Oceanic and Atmospheric Association (NOAA), which deals solely with storms (of all types) by individual states. With the data for snowstorms or

heavy snowfall being provided in Storm Data an accurate cross check with South Dakota Climatological Data was achieved to determine the effects of particular storms or heavy snowfall that affected the study area.

The cities used for the study are: Aberdeen, Brookings, Huron, Mitchell, Sioux Falls, Watertown and Vermillion. The location of where the snowfalls were measured are given in latitude and longitude along with the elevation of the site in feet above sea level are found at the bottom of (Figures 6-12). Aberdeen is used as the northern and western most point for the study area, with Vermillion as the southern most and Sioux Falls as the eastern most point. The remaining four cities complete the elliptical shaped outline. Within the study area the relief of terrain varies from 500-600 feet, which provides a basic consistance in elevation (Figure 1). The study area includes part of or all of 22 counties. An estimated 53 per cent of South Dakota's population is affected by winter storms in this study area. The seven cities (Figure 2) that form the elliptical outline of this study area have 27.8 per cent of the states population based on 1970 census data.

---


5 Ibid.
Fig. 1.

Map of Thesis Area with Cities and Surface Contour Lines for Eastern South Dakota

Source of Data: Department of Natural Resources; Pierre, South Dakota
### Fig. 2

**Major Points of Each City**

<table>
<thead>
<tr>
<th>City's</th>
<th>1970 Population Figures</th>
<th>Year Founded</th>
<th>Major Importance of City</th>
<th>Rivers Located Near City</th>
</tr>
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<tbody>
<tr>
<td>Sioux Falls</td>
<td>95209</td>
<td>1857</td>
<td>South Dakota largest city commercial and industrial center for states agriculture&lt;br&gt;business food and&lt;br&gt;meat processing plants&lt;br&gt;distributing point for&lt;br&gt;farm machinery and cars.&lt;br&gt;Augustana College (est.1860)&lt;br&gt;Sioux Falls College (est.1883)&lt;br&gt;Two television stations, KELO-KSFY&lt;br&gt;Retail center for surrounding&lt;br&gt;farm communities.</td>
<td>Big Sioux River</td>
</tr>
<tr>
<td>Aberdeen</td>
<td>26476</td>
<td>1881</td>
<td>Railroad and wholesale distribution for agricultural area. Grain&lt;br&gt;elevators, stockyards&lt;br&gt;Manufacture steel and iron machinery&lt;br&gt;Northern State College (est.1902)&lt;br&gt;One television station, KABY&lt;br&gt;Retail center for surrounding&lt;br&gt;farm communities.</td>
<td>James River</td>
</tr>
</tbody>
</table>
**Fig. 2. (con't)**

**Major Points of Each City**

<table>
<thead>
<tr>
<th>City's</th>
<th>1970 Population Figures</th>
<th>Year Founded</th>
<th>Major importance of City</th>
<th>Rivers Located Near City</th>
</tr>
</thead>
<tbody>
<tr>
<td>Huron*</td>
<td>14245</td>
<td>1880</td>
<td>Railroad division point</td>
<td>James River</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Meat packing and food processing</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Huron College (est. 1883)</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>State Fair Grounds</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Retail center for surrounding farm communities.</td>
<td></td>
</tr>
<tr>
<td>Brookings*</td>
<td>13717</td>
<td>1879</td>
<td>South Dakota State University, the states largest college (est. 1881)</td>
<td>Big Sioux River</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Medical supplies factory, and major hardware storage house for surrounding states</td>
<td>Retail center for surrounding farm communities</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Retail center for surrounding farm communities.</td>
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<tr>
<td>Mitchell*</td>
<td>13189</td>
<td>1879</td>
<td>Railroad center for farming area</td>
<td>James River</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Meat and poultry packing</td>
<td></td>
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<td></td>
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<td></td>
<td>Dakota Wesleyan University (est. 1885)</td>
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<td></td>
<td></td>
<td></td>
<td>One television station, KXON</td>
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<td></td>
<td></td>
<td></td>
<td>Retail center for surrounding farm communities.</td>
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</table>
### Fig. 2 (con't)

**Major Points of Each City**

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<thead>
<tr>
<th>City's</th>
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<th>Year Founded</th>
<th>Major importance of City</th>
<th>Rivers Located Near City</th>
</tr>
</thead>
<tbody>
<tr>
<td>Watertown*</td>
<td>13179</td>
<td>1875</td>
<td>Railroad shipping and trading center for agricultural region Machine and bottling works Farm implements Cement products Retail center for surrounding farm communities.</td>
<td>Big Sioux River Lake Kcampeska Lake Pelican</td>
</tr>
<tr>
<td>Vermillion</td>
<td>9186</td>
<td>1859</td>
<td>University of South Dakota (est. 1862)</td>
<td>Vermillion River Missouri River</td>
</tr>
</tbody>
</table>

* = County Seats

La = 1970 U.S. Census, U.S. Department of Commerce

With roughly one-third of the state's population, first-hand reports via newspapers, radio and television are found. This provides more descriptive and accurate reports of snowfall; and snowstorms severity and impact. In addition the media includes human interest stories relating to the snowfall.

1.3 Review of Related Literature

Studies pertaining to the study of snowfall and snowstorms for a particular area are not easily found. Literature of recent years is very similar to that of years gone by, in that snowstorms and blizzards are looked at as more of a singular event of importance without any consideration given to the other winter months snowfalls along with previous winter years. Yet it is very important to see winters as a monthly and/or daily event, with a notable snowfall being just another part of numerous winters being measured against each other to establish a pattern in over-all snowfalls as well as snowstorms for an area, be it large or small.

David M. Ludlum in his article in Weatherwise titled, "Early and Late Season Snowfalls: Evidence of Climate Change?", suggests that a single heavy snow or blizzard does not indicate that a major climate change is going to occur, but that it is a part of a very large weather
event. Ludlum shows in his study of Boston, Massachusetts from 1871-1968, that freak snowfalls and snowstorms occurred early as well as late, but it is the seasonal averages which show the real weather pattern.

While Ludlum's article fits into a major scope of this thesis study area, it made no mention of the origin of a snowstorm by geographical area or of low and high pressure systems that together spawn the storms. A revelant paper by Robert E. Black, "A Synoptic Climatology of Blizzards on the North-Central Plains of the United States," studies the origin of blizzards and where they tend to move. Black's paper is important in that it deals in only major winter storms that occurred between November and March for the years 1957 through 1967, which covers approximately the same months and half of the time span used for this study. Another facet of the paper, which is the most important point, is that it is written with just the North-Central states in mind placing eastern South Dakota close to the center of Black's study area. This study according to Black, was done to investigate the relevance of climatology to blizzards in the North-Central Plains of the United States.

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States in an attempt to provide further insight into the characteristics of blizzards.⁷

While both Ludlum's article and Black's study are very outstanding separately, it becomes more interesting when a specific area is studied with both of their articles being used for a single study.

Examples of human endurance and the impact of recent winters and snowstorms on eastern South Dakota are very difficult to find. Only in Ethel L. Hellman's book *Blizzards of South Dakota*, does a vivid picture of winters and winter snowstorms come to light, but these snowstorm accounts come from central and south-central South Dakota.⁸ For eastern South Dakota, examples like those of Hellman's can only be found in the daily newspaper articles from the seven cities studied. Most of the stories in the newspapers depict vivid accounts of heavy snows and snowstorms and how they affected the community. Yet, unless a specific storm was not of great importance (as far as remembering the severity of winter storms; it is difficult to locate factual accounts of the storm and

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events that happened during and after the storm. There are two monthly publications of major importance that fill the gap which exists between the actual severity of the storm compared to the account of the storm in a newspaper article. **Storm Data**, a monthly publication distributed by the U. S. Department of Commerce and prepared by NOAA, documents storms of every type for each state along with a basic regional breakdown of the area hit and how major a storm was. The NOAA publication dictated the time when this thesis would begin in terms of studying winter snowstorms and blizzards in eastern South Dakota. **Storm Data** breaks down an area which was hit by a particular storm, making it easier to cross check specific cities located in the storm area. Though **Storm Data** is a very outstanding publication in this area, it lacks specific snowfall amounts for certain selected cities in a specific setting. However, it does mention the impact of a specific storm by financial cost due to loss of property or crops, livestock and loss of human life due to, or related to the storm.

**Climatological Data for South Dakota**, a monthly publication of NOAA, deals in the specific amounts of snowfall for each day together with other climatological data (daily temperatures, precipitation and soil temperatures) for separate reporting points for the state.
It is this specific breakdown for the individual cities that makes it possible to establish a snowfall trend along with pinpointing the dates of major blizzards and snowstorms that hit eastern South Dakota.

The preceding discussion details the manner in which the documented material was used. Though it is very limited, it sets the base for a very interesting and timely study. Despite this limited literature, it is hoped that this paper does not understate the significance of the snowfalls to eastern South Dakota.

1.4 Methods and Terminology

As defined in this study, winter includes the months of November through April. Seldom do one or more inches of snowfall occur at the selected locations other than during these months. Once the winter period had been defined, then months designated as a winter month had their snowfall amounts recorded. This was done for each of the seven cities for each winter period beginning on November 1, 1959 and continuing through April 30, 1978.

Winter precipitation in the study area is in the form of rain or snow, with snow being the predominant form. The amount of snowfall is used to determine the severity of a winter storm, and when strong winds are accompanied by snowfall, the storm is considered a blizzard. Light snowfall is defined as less than one inch of snow which
falls in a 24 hour period. As defined in *Rules For Riding Out Winter Storms* by the U. S. Department of Commerce, the following are key winter situations:

1. **Heavy Snowfall:** a snowfall of 4 to 6 or more inches in 12 hours, or 6 or more inches in the next 24 hours. A heavy snowfall can occur in any of the below.

2. **Snowstorm:** usually thought of when any measurable amount of snow (usually 1 inch or more) falls over a given area, from one weather stations report to the next report which is approximately 24 hours later.

3. **Blizzard:** described as a snowstorm with windspeeds of at least 35 miles per hour with considerable falling and/or blowing snow, and temperatures of 20 degrees Fahrenheit or less over an extended period.

4. **Severe Blizzard:** when winds are at least 45 miles per hour, dense snow, and temperatures of 10 degrees Fahrenheit or less.\(^9\)

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2.1 An Overview of the Geography and History of Eastern South Dakota

The topographic features of eastern South Dakota (Figure 3) are the direct results of glacial activity. The terrain was built, eroded and rebuilt by the advance and retreat of glaciers during the Nebraskan, Kansan, Illinoian, and Wisconsin glacial periods which began approximately 300 to 600 million years ago. The last glacial stage resulted in three major terrain changes in eastern South Dakota, all of which are very noticeable.¹ The first is the Minnesota River Lowlands which forms the northeast corner of South Dakota. This area is unique in that it drains into the Mississippi River rather than the Missouri River as the rest of South Dakota rivers do. The lowlands are the lowest point above sea level in South Dakota.² To the west and south of the Minnesota River Lowlands lies the Coteau des Prairies. Because the Coteau was covered by glacial deposition, it is a very


²Herbert S. Schell, History of South Dakota (University of Nebraska Press, 1975), p.4.
Fig. 3

Three Main Terrain Regions of Eastern South Dakota

Source of Data: Eastern South Dakota River Basins Study
notable land feature with a higher elevation. In addition, the surface of the Coteau has an uneven and rolling landscape. Along with the eye catching topography left by the retreating glacier, numerous glacial lakes and sloughs were formed. On the western edge of the Coteau des Prairies, lies the James River Valley which transverses the length of the state from the north to the south. Unlike the Coteau to the east, the James River Valley is characterized by a flat to gently rolling river valley with the only major changes being ridges found in the northwest and southern areas.

Eastern South Dakota's climate is of a continental type, characterized by cold winters and warm to hot summers with light moisture in winter and marginal to adequate precipitation for crop farming in the spring and summers. Changes in weather can and do occur when cold fronts and associated low pressure areas move east across the state. Precipitation and stormy weather are usually associated with these low pressure areas and

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3 Resource Inventory of the Big Sioux Coteau (South Dakota Department of Natural Resources, Vol. II-B Sec. II, 1976), pp.3-6.

4 Resources Inventory of the James River Basin (South Dakota Department of Natural Resources, Vol. II-B Sec. XI, 1978), pp.6-8.
cold fronts.\textsuperscript{5}

Figure 4 shows Chernozem as the major soil group in the study area of eastern South Dakota, with Chestnut soils touching on the western fringe of the area.\textsuperscript{6} The Chernozem soils were directly influenced by the native grasslands which were influenced by the climate. In the more humid areas of southeastern South Dakota, tall native grasses once stood, making the soil rich in organic matter. In the western part of the study area the climate becomes drier and less humid with mid and short grasses prevailing. With this change in grass types the soil in the western edge of the study area becomes poorer in organic material.\textsuperscript{7}

Eastern South Dakota water resources (Figure 4) have played and still play a very vital role in the growth and prosperity of its citizens. Surface and groundwater resources of the James River, Missouri River, Big Sioux River, Vermillion River and the Minnesota River are used

\textsuperscript{5}W.F. Lytle and Walter Spuhler, \textit{Climate of South Dakota} (Agricultural Experiment Station, South Dakota State University), p.3.

\textsuperscript{6}Fred C. Westin, Leo T. Puhr, and George J. Buntly, \textit{Soils of South Dakota} (Agronomy Department, Agricultural Experiment Station, South Dakota State University, Soil Survey Series No.3, Revised July 1967), pp.10-19.

\textsuperscript{7}Edward P. Hogan, \textit{Geography of South Dakota} (Brookings, South Dakota, South Dakota State University, Geography Department 1976), pp.7-8.
Fig. 4.

Rivers and Soil Types of Eastern South Dakota

Source of Data: Eastern South Dakota River Basins Study
for numerous purposes. The main uses of these waters are: irrigation, rural domestic use, cities and towns water supplies and a growing industrial use.\(^8\)

To the first inhabitants of this area, the American Indian, the climate, vegetation and water dictated his life style as one of nomadic tribesman following his food supply which consisted of buffalo, deer, antelope and other smaller animals. It was the Indian's nomadic way of life along with climate and water problems in eastern South Dakota, that caused the Indians to not be able to stay in one area and grow as a more unified nation. As the white fur traders and farmers moved into the Indian lands in the 1800's, they caused further problems for the Indians and the Indian way of life, leading to an eventual downfall of a powerful people.\(^9\)

After their initial invasion into the Indian lands in eastern South Dakota, the farmers, too, had to face the problems of drought, crop failures and Indian uprisings. Unlike the Indians, the white men brought supplies and goods with them and established a permanent farmstead and towns to keep their settlements alive. When the

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weather was good, farming paid off for the new settlers, and caused more settlers to move to eastern South Dakota to build farms and towns on the prosperous agricultural lands. Although times were difficult for the new settlers, they stayed despite weather, climate and the native inhabitants of eastern South Dakota.

The determination of the pioneers is evident in eastern South Dakota. Eight of the states ten largest cities are located along the rivers and lakes of this agricultural area. In addition to the number of large cities in eastern South Dakota, the main arteries of major types of transportation go through these agricultural cities. These factors result in new industries and continuing growth to the cities and surrounding areas. (See Figure 2). The development and future growth of the cities of eastern South Dakota is directly related to the growth of the agricultural based economy, which is totally at the mercy of the seasonal weather and climate of the state.

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10 Ibid., pp. 23-29.
CHAPTER III

WINTER WEATHER IN EASTERN SOUTH DAKOTA

3.1 Mid-Latitude Cyclonic Activity

Eastern South Dakota is located in the North American middle-latitude climatic region. The middle-latitude zone lies between 35° and 55° latitude in both the northern and southern hemisphere.¹ South Dakota's climate is characterized by constant change due to the influence of low and high pressure systems and their movement. The dominant type of low-pressure influencing the middle latitude is the wave cyclones.² Wave cyclones are formed when cold polar air masses meet with warmer moist air. The possibility of a wave cyclone exists, when in the cold air mass there is an indentation or trough which is an elongated area of low barometric air pressure. When the warmer moist air meets the cold air it will rise above the cold air below, because the warmer air is lighter than the cold air mass. This confrontation of the air masses results in a vortex of counterclockwise air movement.³ When a wave cyclone takes place in the middle

²Ibid., p.188.
³Ibid., pp.158-189.
latitudes of the United States in the winter, it may develop into a strong winter storm. A prime reason that surface lows can develop into major snowstorms is because of high altitude winds. According to William F. Lytle, these high altitude winds called "jet streams," are found in an upper area of the earths atmosphere called the troposphere which extends upwards 11 miles from the ground. The jet stream, narrow bands of high winds, travel between 115 and 230 miles per hour and are caused by thermal air temperature differences. They are formed between cold polar air from the north and warm equatorial air from the south. When a deviation occurs in a normal jet stream, an upper air low can develop. These lows can become very intense due to the fast movement of the upper winds. When a surface low joins this upper air low, a very intense storm system may develop. Besides adding more vorticity to the surface low, the upper air low directs the path the storm system will follow. This path is called a storm track.⁴ As the storm moves, either north or south, and east depending on the origin of the storm, it will bring warm moist air up from the south, and cold polar air down from the north, resulting in

⁴William F. Lytle, Associate Professor, South Dakota State University. Telephone Communication, December 1, 1978.
heavy snow and strong winds on the north and the northwest side of the cyclone.

A high pressure system, called an anti-cyclone with wind circulation opposite that of a cyclone, is commonly associated with a strong outbreak of extremely cold air from the arctic which moves south toward the middle latitudes. The clockwise movement of the wind also blocks any moisture from moving into the area and brings in only bitter cold air from the north. When the anti-cyclone has moved far enough to the east the clockwise movement of the winds aid in moving warm moist air from the southern gulf to the northern regions.

3.2 Origin of Winter Storms

The major winter storms that hit eastern South Dakota are usually spawned from two areas of the North American continent. The Colorado Low, named for the area in which the cyclone originates, is a major weather maker especially for winter storms. The Alberta Low which develops in the Canadian Province of Alberta, like the Colorado Low, is named for its geographic birth place (Figure 5).

---

Fig. 5.

Origin of Alberta and Colorado Lows That Produce Winter Snowstorms For Eastern South Dakota

A. Basic area of development for Colorado Lows, and their storm track.

B. Basic area of development for Alberta Lows, and their storm track.

Lows originating in the Colorado area usually generate more severe weather during November and March, when the storm tracks are in a more northerly direction. During the months of December, January and February, the Canadian Alberta Lows track farther to the south, setting up the studied area for potentially severe winter storms. \(^6\)

When a Colorado Low tracks across the Central United States the path it pursues dictates its severity. A less intense blizzard generally moves toward Kansas, then migrates into Michigan. A more severe storm will track farther north from Colorado, across Nebraska and into Minnesota. A storm tracking in this particular direction is due to a deepening trough of low pressure which adds to the overall severity of the storm. Eastern South Dakota lies in this storm track.

Alberta Lows usually move east-southeast until they approach the eastern Dakotas, then turn east to northeast. According to Robert E. Black's paper, *A Synoptic Climatology of Blizzards on the North-Central Plains of the United States*, Alberta Lows generally move more rapidly than Colorado Lows. Once away from their origin, there is

almost no tendency for them to stagnate or meander. More rapid movement plus less tendency to stagnate makes blizzard conditions associated with Alberta Lows generally less severe and of shorter duration than Colorado Low blizzards.  

3.3 Past Winters in Eastern South Dakota  

Winter storms were noted in South Dakota by the white man as early as May 5, 1843 when John James Audubon wrote of a blizzard that hit the Dakota Territory and killed over 2,000 bullafo calves. 8 Another blizzard was mentioned by Father Christian Hoecken, who was stranded with a friend in present-day Hutchinson County. Father Hoecken stated the December 11, 1850 storm was a "violent and intense storm." 9 A blizzard on April 13, 1873 was so severe that the 7th Calvary of the United States Army was unable to establish a camp site east of Yankton, so General Custer moved his men into Yankton for shelter. 10 The winter of 1880-1881 has been noted for its heavy snowfall accumulation and a rare blizzard that occurred in late

7Ibid., p.18.  


9Ibid.  

10Ibid.
October. Though most of the snow from this storm melted before the winter, heavy snows were recorded. Hardships were noted by the lack of communication in the Upper Sioux River Area and in the James River Valley area where settlers were snowbound for as long as from October to March.\textsuperscript{11}

On January 12, 1888, "The School Children's Blizzard," the most written and talked about winter storm in American history, struck eastern South Dakota. Eye witness accounts state that one minute the sky was clear and the winds were calm, the next moment a gust of wind blew from out of the northwest where a gray bank of clouds rapidly rolled in. Heavy snow and strong winds seemed to hit at the same time. It was reported by eyewitnesses that a person could not even see one's hand in front of his face. Because the storm hit with such suddenness, countless children were released by their teacher from schools in eastern South Dakota so they could go home to ride out the storm. At least 173 people died in eastern South Dakota because of this storm, the majority being children attempting to reach home before the storm's peak hit.\textsuperscript{12}

\textsuperscript{11}Herbert S. Schell, History of South Dakota (University of Nebraska Press, 1975), pp.180-181.

\textsuperscript{12}The Wi-Iyoki, pp.3-6.
Another notable blizzard occurred on Armistice Day, November 11-12, 1919 which hit early and hard with a considerable amount of snow and strong winds.

The winter of 1951-1952 was one of heavy snowfalls similar to the snowfalls of 1880-1881. The 1880-1881 and 1951-1952 winters were noted more for total accumulation of snowfall than for any single storm.¹³

Other notable blizzards in eastern South Dakota occurred on the following dates: February 17-22, 1962; March 4-5, 1966; January 10-12, 1975; November 9-10, 1977. They are noted for being blizzards or snowfalls of a very severe variety. The winter of 1968-1969 with its record setting snowfall accumulation in eastern South Dakota, along with the storms mentioned are discussed more in depth in Chapter IV.

¹³Ibid., pp.7-8.
CHAPTER IV

AN ANALYSIS OF NINETEEN YEARS OF WEATHER RECORDS
IN EASTERN SOUTH DAKOTA

4.1 Snowfalls Accumulation and Their Tendencies

In order for snowfalls accumulations, along with their tendency in forming trends of low and high snowfall amounts for a particular period of winters to be established, a graph of continuous winter snows must be charted so a visual interpretation can be made (Figures 6-12).

The methodology of tabulating 798 months of winter snowfall and the drawing of a snowfall graph, (Figure 6-12) for each city by each individual winter month was reasonable only if it could be done by a computer. With that, each cities snowfall graph was set up by programming (Appendix C) the computer to list total snowfall amounts for each month to the nearest even number and graph it. Then each particular month was labeled, with the first letter of the given month, and for every six month set (or winter period), the appropriate years were used to label that particular winter period of snowfall. The importance of having each month represented in the snowfall graph is to provide a good visual and indepth look at how each individual monthly city snowfall stacked up against itself for the remaining months studied, as well as against the six other city's and their snowfall graph.
In order to depict the trends in snowfall accumulations for the seven cities, only snowfalls of one inch or greater for a 24 hour period were figured into each monthly total. Snowfalls of lesser amounts were not considered as indicators of any major or strong weather pattern.

Once the total snowfall for each month was tabulated by the computer, the computer was programmed to illustrate each city's monthly accumulative snowfall for the 19 years in the six month winter periods. The table's snowfall scale was set up in two inch intervals for computer programming reasons. With the scale set-up in this manner the computer was programmed to graph an accumulative snowfall as follows: if a monthly snowfall amount totalled 6.85 inches, it was graphed as an accumulative snowfall of six inches for the month, if the amount had been 7.10 inches it would have been charted as an eight inch accumulation. The main purpose of each snowfall graph is to show an approximation of accumulative snowfall for the winter months from November 1959 thru April 1978. The actual amount of snowfall may fall an inch or two on either side of the symbol (#), which depicts the peak accumulative snowfall for each month. When the symbol (#) is missing for a month on a cities snowfall graph it indicates no data was available, or existed in the NOAA
publication *Climatological Data for South Dakota*.¹

To better illustrate the trend of snowfall for the study area, an overlay was drawn (Appendix A). This enables the reader to make an accurate overall comparison of the study area's average snowfall for each individual city. The overlay was derived from the combined seven cities average monthly snowfall for the 19 year period.

Fig. 6.

*** SNOWFALL GRAPH ***

(1953-58 TO 1977-78 NOV. - APR. X=MONTH, Y=IN. OF SNOW(1" OR MORE/24 HOURS))

Source of Data: Climatological Data for South Dakota
Fig. 7.

*** SNOWFALL GRAPH ***

(1959-60 TO 1977-78 NOV. - APR. X-MONTH, ?=IN. OF SNOW(1" OR MORE/24 HOURS))

Source of Data: Climatological Data for South Dakota
Fig. 8.

* * * SNOWFALL GRAPH * * *

(1959-60 TO 1977-78 NOV. - APR. X=MONTH, Y=IN. OF SNOW(1" OR MORE/24 HOURS))

Source of Data: Climatological Data for South Dakota
Fig. 9.

*** SNOWFALL GRAPH ***

(1959-60 TO 1977-78 NOV. - APR. X=MONTH, \( Y = \text{IN. OF SNOW (1" OR MORE/24 HOURS)} \))

Source of Data: Climatological Data for South Dakota
**Fig. 10.**

***** SNOWFALL GRAPH ***

(1959-60 to 1977-78 NOV. - APR. X=MONTH, Y=IN. OF SNOW (1" OR MORE/24 HOURS))

Source of Data: Climatological Data for South Dakota
Fig. 11.

*** SNOWFALL GRAPH ***

(1959-60 TO 1977-78 NOV. - APR. X=MONTH, Y=IN. OF SNOW1" OR MORE/24 HOURS))

Source of Data: Climatological Data for South Dakota
Source of Data: Climatological Data for South Dakota

NDJFM

Source of Data:
Climatological Data for South Dakota

NDJFM

1959/60 to 1977/78

(* * *. SNOWFALL GRAPH * * *

(1959-60 to 1977-78 "IND."

-MTH

X=MTH,

Y=IN. OF SNOW (IN. OR INCHES/24 HOURS)

City of Vermillion
1959-60 61/62 62/63 63/64 64/65 65/66 66/67 67/68 68/69 69/70 70/71 71/72 72/73 73/74 74/75 75/76 76/77 77/78 78/79

ELEVATION 1239
When an obvious difference between the overlay and an individual city's snowfall graphs exists, the difference is due mainly to a winter snowstorm that hit only a portion of the study area. Regardless of these slight differences, a trend can be noted in snowfall tendencies in all the cities.

Figure 13 indicates the yearly average snowfall accumulation for the seven cities of eastern South Dakota from 1959 to 1978. Exceptions to the seven city average for yearly snowfall was the winter of 1970-1971 when Vermillion was missing snowfall data, and again for the winters of 1972-1973; 1973-1974; 1975-1976 and 1976-1977 when Mitchell was missing snowfall data. The average snowfalls (Figure 13) for the seven cities indicated a trend in which a winter which has very low snowfall, is followed by a winter having snowfalls that are much above an average winter. The extremes of snowfalls, which averaged 56.8 inches in 1968-1969 and 46 inches in 1974-1975, to the lowest averages of 10.8 inches in 1967-1968 to 17.2 inches in 1973-1974, are examples of this trend.
Fig. 13

Average Snowfall Per-Year For Seven Eastern South Dakota Cities From: Nov. 1959-Apr. 1978

Source of Data: Climatological Data For South Dakota
4.2 Pattern in Snowfalls

When the snowfall amounts are viewed from another perspective, namely occurrence of set snowfall amounts, a pattern becomes more clear. Figure 14 gives a breakdown of occurrence for each snowfall, with totals (Figures 6-12), ranging from one inch to 18 inches for a 24 hour period for individual cities. The accompanying percentages in Figure 14 give the possibility of a given number of inches in a 24 hour period. Figure 15 depicts the total number of snowfall occurrences for each city. After breaking the occurrence rate of snowfall into the ranges of one, three, six, nine, and twelve inches and greater, a map was drawn. Figure 15 shows that a snowfall "core" occurs in eastern South Dakota. The core's axis runs from the northwest part of eastern South Dakota to the southeast part placing Huron, Brookings and Sioux Falls in the area of heaviest snowfalls. This snow axis, falls off toward the northeast and around the Watertown area quite rapidly. And towards Aberdeen, on the north, this slope is not nearly as steep. Snowfall to the south and southwest of the core area shows the gradient toward Mitchell, and Vermillion to be very similar to that of the Aberdeen area.

The snowfall core is well defined by the maps of the area with snowfalls of greater than three inches. Yet, on the one inch and greater snowfall occurrence map, the
snowfall core is centered around Watertown, with the occurrence rate of snowfalls sloping off gently towards Aberdeen to the northwest, and a steeper gradient of lesser occurrence of total number of snowfalls towards Brookings. Two possible reasons for Watertown having the highest occurrence of snowfalls of one inch and greater are: (1) Lake Kampska and Lake Pelican may cause enough air instability to cause numerous one inch snowfalls or (2) the procedure used to measure snowfalls in any of the given cities may give way to inaccuracies in the amount of snowfall recorded.
## Snowfall Occurrence and Probability Table By The Inch

<table>
<thead>
<tr>
<th>Inches of Snowfall</th>
<th>Aberdeen</th>
<th>Brookings</th>
<th>Huron</th>
<th>Mitchell</th>
<th>Sioux Falls</th>
<th>Watertown</th>
<th>Vermillion</th>
</tr>
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<td>68 la</td>
<td>99 la</td>
<td>82 la</td>
<td>93 la</td>
<td>115 la</td>
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<tr>
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<td>48% b</td>
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### Table: Snowfall Occurrence and Probability Table By The Inch

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| TOTAL             | 198      | 189       | 206    | 173      | 196        | 216      | 175        |

**La** = Number Of Snowfall By The Inch  
**Lb** = Probability Of A Snowfall By Amounts  
Source of Data: Climatological Data for South Dakota
Fig. 15

Snowfalls of One Inch and Greater For Seven Eastern South Dakota Cities: From November 1959-April 1978

Source of Data: Climatological Data for South Dakota
Fig. 15 (con't)

Snowfalls of One Inch and Greater for Seven Eastern South Dakota Cities: From November 1959-April 1978

greater than nine inch snowfalls

greater than twelve inch snowfalls
4.3 Blizzard and Snowstorms

Winter snowstorms are a fact of life in eastern South Dakota. On the average, the area of study received two or three severe storms per year between 1959 and 1978 (Figure 16). During this period, as many as six storms may hit during one winter period with no storms the following year. It is not the number of storms occurring by the year, but the severity and impact that makes a storm notable. Severity in a snowstorm is usually measured by its duration, snowfall amount, temperature and winds. The impact of the storm is measured by the loss of human life, costliness of snow clean-up, and livestock loss. It is the combination of severity and impact that makes a winter blizzard or snowstorm one of historical as well as geographical importance.

Snowstorms of a severe nature or blizzard occurred 50 times in eastern South Dakota from November 1959 to April 1978. A breakdown of the 50 winterstorms by the number that occurred in each year of this study, are found on Figure 16.

Figure 17 lists all winter storms by the date of occurrence, type and severity of impact. For these winter storms, 23 maps have been prepared. At least three of the seven cities must have had a snowfall of six or more inches to be included in the mapping.
See Appendix B for 19 of the maps, with the 4 other maps being found in Chapter IV Section 4.4. This was done to give a better overview of a snowstorm or blizzard by the amount of snowfall for that particular storm.
Fig. 16

Average Number of Snowstorms and Blizzards Per-Year
For Seven Eastern South Dakota Cities From: Nov. 1959-Apr. 1978

Source of Data: Storm Data and Climatological Data
For South Dakota
### Index of 50 Winter Snowstorms In Eastern South Dakota

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<thead>
<tr>
<th>Date</th>
<th>Storm Type</th>
<th>Special Comments</th>
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<td>Nov. 4-5 1959</td>
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<tr>
<td>Nov. 12-13 1959</td>
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<td>Dec. 27-28 1959</td>
<td>Moderate Ice &amp; Snow</td>
<td>1 Death, $400,000 in Property Damage</td>
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<td>Dec. 31-Jan. 2</td>
<td>Moderate-Heavy Snow</td>
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<td>1960</td>
<td></td>
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<tr>
<td>Mar. 8-9 1960</td>
<td>Moderate-Heavy Snow</td>
<td>None</td>
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<tr>
<td>Apr. 1-2 1960</td>
<td>Heavy Snow</td>
<td>None</td>
</tr>
<tr>
<td>Nov. 27-28 1960</td>
<td>Blizzard</td>
<td>1 Death, 3 Injured, $210,000 in Property Damage</td>
</tr>
<tr>
<td>Feb. 1 1961</td>
<td>Moderate Snow</td>
<td>2 Deaths, 1 Injured in Beadle County</td>
</tr>
<tr>
<td>Dec. 8-9 1961</td>
<td>Moderate Snow</td>
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<td>Jan. 6-9 1962</td>
<td>Near Blizzard</td>
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<tr>
<td>Feb. 17-21 1962</td>
<td>Extremely Heavy Snow</td>
<td>Huron, Brookings, Mitchell, Sioux Falls, Vermillion</td>
</tr>
<tr>
<td>Mar. 3-5 1962</td>
<td>Blizzard</td>
<td>1 Death by Exposure</td>
</tr>
<tr>
<td>Mar. 11-13 1962</td>
<td>Blizzard</td>
<td>1 Death by Exposure</td>
</tr>
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<td>Dec. 7 1963</td>
<td>Blizzard Mod.-Heavy Snow</td>
<td>50-60 MPH Winds</td>
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<tr>
<td>Mar. 19-20 1964</td>
<td>Snow Heavy-Light</td>
<td>3 Deaths in Sioux Falls While Shoveling</td>
</tr>
<tr>
<td>Apr. 12-13 1964</td>
<td>Blizzard</td>
<td>$5,000-$50,000 Property Damage</td>
</tr>
<tr>
<td>Mar. 16-17 1965</td>
<td>Blizzard</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>Heavy Snow</td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td>Storm Type</td>
<td>Special Comments</td>
</tr>
<tr>
<td>-------------</td>
<td>-----------------------------</td>
<td>-------------------------------------------</td>
</tr>
<tr>
<td>Mar. 2-5 1966</td>
<td>Blizzard, Heavy Snow</td>
<td>100 MPH Winds, Heavy Cattle loss</td>
</tr>
<tr>
<td>Mar. 22-23 1966</td>
<td>Blizzard</td>
<td>2 Deaths in Yankton and Sioux Falls</td>
</tr>
<tr>
<td>Jan. 6 1967</td>
<td>Blizzard, Moderate Snow</td>
<td>None</td>
</tr>
<tr>
<td>Feb. 14-15 1967</td>
<td>Blizzard</td>
<td>1 Death at Yale (near Huron)</td>
</tr>
<tr>
<td>Apr. 3 1968</td>
<td>Blizzard</td>
<td>Aberdeen Hard Hit with $50,000-$500,000 Property Damage</td>
</tr>
<tr>
<td>Dec. 12-13 1968</td>
<td>Blizzard</td>
<td>1 Death in Allen, S.D.</td>
</tr>
<tr>
<td>Dec. 18 1968</td>
<td>Heavy Snow</td>
<td>Southeast had heavy Property Damage $5,000-$50,000</td>
</tr>
<tr>
<td>Dec. 21-22 1968</td>
<td>Blizzard</td>
<td>Southeast Had Heavy Snow</td>
</tr>
<tr>
<td>Feb. 14-15 1969</td>
<td>Heavy Snow</td>
<td>None</td>
</tr>
<tr>
<td>Feb. 20-21 1969</td>
<td>Heavy Snow</td>
<td>None</td>
</tr>
<tr>
<td>Feb. 27-28 1969</td>
<td>Heavy Snow</td>
<td>None</td>
</tr>
<tr>
<td>Dec. 27-28 1969</td>
<td>Moderate-Heavy Snow</td>
<td>None</td>
</tr>
<tr>
<td>Dec. 9-11 1970</td>
<td>Moderate-Heavy Snow</td>
<td>None</td>
</tr>
<tr>
<td>Feb. 18-19 1971</td>
<td>Blizzard with Light Snow</td>
<td>None</td>
</tr>
<tr>
<td>Feb. 26 1971</td>
<td>Blizzard with Light Snow</td>
<td>None</td>
</tr>
<tr>
<td>Mar. 17-19 1971</td>
<td>Blizzard-Heavy Snow</td>
<td>Southern Area Mainly</td>
</tr>
<tr>
<td>Feb. 7-10 1972</td>
<td>Heavy Snow</td>
<td>None</td>
</tr>
<tr>
<td>Feb. 17 1972</td>
<td>Blizzard</td>
<td>None</td>
</tr>
<tr>
<td>Feb. 23 1972</td>
<td>Near Blizzard</td>
<td>North Area Mainly</td>
</tr>
<tr>
<td>Nov. 2 1972</td>
<td>Very Heavy Snow</td>
<td>Huron to Charles Mix Areas, $5,000-$50,000 Property Damage</td>
</tr>
</tbody>
</table>
## Fig. 17 (con't)

### Index of 50 Winter Snowstorms In Eastern South Dakota

<table>
<thead>
<tr>
<th>Date</th>
<th>Storm Type</th>
<th>Special Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dec. 29-31 1972</td>
<td>Blizzard, Moderate to Heavy Snow</td>
<td>None</td>
</tr>
<tr>
<td>Nov. 21-22 1973</td>
<td>Heavy Snow</td>
<td>Northern Area</td>
</tr>
<tr>
<td>Dec. 13 1973</td>
<td>Heavy Snow, Near Blizzard</td>
<td>Northern Area</td>
</tr>
<tr>
<td>Dec. 24 1973</td>
<td>Heavy Snow</td>
<td>None</td>
</tr>
<tr>
<td>Jan. 8-12 1975</td>
<td>Heavy Snow, Severe Blizzard</td>
<td>8 Deaths, known as Blizzard of the Century. 100 MPH winds, KSFY &amp; KELO T.V. towers collapse Damage, $5,000,000-$50,000,000</td>
</tr>
<tr>
<td>Mar. 23-24 1975</td>
<td>Blizzard</td>
<td>None</td>
</tr>
<tr>
<td>Mar. 26-28 1975</td>
<td>Blizzard</td>
<td>KXON-TV tower in Mitchell and KJAM-Radio tower in Madison collapse</td>
</tr>
<tr>
<td>Apr. 8-9 1975</td>
<td>Moderate Snow</td>
<td>1 Death</td>
</tr>
<tr>
<td>Nov. 19-20 1975</td>
<td>Blizzard, Heavy Snow</td>
<td>1 Death in Charles Mix County, died of exposure while walking Mainly Southern Area</td>
</tr>
<tr>
<td>Jan. 1-2 1976</td>
<td>Blizzard</td>
<td>None</td>
</tr>
<tr>
<td>Mar. 3-4 1976</td>
<td>Heavy Snow</td>
<td>Mainly Southern Area</td>
</tr>
<tr>
<td>Dec. 5 1976</td>
<td>Heavy Snow, Strong Winds</td>
<td>Mainly Southern Area</td>
</tr>
<tr>
<td>Feb. 23-24 1977</td>
<td>Heavy Snow</td>
<td>None</td>
</tr>
<tr>
<td>Mar. 2-3 1977</td>
<td>Heavy Snow</td>
<td>None</td>
</tr>
<tr>
<td>Nov. 9-10 1977</td>
<td>Blizzard, Heavy Snow</td>
<td>Earliest Blizzard on Record for Area, KDLO-TV Tower in Garden City falls Property Damage $5,000-$50,000.</td>
</tr>
<tr>
<td>Jan. 25-26 1978</td>
<td>Blizzard Conditions, Light to Moderate Snow</td>
<td>None</td>
</tr>
</tbody>
</table>

Source of Data: Storm Data
4.4 Case Studies

Of the five cases studied, four are particularly notable. The first is the week long snowstorm that hit the entire study area during February 17-22, 1962 (Figure 18). This storm caused record setting snowfall amounts in the Sioux Falls and Huron areas for 24 hour periods plus setting a record for total snowfall accumulation for a five day period. This storm was one of extremely heavy snow accompanied by little or no wind. Three deaths were reported in Sioux Falls due to heart attacks caused by the individuals shoveling the heavy accumulation of snow from their driveways and sidewalks.²

The second storm occurred March 4-5, 1966 (Figure 19). The effects were felt the hardest in the western section of the study area near Aberdeen, Huron and Mitchell. This particular blizzard has been referred to as one of the severest on record for the area. According to the U.S. Department of Commerce/Weather Service, the storm was centered over eastern Idaho and Wyoming on Tuesday, March 1st. By the evening of March 2, the low pressure center of the storm was centered over north central Nebraska. By this time, warm moist air from the south and southeast

Fig. 18.

Snowfall For February 17-22, 1962, Snowstorm

Source of Data: Climatological Data for South Dakota
Fig. 19.
Snowfall For March 4-5, 1966, Snowstorm

Source of Data: Climatological Data for South Dakota
was being lifted above the cold air which was moving in from the north and northwest. When the two air masses met over the Dakotas and Minnesota, the result was very heavy snow with very strong, gusty winds. Later on the evening of March 2nd, the low pressure center moved to near Mitchell, then moved northwestward toward Pierre and remained stationary for 12 hours. The low then moved into southern Minnesota, before it moved into the Chicago area, and stalled another 72 hours.\(^3\)

This storm was highly developed, and in addition to its looping path in South Dakota and its stalling actions, this caused the blizzard to deposit greater amounts of snow.

The area that was the hardest hit by this storm was Central South Dakota, including the western three cities of the study area and surrounding areas. The snowfall in this area was very heavy, which, accompanied with the wind, caused tremendous loss. Over 100,000 farm animals were lost in the central part of the state. The livestock alone were valued at over $20,000,000.\(^4\)

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\(^3\) Ethel L. Hellman, Blizzards of South Dakota (Millboro, South Dakota, 1970), p.135.

\(^4\) Hazard and Vulnerability Analysis, (South Dakota Division of Civil Defense, South Dakota Department of Military and Veteran Affairs, October, 1976), pp.82-83.
Although this was the first blizzard of the winter for this part of the studied area, the three cities hit the hardest, Aberdeen, Huron, and Mitchell had a common denominator; no movement was possible. On March 6, 1966 the Huron Daily Plainsman, proclaimed that this March blizzard surpassed the Blizzard of 1888 in terms of snowfall and wind, the only exception being lower temperatures in 1888.\(^5\) The Mitchell Daily Republic, on March 7, 1966 reported "Operation Bulldozer" was being put into effect; 70 private contractors, men and machines, aided the storm ridden area.\(^6\) This operation was essential to save any livestock still alive, but stranded by the blizzard. The next day, the Mitchell Daily Republic, stated that Governor Nils Boe had declared Central South Dakota a Blizzard Disaster Area.\(^7\) Aberdeen, Huron, and Mitchell desperately needed a source of aid for clearing roads and aid to farmers. The "Blizzard of 1966" killed mainly livestock, unlike the "Blizzard of 1888", which killed many people.


Nine years passed before another extremely severe blizzard struck. The third case study began on January 10, 1975 after a "Colorado Low" moved out of the Rocky Mountains quickly into the state of Kansas and began to strengthen rapidly.

As the low deepened, a high pressure system to the east helped to bring Gulf moisture north to the Dakotas and Minnesota. This was the case of the January 1975 blizzard, as it moved from central Kansas and north to the Sioux City, Iowa area on January 11, 1975. As it tracked northward toward Sioux City and beyond towards Hudson Bay, eastern South Dakota was hit by moderate to heavy snows with very strong winds (Figure 20). To make things worse, two days prior to the storm, the same area had been blanketed with 4 to 8 inches of snow. This storm was disastrous in terms of loss of human life. The Watertown Public Opinion, on January 13, 1975 reported that six members of the Myron Hjiellming family died of asphyxiation near Summit South Dakota when their home sewer exhaust vent became plugged with ice and snow.\(^8\)

On January 13, the Sioux Falls Argus Leader, reported

\(^8\)"Six In Family Dead Of Asphyxiation", Watertown Public Opinion, January 13, 1975, p.1.
Fig. 20.
Snowfall For January 7-11, 1975, Snowstorm

Source of Data: Climatological Data for South Dakota
two more storm related deaths. Two Augustana college students were found dead due to exposure. The two left their stalled car near Valley Springs and attempted to walk to a truck stop about a mile away. This blizzard was called the "Blizzard of the Century" by the National Weather Service, causing countless inconveniences due to minor car accidents, power and phone outages, along with snow blocked roads. When a major storm like this hits, it also causes major unexpected problems. Such was the case when a 1,986 foot broadcast tower near Sioux Falls, which was used by the National Broadcasting Company and Columbia Broadcasting System television stations, collapsed. Sioux Falls Columbia Broadcasting System affiliate, KELO had a secondary tower which was used for broadcasting. It was put into operation hours later. National Broadcasting Company affiliate KSYR had no back-up tower, so through the combined effort of the two television stations and networks along with the Federal Communication Commission, thousands of snowbound South Dakotans saw Super Bowl X, a National Broadcast Company production aired on KELO. Another storm related loss was that of livestock

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Fig. 21.

Snowfall For November 9-10, 1977, Snowstorm

Source of Data: Climatological Data for South Dakota
of 1959-1960. This winter's snowfall began in December 1968 and continued intermitantly until late March of 1969, surpassing the 1951-1952 snowfalls. Heavy snow over the entire area caused numerous days of school closure, cancelled meetings and promoted countless minor car accidents.
CHAPTER V

SUMMARY AND CONCLUSIONS

5.1 Summary

The aim of this study was to determine the trend of snowfall and snowstorms in eastern South Dakota. It can be concluded that there is a trend in snowfall occurrences and snowfall amounts. There is a winter season in which the average snowfall for the seven cities is double that of normal (28.3 inches) occurring every six to seven years. The winter preceding these heavy snowfall winter seasons, usually falls far short of an average snowfall for the study area.

Winter snowstorms and blizzards seem to follow the basic rhythmic pattern set by snowfall. The snowstorms are more erratic, ranging from a peak of five and six winter storms in two different winter seasons during the study, to no major storms at all usually occurring in the years following winters of heavy snow.

A snowfall "core" was evident for the area. This core is generally centered around Brookings, Huron and Sioux Falls. These cities have the highest occurrence of snowfalls of three inches and greater. Also found in the "core" for the heaviest snowfall for the 23 snowstorms which are mapped for the studies area of which 19 are found in Appendix B and 4 others are in Chapter IV Section 4.4.
The individual case studies of winter snowstorms proved to be some of the worst in eastern South Dakota history. These storms were notable because of loss of human lives, heavy loss of livestock, storm intensity or their unexpected early arrival.

Winter snowstorms in eastern South Dakota are a fascinating and dangerous fact of life to the citizens of the state. With that in mind, a more in depth study of the history of winter snowstorms would be beneficial to help people and commerce to better understand the importance of their states winters in a geographical and historical importance.

5.2 Conclusion and Recommendation for Further Study

The purpose of this study was to determine the trend in snowfall and snowstorms which occur in eastern South Dakota. This study takes raw climatological data of importance and illustrates the overall 19 year pattern for the selected cities with cartographic displays. The main emphasis was to use select cities to determine the snowfall trend which occurs in eastern South Dakota. Through the organization of climatological data, and the few resources that depict this type of study, the first step to a possible larger and broader historical and geographical approach to the study of winter snowstorms and snowfalls was taken.
With computer programming, the thesis topic of this paper could be expanded by using additional data collection points, rather than using just seven select cities.

Future research would be aided by widening the scope into interviews of different participants to go along with the specific case studies. First hand accounts would enhance the research by making it an asthetic study of people and setting. This could then be backed up by factual weather data. With improved data collection procedures and extensive oral interviews, a better historical approach to the geography of winter snowstorms and snowfall patterns in eastern South Dakota can be achieved.
Fig. 23.

Snowfall For November 12-13, 1959, Snowstorm.

Source of Data: Climatological Data for South Dakota
Fig. 24.
Snowfall For March 8-12, 1960, Snowstorm

Source of Data: Climatological Data for South Dakota
Fig. 25.

Snowfall For March 10-13, 1962, Snowstorm

Source of Data: Climatological Data for South Dakota
Fig. 26.
Snowfall For January 10-12, 1963, Snowstorm

Source of Data: Climatological Data for South Dakota
Fig. 27.
Snowfall For March 18-19, 1963, Snowstorm

Source of Data: Climatological Data for South Dakota
Fig. 28.

Snowfall For March 16-18, 1965, Snowstorm

Source of Data: Climatological Data for South Dakota
Fig. 29.

Snowfall For February 14-16, 1969, Snowstorm

Source of Data: Climatological Data for South Dakota
Fig. 30.
Snowfall For February 20-21, 1969 Snowstorm

Source of Data: Climatological Data for South Dakota
Fig. 31.

Snowfall For February 26-29, 1969, Snowstorm

Source of Data: Climatological Data for South Dakota
Fig. 32.
Snowfall For December 27-28, 1969, Snowstorm

Source of Data: Climatological Data for South Dakota
Snowfall For December 9-11, 1970, Snowstorm

Source of Data: Climatological Data for South Dakota
Fig. 34.
Snowfall For February 7-10, 1972, Snowstorm

Source of Data: Climatological Data for South Dakota
Fig. 35.
Snowfall For March 23-25, 1975, Snowstorm

Source of Data: Climatological Data for South Dakota
Fig. 36.
Snowfall For March 26-28, 1975, Snowstorm

Source of Data: Climatological Data for South Dakota
Fig. 37.
Snowfall For November 19-21, 1975, Snowstorm

Source of Data: Climatological Data for South Dakota
Fig. 38.
Snowfall For March 4-5, 1976, Snowstorm

Source of Data: Climatological Data for South Dakota
Fig. 39.
Snowfall For February 23-24, 1977, Snowstorm

Source of Data: Climatological Data for South Dakota
Fig. 40.
Snowfall For March 2-4, 1977, Snowstorm

Source of Data: Climatological Data for South Dakota
Fig. 40.

Snowfall For March 2-4, 1977, Snowstorm

Source of Data: Climatological Data for South Dakota
**Fig. 41**

********** Computer Program "A" **********

PROGRAM: CREATE WRITTEN BY JOEL PEA ON KEITH COURIER'S
TRS-80 DISK BASIC MICROCOMPUTER.

```
1 CLEARMEM/10K
2 DIM D$(19, 80):CLS
3 INPUT "FILENAME", F:OPEN 0, 1:LEFT$(F:8)+"/DAT"
4 PRINT "ENTER 2 HEADER LINES:";
5 LINE INPUT H1$:LINE INPUT H2$:PRINT#1, H1$:PRINT#1, H2$
6 FOR CX=1 TO 70
7 INPUT "CITY": CS:INPUT "LAT.": LA$: INPUT "LONG.": LS$: INPUT "ELEV.": EX
8 PRINT#1, CS:PRINT#1, LA$: EX
9 NEXT CX
10 FOR CX=1 TO 15:PRINT "YEAR": Y$: FOR M=2 TO 15: INPUT D$(M, Y$)=CINT(D$(M)): NEXT
11 PRINT#1, D$(M, Y$): FOR M=2 TO 15: PRINT#1, D$(M, Y$): NEXT: PRINT#1
12 NEXT Y$: CS:CLOSE: END
```
********** Computer Program "B" **********

PROGRAM: CREATE  WRITTEN BY JOEL AEA AND KEITH COURIER

1 CLEAR MEM/10%
2 DIM X(19%, 6%):CLS
3 GOSUB500: LPRINTTAB(async (10-LEN (H1%))/2%): H1%
4 LPRINTTAB(async (12% - LEN (H2%))/2%): H2%: LPRINT: LPRINT
5 FOR X=(5%): TO 0% : STEP-2%: IF X/(1%)/10% THEN LPRINT USING"#:####"); IF ELSEPRINT" ! "
6 FOR X=(1%): TO 0%: D=0%: CSNG(MX%1%): H2$: LPRINT: LPRINT
7 IF D<=0% THEN LPRINT" ": ELSE IF D=(1%): THEN LPRINT" ": ELSEIF D=(1%): THEN LPRINT" ": ELSEPRINT" ! ";
8 NEXT:MX: MX: LPRINT: NEXT: MX
9 LPRINT" *STRING#(114%): "
10 LPRINT" "; FOR X=(1%): TO 19%: LPRINT "NO JFMA"); NEXT: LPRINT
11 LPRINT" "; FOR X=(1%): TO 19%: LPRINT USING"### "; R3%+1%: 59%+1%: NEXT: LPRINT
12 LPRINTTAB(45%); "CITY OF "; C": "L%: "L%: "L%: ELEVATION": E;
13 LPRINTCHR$((120%)): END
14 INPUT "GRAPH TYPE (FILENAME) ": FS: OPEN"1", 1%: FS="/DAT
15 LINEINPUT#1%: H1%: LINEINPUT#1%: H2%
16 INPUT "CITY": C%
17 INPUT#1%: C2%: IF C2%:$1%=THEN ELSEINPUT#1%: L%: L%: EX
18 FOR X=(1%): TO 19%: INPUT#1%: DX(X%): DX(Y%): DX(X%): DX(Y%): DX(Y%): EX
19 NEXT: RETURN
BIBLIOGRAPHY


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