Thunderstorm ‘disasters’ in Saskatchewan

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Abstract: In Canada, Alberta and southern Ontario rank as the places most noted for intense hailstorms and ferocious tornadoes. In less populous areas these thunderstorm hazards receive limited media/public attention. Thus, the severity of the hazard becomes downplayed in part from a lack of awareness. However, studies in Saskatchewan – The Saskatchewan Hail Project (or SHAP) and the Saskatchewan Tornado Project (or STP) – have documented thunderstorm events and suggest that severe thunderstorm events cause great amounts of damage in less populated regions. This paper cites several cases that demonstrate that thunderstorm ‘disasters’ do frequent Saskatchewan and that these storms can create more debilitating effects on smaller communities than they would on larger urban centers. In addition, implications relating to preparedness and responses to these events are discussed in order to place Saskatchewan’s thunderstorm hazard in a broader perspective.

Introduction

Throughout the past decade or so, there has been an apparent increase in the frequency and severity of thunderstorm disasters. Concern regarding this trend is evident in the literature produced by those involved with risk management (eg. Burton, 1994; Howard, 1995; Pang, 1999a) and by those who study the influence of climate change on thunderstorm weather (eg. Brooks, 1999; Etkin, 1995). Consequently, insurers, bureaucrats, academics, and victims have become motivated to work collaboratively towards mitigation efforts. These efforts resulted in a national mitigation policy for Canada (Pang, 1999b; Insurance Bureau of Canada, 1999).

In Canada, Alberta and southern Ontario are places best known for severe thunderstorms, largely due to a long research history. However, thunderstorm disasters do occur in the less populated regions but on a smaller monetary scale. In addition, a disastrous thunderstorm has a much more debilitating effect on a small community than a same magnitude storm hitting a metropolitan city. Yet the thunderstorm hazard receives less attention and its severity is downplayed outside these two areas in Canada. Studies in Saskatchewan – The Saskatchewan Hail Project (or SHAP) and the Saskatchewan Tornado Project (or STP) – have documented severe thunderstorms and have suggested that they cause great destruction in the less populated regions. This paper cites several cases that demonstrate that thunderstorm 'disasters' do strike Saskatchewan. In addition, the preparedness for, the responses to, and the evaluation of these events are discussed to place Saskatchewan's thunderstorm hazard in a broader perspective.

Data and Procedure

Although vast amounts of thunderstorm literature do not exist in Saskatchewan, several works have documented thunderstorms over the years and have contributed to our understanding of the hazard. A large hailswath database was created during the Saskatchewan Hail Project (SHAP) for 1979-1995 (Paul and McInnis, 1999). For the same period, McInnis (2000) provided a detailed investigation hailswath characteristics. The Saskatchewan Tornado Project (STP) produced a historical tornado archive from 1906-1991 (Paul, 1995). As well, Blair's (1983) thesis examined the thunderstorm hazard throughout the decade ending in 1980. Earlier, Paul's (1980) results from the 1973-1977 Saskatchewan Hail Research Project (SHARP) stand as the first intensive excursion into thunderstorm hazard research in the province. In addition, various reports from the Atmospheric Environment Service (AES) have contributed greatly to the documentation of thunderstorm events. Collectively, these works form a partial archive of severe thunderstorm events and thus substantial information up to 1995 can be easily obtained in the province.

On the other hand, post-1995 thunderstorm information must be collected manually. Crop-hail insurance records, local newspapers, and severe weather reports are data sources previously used to outline geographical characteristics of individual thunderstorms in Saskatchewan and elsewhere (Côté, 1983; Frisby, 1964; Raddatz *et. al.*, 1983). The information for the Osler (04 July 1996) storm was acquired by these means.

Five good examples of thunderstorm disasters in Saskatchewan were picked for discussion in this paper. By no means is this sample exhaustive, as plenty of disastrous storms have hit the province over the years. Most of the information from four of these examples comes from the existing thunderstorm databases. The severity of the Osler storm became known to the author during the data collection phase of SHAP and the information about this storm was collected during the spring of 2000 specifically for this paper.

Results

A composite map of the five storm tracks appears in Figure 1. The lines represent approximate centerlines of the hailswaths as outlined by crop-hail insurance claims. Although the lines approximate hailswath lengths, swath widths, due to variability along the storm path, they are not indicated on the map. Each swath is labeled with its respective date. Major cities and affected towns are labeled. One may note that four of the five storms are located in southern Saskatchewan. This pattern does not suggest that severe thunderstorms are exclusive to southern Saskatchewan; they may affect most areas of the province. From this map, one can visually appreciate the location, direction, and length of each storm.

As complement to the map, Table 1 offers details about the hailswath, wind, rainfall, and damage characteristics for each storm. All of these examples were multi-event storms and thus are very dangerous and are consequential to the insurance industry (Burton, 1998). That is, every storm recorded a combination of thunderstorm

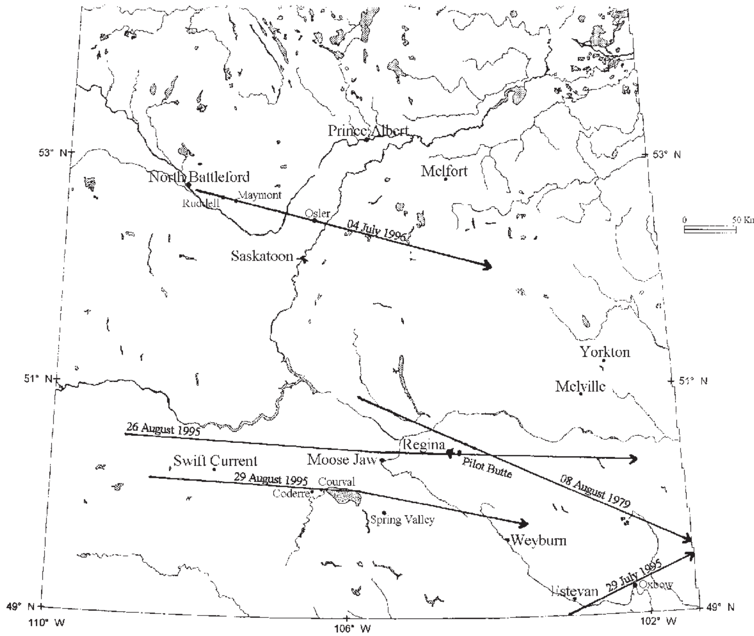

Figure 1: *Location of the 5 storm tracks in southern Saskatchewan.*

weather including lightning, wind, rain, and hail. Although each storm produced very long hailswaths and damaging hail, wind caused the most havoc. In all cases, moderate and/or heavy rainfall was reported at some point along the path of the storm. Localized flooding resulted from the Pilot Butte and Osler storms. A State of Emergency (SOE) was declared as a result of the Oxbow, Pilot Butte, and Osler storms. The Regina and Oxbow storms tracked from directions other than west. Although two tornadoes were reported in Regina, the storm is not considered a 'true' urban disaster because the damages were too localized within the city; in a sense, this storm hit Regina only a glancing blow.

The Five Storms

The following sections describe the dynamics of each storm and explain some of their more outstanding events.

Table 1: *Information on five Saskatchewan thunderstorm 'disasters.'*

Storm Information	Regina Storm, 08 August 1979	Oxbow Storm, 29 July 1995	Pilot Butte Storm, 26 August 1995	Spring Valley Storm, 29 August 1995	Osler Storm, 04 July 1996
Hailswath: • Length • Width • Direction • Hail stone sizes	L: 347 km (215 mi.) W: mostly 25 km (15 mi.) D: NW (300°)	L: 137 km (85 mi.) W: 10-16 km (6-10 mi.) D: W (250°); more likely SW Small hail at Oxbow	L: 508 km (315 mi.) W: 16-32 km (10-20 mi.) D: W (270°) Golfball and larger, drifts 50 cm deep in Pilot Butte	L: 370 km (230 mi.) W: 16-19 km (10-12 mi.) D: W (280°) Pea to golfball >golfball at Coderre	L: 295 km (185 mi.) W: 10-25 km (6-15 mi.) D: W (280°) Loonie size in places Golfball at N. Battleford Softball size at Osler
Wind Events: Tornadoes: • F-scale • Direction • Dimensions Other Wind • Microburst or 'Plow' winds	Tornadoes: F1 Regina (18:00) F2 Regina (18:00) D: 280° L: 15 km Wind gusts: up to 120 km/h	'Plow winds': 100-150 km/h microburst hits Oxbow Another storm hits Northgate with a 'plow wind'	Tornado: F0 N side of Regina? 'Plow wind': >120 km/h at Pilot Butte Wind gusts: 80-100 km/h in Regina ~100 km/h at Gull Lake	Tornadoes: F1 Courval/Coderre area (17:20) F1-F2 30 km S of Moose Jaw (18:10) F2-F3 Spring Valley (18:40) Winds gusts: >100 km/h	2 tornadoes: Funnel clouds sighted at Ruddell (17:00); Maymont (18:00) F2-F3 tornadoes (250-330 km/h) Wind gusts/microburst: 120-150 km/h touchdown E of Saskatoon
Rainfall: • Light • Moderate • Heavy	Moderate to heavy	Heavy rainfall at Oxbow	Flooding: N side of Regina Bible College at Caronport flooded with 20-25 cm rain in 1 hr	Heavy rainfall	43mm in Saskatoon 76mm north of Saskatoon North Battleford flooded
Damages: • Events • Monetary Losses	Regina two areas hit hard: Normanview (NW) & Glencairn (E); roof torn of Exhibition Park Buillding Minor injuries 5900 claims for about $4 million (1979) $10 million (total) aprox. $24 million (2000)	SOE. aid from PDAP; MDS Oxbow water supply tower left leaning Local Inn lost roof Transformer moved 3 minor injuries $5-10 million	Pilot Butte: SOE declared within 1 hr of event. All trees & buildings suffered damages 9 injuries PDAP for assistance $16-30 million	Courval 7 grains bins destroyed 3-500 gal. fuel tanks moved S of Moose Jaw 1 farm destroyed Spring Valley 4 farms demolished No injuries $11-12 million	SOE; MDS; PDAP standby only Wind damages through Maymont, Saskatoon and Osler Widespread power outage (12 towers costing $1 million) No injuries Saskatoon hit slightly Drive Inn demolished Initial est. > $8 million

Storm Dates

Regina storm, 08 August 1979:

This storm tracked in from the northwest laying down a hailswath nearly 350 km in length and averaging about 25 km in width. It hit Regina late in the afternoon with hail, wind, and heavy rain. Two tornadoes were spotted in the city (18:00), one of which reached a F2 classification (Paul, 1995). In addition to the tornadoes, wind gusts up to 120 km/h were reported in Regina. Normanview in the northwest and Glencairn in the east were the areas of Regina hit hardest by the storm. However, the Exhibition Park Building in the north-central area lost its roof in the storm. Luckily, all reported injuries were minor. Saskatchewan Government Insurance (SGI) estimated that 5900 claims cost close to $4 million and total damages were estimated at $10 million (Blair, 1983). This converts to about $24-25 million in year 2000 dollars.

Oxbow storm, 29 July 1995:

Oxbow was hit very hard by an overnight storm on 29-30 July 1995. The thunderheads came in from the southwest dumping small hailstones and heavy rain in Oxbow. The excessive wind (100-150 km/h) from a microburst was responsible for most of the destruction. A State of Emergency (SOE) was declared and the Mennonite Disaster Service (MDS) and students from Youth Employment Canada oversaw the clean up. Aid from the Provincial Disaster Assistance Program (PDAP) was requested to help with clean up and the non-insurable damages in Oxbow. The total damages from this storm were expected to be around $10 million.

This storm caused several noteworthy events. First, the gale force winds pushed the massive 690,000 litre water supply tower into a leaning position much like the famous leaning tower of Pisa. Second, a 2000-lb power transformer was moved off its moorings. Last, a local Inn had its roof torn off in the gale. Remarkably, there were only three minor injuries reported!

Pilot Butte, 26 August 1995:

Late on Saturday afternoon 26 August 1995, a massive thunderstorm tracked some 500 km across southern Saskatchewan. It roughly followed the Trans-Canada Highway and lasted more than 10 hours. Heavy rains, unofficially reported at 200-250 mm in 1 hour (Cripps, 1995), flooded the Briercrest Bible College at Caronport just west of Moose Jaw. At 16:40 the town of Pilot Butte, a small bedroom community a few km east of Regina, was lambasted with rain, hail, and a powerful plow wind (>120 km/h). Golfball and larger hail left drifts 50 cm deep in several places around the town. Much of the damage was typical of wind and hail. For example, tattered siding and shingles on houses, broken windows in buildings, and dented cars were all common in Pilot Butte. The damage was widespread as all the 400 or more dwellings in town experienced damages of some type.

In addition to the typical damage, there was plenty of severe losses caused by the 'plow wind'. The cement factory on the outskirts of town was flattened. The 72-unit trailer park was in total ruin. The Betteridge farmstead, next to the town, was reduced to a pile of rubble. Yet the most heartfelt loss in some ways involved the more than 2400 trees that were marred and subjected to removal.

Within an hour of the event, the mayor declared a State of Emergency (SOE). The town hall was converted into headquarters for the recovery operations, the rink became a temporary hospital, and nine people were treated for injuries. A preliminary estimate suggested that the storm cost at least $16 million but a more detailed damage assessment set the total close to $30 million (McInnis, 1998).

Spring Valley, 29 August 1995:

Three days following the destruction in Pilot Butte southern Saskatchewan was visited by another devastating storm. However, this storm tracked several dozen kilometres south of the previous storm. Again, this storm came from the west dumping heavy rain and hailstones from pea to golfball size and larger along its nearly 400 km path. There were at least two tornadoes, possibly three, resulting from the storm. The first, an F1 tornado accompanied by larger than golfball size hail struck the Courval/Coderre area (17:20). In the Courval area, 7 grain bins were destroyed and three 500-gallon fuel tanks were moved a distance. The second, an F1-F2 tornado was spotted 30 km south of Moose Jaw (18:10). It destroyed one farm. The third, an F2-F3 tornado hit the Spring Valley area (18:40) severely damaging four farmsteads in the process (Cripps, 1997). Due to the closeness of the events in time and space, one may speculate that the third reported tornado might simply be a double spotting of the second tornado. Regardless, there were no injuries reported from the storm and the damages cost $11-12 million.

Osler storm, 04 July 1996:

Just before 17:00 on 04 July 1996, North Battleford was flooded by heavy rains and hit hard by golfball size hail. This marked the beginning of a storm that laid down a 300 km long hailswath that extended from the North Battleford area eastward to the Watson area. Along the way 2 tornadoes were sighted, one at Ruddell (17:00), the other at Maymont (18:00). At least one of these tornadoes reached F2-F3 status. However, Osler bore the brunt of the storm as it was pounded by ferocious plow winds (120-150 km/h) and hail the size of softballs. Winds were not as strong in Saskatoon. Instead the city experienced heavy rains and power outages. Yet powerful winds crushed the Sundown Drive Inn just east of the city.

In Osler, a State of Emergency (SOE) was declared and the Mennonite Disaster Service (MDS) conducted the majority of the restoration operations. In this case, the Provincial Disaster Assistance Program (PDAP) assumed a standby role only. There were no injuries resulting from this storm. Initial estimates placed storm damages at more than $8 million.

Discussion

The succeeding sections discuss several topics relating to the preparedness for and responses to these events. As well, comments on the evaluation of disastrous events are presented.

Preparedness for these events:

When atmospheric conditions indicate possible severe weather, the public generally relies on the Atmospheric Environment Service (AES) to forecast dangerous weather. Unfortunately, the five storms exemplify some failings in the official forecast system. In these cases, the severe weather watches, when issued, were well in advance of the event. However, warnings for these storms were generally poor. For example, a storm warning, with no mention of tornadoes, was issued after the storm hit Regina on 08 August 1979 (Blair, 1983). During the Pilot Butte storm, hail and severe weather warnings were issued for Regina (Last Mountain-Wascana district). However, there was only a 3 minute tornado/wind warning in Regina and no warning was issued specifically for Pilot Butte (Cripps, 1995). Likewise, warnings for the tornadoes during the Spring Valley storm were short; only for the tornado south of Moose Jaw was there sufficient warning time (more than 20 minutes) for people to respond. The situation was similar for the Oxbow and Osler storms; both storms had watches issued, with no subsequent warnings.

Some useful lessons can be learned from these forecast problems. Foremost, an improved delivery method for severe weather warnings by the Atmospheric Environment Service (AES) could be the impetus to increase public preparedness for disastrous events. In addition, weather office closures in recent years exacerbates the forecast problem. Thus, the public, rather than losing faith in the forecaster, must realize that the weather watches may have to be imbued with as much importance as weather warnings until the warning lead times are improved.

Responses to these events:

The most obvious and important response to a disastrous thunderstorm is the initial recovery process. This process involves addressing any problems that require immediate attention including stabilizing downed power lines, caring for injured people, and restoring dwellings to a habitable state. However, these storms can have an enormous impact on the smaller communities. In the Pilot Butte case, the tremendous destruction in the town caught residents off guard and consequently they struggled with their emergency plan to rebuild their town. Thus, several weeks were dedicated to restoring the town. On the other hand, the Mennonite community helped to bring both Oxbow and Osler back to a livable state rather quickly. Thus, the organization and execution of a plan during a state of emergency is paramount in speeding up the recovery process.

In addition to the five storms described in this paper, the recent thunderstorm flooding of the town of Vanguard early in the summer of 2000 is a good example of the devastation a thunderstorm can create in a small town. The community is still suffering from many problems invoked by the extreme flood. The town's water supply was contaminated for many weeks. In addition, the loss of several businesses and extensive damage to the rail line, most of which will not be rebuilt, leaves many fearful that the result of this storm will be a ghost town.

Evaluation of severe thunderstorm events:

Investigators encounter several problems when assessing thunderstorm damages. Media reports of storm damage are usually preliminary; rarely do follow-up reports provide definitive figures. Because of chronic underestimates, the public awareness of the monetary losses from thunderstorms remains low.

However, detailed damage assessments of Saskatchewan thunderstorms, by McInnis (2000, 1998), reveal several other inherent difficulties one faces when using data from insurance companies. First, one is often uncertain whether all the recorded costs resulted from one storm on one day, due to reporting procedures which may lump several storms together. Second, distinguishing among wind, hail, and rain damage is difficult on site; the insurance records reflect this problem. Thus, the statistics are usually a mixture of wind, hail, and rain losses; seldom, for example, recording only tornado damage. A standardized method of data collection among insurance companies may be useful to those in the business and academic fields interested in monitoring losses from weather associated with thunderstorms.

Conventionally thunderstorm research has predominantly examined the thunderstorm hazards – lightning, rain, wind, and hail – as separate events. However, one would expect a thunderstorm to produce a combination of them. This fact is exemplified by the five storms discussed herein, all of which produced hail, rain, wind, and/or tornadoes. Due to this ability to generate many types of weather, thunderstorms may cause multi-event disasters. These events are important to the insurance industry because they are extremely destructive and cost large sums of money. Already work has begun in Saskatchewan to investigate relationships among the weather associated with thunderstorms (Paul and McInnis, 2000). Furthermore, the author suggests that the insurance industry consider examining the inter-relationships among thunderstorm hazards.

Saskatchewan has not experienced a thunderstorm 'disaster' in one of its major cities in recent years. The closest recent example of an urban disaster was the Regina storm on 08 August 1979, and, in this case, the storm did not hit with all its potential as only part of the storm track affected the city. However, storm track and settlement patterns in Saskatchewan make it possible that Moose Jaw/Regina or Melville/Yorkton, or North Battleford/Saskatoon could fall victim to the full fury of a single severe thunderstorm. This could easily create losses, in the $100 million range, comparable to those posted in Alberta (Charlton *et. al.*, 1995). In addition, one could expect large losses (in the order of $100 million) from a direct hit to either Saskatoon or Regina in light of the enormous losses experienced in the small town of Pilot Butte.

Saskatchewan is generally considered a smaller market and thus receives little attention from those involved in the realm of natural hazards. For example, the Winnipeg Mitigation Workshop on 02 October 1998, aimed at protecting Canadians from natural hazards at a regional level, focussed mostly on the 1997 Winnipeg flood. Saskatchewan's thunderstorm hazard received little attention. Certainly, one may argue that mitigation and research should focus primarily on areas with large populations. But, a bias towards more highly populated regions is unjust, especially since the Saskatchewan hail hazard has been ranked among the worst in North America (Paul, 1982; Paul, 1980). In addition, due to their more fragile economies, smaller markets – especially a poor province like Saskatchewan – are extremely vulnerable to natural hazards and disasters. A small population base results in low capital derived from taxation. Thus, when a town is hit by a storm it can be completely disabled for several days whereas, a similar storm hitting a large centre like Calgary may disable only one neighbourhood. Moreover, the economic situation in Saskatchewan is such that a single storm disaster could virtually destroy a small town; this point was alluded to during the brief comments about the Vanguard flood. However, the various socioeconomic and cultural impacts of thunderstorms on large markets and small markets, while interesting, are beyond the scope of this paper. Nevertheless, a strong argument can be made that small centres are more easily incapacitated by severe thunderstorms than large urban centres.

Conclusions

In summation, some general observations can be made about the five thunderstorm disasters presented in this paper. First, every storm produced a very long hailswath, with heavy rains. Second, four of the five storms tracked from the west. Third, powerful winds, microbursts, and/or tornadoes were common to the five storms. Fourth, winds caused the most significant damages during these storms. Last, the Regina, Spring Valley, and Osler storms all produced two or more tornadoes. These observations would open many avenues to consider if one were to construct theories about thunderstorms in Saskatchewan. Although this paper has unveiled several possibilities, the sample size is not sufficient to base theory upon. More work is necessary before valid theories can be constructed.

There are several chief points that can be drawn from this paper. First, these five storms exposed some shortcomings in the official forecast system; the weather warnings were generally poor. For the time being, the public may have to give a weather watch as much regard as they would a weather warning. Second, precise monetary assessments of thunderstorm damages are presently an unworkable task. Although detailed attempts produce more realistic figures, they still can only be regarded as best estimates. Third, wind, hail and rain account for most of the thunderstorm damage in Saskatchewan, and thus research is needed to examine the multi-event storms, and those with a vested interest (the insurance industry) are urged to participate fully. Fourth, Saskatchewan has been fortunate that recently an urban centre has not been a directly hit by a major thunderstorm. Last, small centres are less resilient than large urban centres when hit by a disastrous thunderstorm and thus deserve more attention from those in the discipline of natural hazards.

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