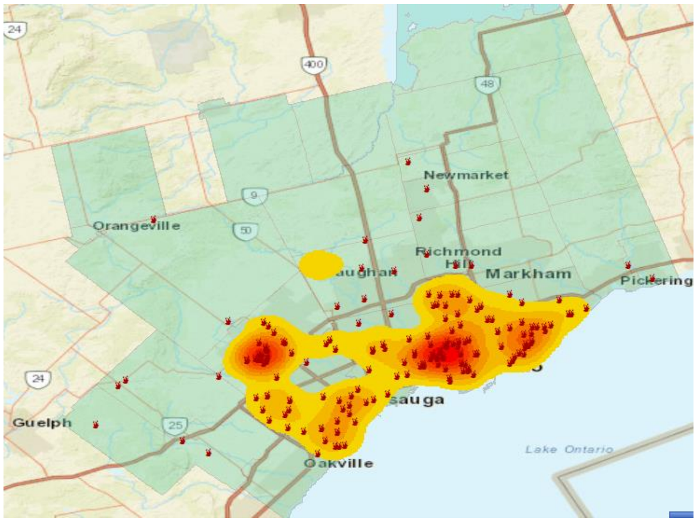
Fire and Disasters
Examining Fire Incidents During Major Disasters and Emergencies in Canada



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EEXECUTIVE SUMMARY

BACKGROUND

Canadian cities, towns, municipalities, regions, and provinces experience various types of major disaster and emergencies. Major disasters and emergencies are larger than everyday emergencies and can quickly overwhelm the first responders that are called to respond to them. Major disasters and emergencies may require the application of different performance standards and protocols. While fire departments are proficient at planning and preparing for normal operating conditions and some of them have great experiences with large emergencies, a better understanding and preparedness for disaster events is more challenging. Understanding the nature, volume, characteristics and response performances of fire departments during major disasters and emergencies is very important. This study aims to provide some insights into the patterns and characteristics of fire incidents during major disaster and emergencies in Canada using the National Fire Incident Database (NFID).

METHOD

This study uses NFID for fire incident data and EM-DAT and Canadian Disaster Database (CDD) for disaster and emergency events in Canada. Using these databases, fire incidents that have occurred during major disaster events in six provinces (New Brunswick, Ontario, Manitoba, Saskatchewan, Alberta and British Columbia) have been identified. Statistical comparisons have been made between the fire incidents in disaster and emergency situations and the fire incidents in normal situations. While the NFID has limitations in terms of spatial (New Brunswick, Ontario, Manitoba, Saskatchewan, Alberta, and British Columbia) and temporal (2005-2015) coverages, completeness of data items, and type of incidents that it covers, it does provide the necessary data infrastructure for more advance analysis in the future. Fire incidents during the Vancouver Riot (2011), Slave Lake Wildfire (2011), Flash Flood in Toronto (2013), Ice Storm in the Greater Toronto Area (2013), Southern Alberta Flood (2013) have been examined in detail.

FINDINGS

There is a difference between the numbers of fire incidents during major emergencies in different jurisdictions compared to the number of fire incidents in normal situations. Having a larger number of disaster and emergencies does not necessarily mean having a larger number of fire incidents during disasters and emergencies. It depends on a number of factors including the type, the timing, and the impact areas of disasters.

Ontario has the largest number of disasters (40) during the study period, most of these disasters had a short time span and due to the types of disasters (floods and ice storm) there was no significant increase in the number of fire incidents during these emergencies. On the other hand, British Colombia and Alberta with 32 and 23 disasters recorded between the years 2005 to 2014, experienced a great share of fire incidents during disaster and emergency days much of which is

related to the wildfires. This may suggest that the type and duration of disaster events can have impacts on the number of fire incidents during disaster and emergency situations.

The number of fire incidents during normal situations showed a downward trend during the study period (2005-2014) in most jurisdictions, but the number of fire incidents during major disasters and emergencies displayed an increasing trend overall with varied and fluctuated data depending on each jurisdiction and on the number and type of disasters experienced in each year. Alberta and British Colombia have a different pattern compared to other jurisdictions, most of which are attributed to major wildfires and flooding.

Fire incidents during major disasters and emergencies are higher from May to September compared to other months. April has the highest number of fire incidents for Ontario and Manitoba. The month of May has the highest rate of fire incidents in Saskatchewan and Alberta. July has the highest number of fire incidents in British Colombia.

Out of 5769 fire incidents that have occurred during major disasters and emergencies, 75 had involved injuries. 58 out of the 75 fire incidents involved 1 injured person and 9 of them had 2 injuries.

Residential buildings are the most common occupancy groups involved in the reported fire incidents during major disasters and emergencies. Close to 40 percent of the fire incidents with known occupancy group have occurred in residential buildings. Relatively higher portions of residential and vehicle fires are reported during major disasters and emergencies compared to normal situations.

"S*moker's material and open flame*" and "*exposure*" were the highest observed ignition sources, which was seen as understandable considering that a significant number of fire incidents during major disasters and emergencies were wildfire related incidents.

Our results show that a large share of fire incidents were caused by "*mechanical and electrical failures*" and "*human failing*". There was an increase during major disasters and emergencies of fire incidents caused by these factors.

More fire incidents originate in "*Outside area*" than normal situations. Less fire incidents seem to originate in vehicle, function, structural, and storage areas.

While it appears that more fire incidents that occur during major disasters and emergencies are confined to their object or area of origin, they can extend beyond the building of origin.

A higher percentage of fire incidents during emergency situations have been classified as "*Burnt out*" compared to normal situations. This could be due to the fact that the use of handheld fire extinguishers is also higher for fire incidents during emergency situations.

The six major disasters that were examined in this study to further understand the similarities and differences of fire incident patterns during normal and emergency situations were:

1. Toronto Sunrise Propane Explosion, 2008

2. Slave Lake Wildfire, 2011
3. Vancouver Riot, 2011
4. Alberta Flood, 2013
5. Flash Flood in Toronto, 2013
6. Ice Storm in the Greater Toronto Area, 2013

The Toronto Sunrise Propane Explosion was the first major emergency that was examined. It is the only technological disaster case include in this study. On the same day as the sunrise propane explosion, a number of fire incidents in Toronto occurred. For that one day, fire incidents were 20 times higher than the daily average. Majority of the reported fire incidents were related to the explosion. All fire incidents were clustered within the defined emergency zones. Majority of the fire incidents that occurred on August 10, 2008 in the City of Toronto and in the emergency zones were residential fires. A significant number of fire incidents were clustered around the emergency zone. Unlike the average day, more than 97 percent of the fire incidents on August 10

Slave Lake Wildfire in 2011 was the second major disaster that was examined. Wildfires are major issues in many parts of Canada. According to the Canadian Disaster Database, 98 wildfire disasters have occurred in Canada during 1900-2016 and there seems to be an increasing trend in the number, intensity, and consequences of wildfire disasters (Canadian Disaster Database, 2017). Majority of the Canadian wildfire disaster events have occurred during the months of July, June and May.

Wildfires emergencies are among the most common weather and climate related disasters in Canada. The Slave Lake Wildfire in May 2011 was one of the largest wildfire in Canadian disaster history. It created a significantly high number of fire incidents that required response by fire fighters from various fire departments in Alberta and beyond. Alberta fire incidents records have significantly changed as a result of this wildfire. Although not covered in this study, the Fort McMurray fire added to these records even further. Comparing with the fire incidents occurred in Alberta without considering the Slave Lake Region, it was highlighted that during wildfire emergencies the highest portion of fire incidents, even evacuation is in place, occur in residential buildings within smaller towns.

It has to be mentioned that due to large volumes of unknowns for many of the fire incidents attributes, it was not possible to examine all attributes in details. Also, due to the unavailability of exact locations for fire incidents in the Slave Lake Region, it was not possible to carry out any spatial analysis on the data. Availability of such information could provide opportunities for more complex statistical and spatial analyses.

Slave Lake Wildfire was one of the most destructive wildfires in Canadian history. More than 30 fire departments from across the province and Canada were dispatched to the Slave Lake wildfire. Number of recorded fire incidents during the wildfire days increased dramatically. About 1402 fire incidents were recorded in the Slave Lake Region on May 14, 2011. Mutual aid was heavily used in these fire incidents. Residential occupancy fire increased during this emergency. More than 84% of these incidents occurred in single detached residential buildings.

A very high percentage of fires in the Slave Lake region have been ignited first through "*exposure*" (33%) which is much higher than the Alberta fires excluding the Slave Lake region suggesting that exposure is the leading ignition source for fire incidents during the wildfire emergencies (Table 6.4 and Figure 6.9). "*Smoker's material and open flame*" is also an important igniting object for both Alberta and Slave Lake fires during these days. Exposure and Smoker's material and open flame had higher percentages of fires when compared with fire incidents in normal situations. Exposure fires have been responsible for 53.8% of fire incidents. Majority of fire incidents in both the Slave Lake Region and Alberta (excluding the Slave Lake) have been initially detected by the "*Visual sighting or other means of personal detection*".

The third disaster case was a human made emergency. Fire incidents that occurred during a riot in Vancouver between June 15 and 16, 2011 were examined in more details and were compared with the fire incidents reported in the rest of British Columbia (BC) on the same day. There was a significant difference between the combinations of fire incidents in terms of property class during the riot days compared with fire incidents in the rest of BC. "*Trash, rubbish and recyclables*" increased during riot emergencies consisting of more than 70% of the fire incidents in Vancouver. Majority of riot incidents were in "*outside area and vehicles*" in terms of ground floor area attribute.

Close to 70 percent of the fire incidents during the riot originated from garbage and rubbish, meaning that close to 50 percent of the fire incidents have been as the direct result of riot. 65% of fire incidents during the riot was due to "*trash, rubbish area*", "*vehicle storage*", "*vehicle - fuel area*", "*vehicle - passenger area*" and "v*ehicle Area – unclassified*". Majority of the fire incidents during the riot are confined to an object of origin. Also, it was found that a higher percentage of the fire incidents during the riot were either "*burned out- no extinguishment attempted*" or "*extinguished by occupant*".

The fourth case study was the Southern Alberta Flood of June/July 2013. This case was selected because flooding is one of the most frequent and costliest disaster events in Canada and this disaster was listed as the costliest flood disaster in Canadian history. While fire incidents are not expected to happen as the direct result of flooding, fire incidents may increase due to a large number of secondary hazards associated with flooding events such as power outages, vehicle accidents, release of hazardous materials, etc. that may cause fire incidents. Overall, the Southern Alberta Flood did not change the number of fire incidents very much, however, it may have impacted the nature of fire incidents. For example, there was an increase in the number of fire incidents ignited by "*electrical distribution equipment*". "*Electricity", "gasoline",* and *"match and lighter*" have contributed the most as fuel or energy for fire incidents during the flood event. It is also more likely that "f*lammable liquids, combustible liquid*", and "*wood, paper products*" play more roles in flooding period as the first ignited materials. It seems that flooding contributes to more fire incidents caused by "*mechanical/electrical failure/malfunction*" and "*vehicle accident*" as well. It was also found that the percentage of fire incidents extinguished by fire department is lower during a flood event compared to normal situations.

The Flash Flood that occurred on Toronto in July 8, 2013 was the fifth case study. This case study was selected because of its impact in a large populated area as well as its significant economic costs. The flash flood caused major disruptions in the city and the surrounding areas. At the time with more than $944 million insured and infrastructure losses, it was recorded as the most expensive disaster for the province of Ontario and among the top 10 costliest disasters in Canada. Fire incidents during this event (July8 to July 10) were compared with the fire incidents on the same days in Toronto in 2014. Overall, 30 fire incidents have been reported for July 8-10, 2013 and 30 fire incidents for July 8-10 2014.

Smaller crew sizes were used more often in response to fire incidents during the flash flood in Toronto. It was also found that distance to emergencies had increased during the flash flood days. The numbers of fire incidents that were cleared before the arrival of fire crews were higher during the 2013 flash flood days compared to similar days in 2014. In addition, more fire incidents with "*smoke showing only*" occurred during the flash flood days in 2013.

Relatively more residential fires were reported during the flash flood days in 2013. More fire incidents were reported in high rise buildings during the July 2013 flash flood. Fire incidents related to "*cooking equipment, electrical distribution equipment*" and "*miscellaneous*" show higher percentages for the July 2013 flash flood dates. Massive power outages can partially explain these patterns. The number of fire incidents with electricity as the fuel or energy was higher during the flash flood days.

The last emergency case that was examined in this study is the December 2013 Ice Storm in the Greater Toronto Area. This ice storm caused massive power outages in the impacted areas in which more than 600,000 households were without power, some for more than a week. According to the Toronto Fire Services database (not the NFID) on December 22, 2013 there were 3820 service requests received. Fire incidents for December 21-27, 2013 (190 cases) were compared with the fire incidents for the same days in 2014 (81 cases). Close to half of the fire incidents during the ice storm occurred in the City of Toronto and majority of the remaining incidents occured in Brampton (17%) and Mississauga (16%). It appears from the findings that mutual aid was not used in this case. It is not clear whether it was because there was no need or because all neighboring fire departments were experiencing similar event at the same time. Fire incidents in Toronto are clustered in certain parts of the city. Larger portion of fires during the ice storm were categorized as "*fire with no evidence from*" in terms of status on arrival. Very few rescue operations were needed and there were no increases in death or injuries due to fire incidents during the ice storm. Higher than usual fire incidents were reported on "*special property*" and "*transportation equipment*" property group during the ice storm.

A higher than normal number of fire incidents are likely to be ignited by "s*moker's material and open flame*" and "*heating equipment*" during the ice storm event. Similarity, higher than usual number of fire incidents were fueled by "*coal and wood*", "*exposure fire*" and "e*lectricity*" during the ice storm. "*Wood and paper*" and "*building components*" seem to play more role as the materials first ignited during the ice storm emergency. Apparently it was found that the area of origin of more fire incidents are the "*assembly, family, sales area*" and "*service facility*" during the ice storm days compared to normal days.

1 INTRODUCTION

INTRODUCTION

Disasters have the capacity to undermine fire departments primary mission. Understanding the nature, volume, impacts, and response performances and resilience of fire departments during major disasters and emergencies is very important and such a study provides valuable information to fire departments for risk mitigation, preparedness and response management during major disaster and emergencies in their respected communities. While fire departments are proficient at planning and preparing for normal operating conditions (Simpson and Hancock, 2009), better understanding and preparedness for major disaster events is more challenging, in part due to having limited data associated with rare, potentially catastrophic events (McLay et al., 2012). Better knowledge of the expected situations and preparedness leads to a better fire response for people during such events.

The ability to accurately assess the volume and nature of fire incidents during potential disaster events is critical for effective use of fire departments' resources. Such assessment will provide insight into the factors that can assist fire department leaders in planning for large disaster and emergency events in their jurisdictions. Some of the preparedness decisions that could be enhanced as a result of such assessment include: improved methods for contingency planning for scheduling staff on short notice; determining which types of fire response units are more likely in demand in different disaster situations; what challenges fire response personnel might face on the ground; and what type of impacts they might expect. This information can also help fire departments to better understand continuity of operations issues during major disaster and emergencies. Moreover, this type of information can provide a better understanding on the amount of additional risks that fire fighters face during major emergencies as compared to normal situations.

The main aim of this study is to provide some insights into fire incidents pattern during major disasters and emergencies in Canada so that fire departments can learn from past disaster cases and prepare accordingly.

FIRES AND DISASTERS

Fire incidents have been examined in normal conditions from different aspects (Asgary et al., 2009a; Asgary et al., 2009b; Asgary et al. 2010; Asgary et al., 2012; Sadeghi-Naini and Asgary, 2013). However, studies on fire incidents during major disaster and emergency situations are rare globally and very limited in Canada.

During most disaster and emergency situations the total number of 911 calls increase (Conzelmann et al., 2007; Higgins, 2014; Rajaram et al., 2016) and demand for and pressure on emergency services including fire departments rise. Response time to incidents may increase not only due to the increasing demands, but also due to more disruptions, communication, traffic, and other problems. Some of the incidents may be responded by volunteers and ordinary citizens (Glass, 2001). For example, when the Nimitz Freeway collapsed during the Loma Prieta earthquake, there were 150 people on the freeway. About 50 people were killed instantly or relatively quickly; about 50 people walked away from the scene on their own; and about 50 were rescued. Of those 50 who were rescued, 49 were rescued by lay bystanders, workers in an industrial facility (Glass, 2001; 72). Similarly after the 1995 Kobe earthquake significant number of fires (18 % or 41) was extinguished by the public. It has been argued that without the public initiative in fighting fires the number of fires and fire losses would have increased (Thomas, 2005).

Disaster and emergency situations create circumstances for individual and organizational behaviour to change. During major emergencies, some people may turn into various alternative options some of which may not be safe. For example, according to Chan et al. (2013) 437 Carbon monoxide (CO) exposures were reported to the New York City Poison Control Center (NYCPCC) during Hurricane Sandy. It was a significant increase when compared with preceding years. Indoor grilling and generators were found to be the most common sources of CO exposure. People may show different behaviour during disaster and emergency situations which can complicate the works for fire departments. For example, during the 2013 Ice Storm in Toronto, power outage during the holiday season and cold weather caused citizens to disregard fire-safety measures, resulting in an increase in the number of fire incidents. As a result during the ice storm days, Toronto Fire Services issued daily press releases in order to provide ice-storm related fire-safety tips, largely focused on candle safety, cooking, heating and messages related to carbon monoxide, which was increasingly becoming a problem as residents looked for ways to provide heat to their homes (Higgins, 2014).

Major emergencies often impact utilities and infrastructure such as power, water, telecommunication and pipelines. Secondary hazards, such as power outage, could increase fire incidents. During the 2013 Ice Storm in Toronto that resulted a widespread and long lasting power outage and left more than 300,000 customers without power (Armenakis and Nirupama, 2014), demand for first responders, including fire services increased significantly (City of Toronto, 2013). Most of the increase was attributed to the use of inappropriate heating sources and generators in enclosed spaces (Rajaram et al., 2016). A number of CO related calls to fire services increased five times during emergency situations in the City of Toronto during the power outage period (December 21 to December 31). Similar experience was observed during Hurricane Sandy in 2012. Widespread utility and communication outages occurred and the 911-dispatch system was overloaded (Hughes et al., 2014).

Some disasters such as earthquakes can increase the number of fire incidents. Fires following these events may cause more damages than the primary hazard. Historically, both San Francisco and Tokyo were destroyed by fires after major earthquakes hit them in 1906 and 1923 respectively (Mousavi et al., 2008). It is estimated that between 30-50 fire incidents occurred in the San Fernando Valley after the 1994 Northridge earthquake and a few low-rise buildings were completely destroyed and some multi-storey buildings suffered extensive damage. A large number of fire incidents were reported after the 1995 Kobe earthquake as well (Mousavi et al., 2008).

During the first 3 days following the earthquake, more than 285 fires occurred in the Hyogo and Osaka Prefectures (Hokugo 1997; Beall, 1997). Of those fires many of them (138) were in Kobe City. Around 77 of these fire incidents involved multiple buildings. Fire spread rapidly in these buildings because they were very close to each other. Although most of the buildings were clad with non-combustible cladding, the earthquake damage allowed fires to spread (Hokugo, 1997). Investigations were made by the Kobe Fire Department to find out the ignition sources of these fires. Out of 81 ignition sources identified, 44 fires were caused by electric appliances and electrical systems malfunctions, 5 fires by gas heaters and stoves, 5 fires by kerosene heaters and 6 fires were associated with gas leak (Bella, 1997). Thirty-five ignitions occurred immediately after the electricity was turned back on. A number of fires were also due to a gas leaks similar to the Northridge and Loma Prieta earthquakes in California (Botting, 1998; Scawthorn, 1998). Twenty-four ignitions were attributed to gas leaks although the causes of half the fires were unknown. A large proportion of the gas leaks that occurred were gas pipes entered buildings (Hokugo 1997; Thomas, 2005).

It has to be mentioned that the number of fire incidents after the earthquake might also vary from country to country. For example, despite the huge number of human fatalities (17000) and significant property dames after the 1999 Marmara earthquake in Turkey, the loss of life and injuries due to fire was minimal. Since the main construction materials were non-flammable reinforced concrete and masonry, there was no conflagration in this earthquake. The earthquake only caused a major fire in an oil refinery (Mousavi et al. 2016).

Evidences suggest that fire incidents patterns vary between different types of disasters and emergencies. For example, a study conducted by McLay et al. (2013) revealed that response and service times are significantly longer during blizzard emergencies as compared with hurricane cases. Disasters and emergencies could limit the capacity (human, equipment, communication) as well as the ability (access, environment, etc.) of fire departments to effectively perform their operations as they do in normal situations (Nirupama et al., 2014). Such conditions may result in different levels and patterns of human and property losses (Yates, 2013). For example studies have shown that large scale power outages have increased human impacts (i.e. mortality and morbidity) through fires and carbon monoxide poisoning (Cukor and Restuccia 2007; Lawrence et al. 2004) among other things. During the power outage people started using very different types of exposed flames for lighting, cooking, and heating which led to more fire accidents and losses.

Disasters may also change the normal patterns of fire incidents. Depending on the timing and the day of the event, the number of fire incidents and their spatial and temporal pattern may shift. For example, between 16:00 on Dec. 21 (the night of the ice storm) and 06:00 on Dec. 22, Toronto Fire Service had responded to 1,200 calls, almost 800 of which occurred between midnight and 06:00. Almost 500 of those calls were related to downed wires, but there were also a significant number of alarm ringing calls and elevator-rescue calls as the power shut down across the city (Higgins, 2014). This volume of incidents and their timing are certainly different from normal operations.

FIRE DEPARTMENTS AND DISASTERS

Very few studies have examined the challenges that fire departments face during a major disaster and emergency situations (Hazen, 1979; Britton, 1983; Warheit 1970a, 1970b; Warheit and Waxman, 1973; Waxman, 1973; and Weller, 1973; Wenger, 1989). A pioneering study in this area was conducted by Warheit (1996). This study investigated the functioning of fire departments in major emergencies based on the examination of fire department operations in a number of domestic and foreign disasters. Warheit examined fire departments in terms of their typical organizational patterns, their disaster-related tasks and activities, and their organizational adaptation to demand situations. He argued that unlike many other organizations, fire departments are likely to continue to cope with tasks similar to their pre-disaster responsibilities since their specialized tasks can seldom be pre-empted by other groups or agencies.

Large disaster and emergency situations can become very different from normal situations for fire departments. Disaster situations can quickly overwhelm the fire departments existing or access to resources. For example, after the 1995 Kobe earthquake, the water supply for firefighting was available only for 2 to 3 hours. During Hurricane Katrina the scale of the disaster immediately exceeded the capacity of local emergency response institutions, particularly fire and police (Baker and Refsgaard, 2007). During the 2008 Hurricane Ike windstorm in Ohio, within 1 h of the start of the windstorm, the Cincinnati fire department extended all shifts and called in many of the off-duty firefighters. The fire department received more than 700 calls on September 14, 2008. The usual number of calls for such a day would have been about 200 (Schmidlin, 2011).

While, the fire departments' response to emergency calls during a large disaster and emergency events is very important and highly critical, response time will increase during disaster and emergency situations. It is apparent that more requests, limited resources, traffic and communication disruptions could lead to increasing response time (Higgins, 2014). Triaging the requests may be needed under such situations. Fire departments may need to make some adjustments to their operational protocols. For example, Toronto Fire Services had to activate their single-truck response protocol during the December 2013 Ice Storm in order to keep up with the increasing volume of calls for services. As mentioned by Higgins (2014), fire response becomes even more critical during disaster events. For example, there may be an immediate increase in certain types of fires or rescue services. An impaired traffic network may lead to longer fire response and service times that indirectly affect the impacted population.

Lack of or impaired fire services during major emergencies should also be considered by the general public and businesses that are active in disaster and emergency zones. Even if their own house or building might not have been impacted directly, their risk will be higher because it is likely that emergency services may not be easily accessible. Nielson (2015) found that even when certain employees could access the work place during the Calgary flood without difficulty, the risk to employees was much greater than normal situations because "if something happened to them in the work place there likely would have been no fire, police, or ambulance services available to respond". This is important, partially because unlike many other community services, fire services are not something that can be provided by spontaneous volunteers (Waldman et al., 2016).

Some disasters such as wildfire may increase the need for mutual assistance. This has been the case in most recent wildfires in Canada and the one that will be examined in this report, Slave Lake Wildfire. This wildfire could not have been controlled by the limited resources available to the Lesser Slave Regional Fire Service (LSRFS). However, even additional crews may not be effective for some disaster scenarios. For example, it is argued that despite having a large number of fire fighters and fire trucks were sent to Kobe from neighbouring cities such as Osaka, they were not able to operate effectively because of the lack of water and lack of access due to damaged roads and collapsed buildings blocking streets. In addition, communication with fire crews was also very difficult since the telecommunications system had been failed as well (Hokugo, 1997).

Disaster and emergency situations also pose a higher risks to fire fighters. Many fire fighters have lost their lives responding to fires during major disaster and emergencies. During the Chernobyl disaster (April, 26, 1986) about 250 firefighters who were at the nuclear power plant immediately after the accident were acutely exposed to high doses of radiation (Lucchini et al., 2017). During a major wildfire disaster in August 30, 1987, seven firefighters were killed (Duclos et al., 1990). More than 343 emergency workers many of whom were fire fighters lost their lives in the World Trade Center after the September 11 Terrorist Attack (McInnes, 2003). Moreover, the Fire Department of New York (FDNY) soon after the attack reported respiratory effects in firefighters (Lucchini et al., 2017). Most recently 16 fire fighters lost their lives in responding to Plasco Tower fire disaster in Tehran in 2016.

Research conducted on firefighters involved in major disaster response operations suggests that these firefighters are more likely to show PTSD symptoms (McFarlane, 1988, Sprang, 1999; Berninger et al., 2005) and experience long term health issues. For example a study conducted by Osofsky et al. (2011) on fire fighters after Hurricane Katrina found that the first responders who were involved in this disaster reported that they experienced a multitude of significant losses and stressors, including loss of home, separation from family and stressful working conditions. They found that 44.6% of their samples reported that they would participate in mental health services if they were offered. As a result of these studies, providing short term and long term support to fighter fighters during and after the major disasters are recommended (Tak et al., 2007).

Fire departments vary in size and resources, which can affect their level of preparedness for major disasters and emergencies. Many smaller fire departments may not have resources to pre-plan for such events. It is more likely for large fire departments to have more experiences, resources and equipment to respond during major disasters and emergencies.

During disasters and emergencies fire departments may need to be involved in operations that are not their routine activity. In order to conduct these roles effectively additional training and exercises are needed. For example, in hurricanes, floods, and wildfires, local fire departments often are involved in evacuation operations (Wenger, 1989).

While fire departments’ facilities are essential for coping with large scale disaster and emergencies, they may be impacted by the disaster themselves. These may add to the resource issues during disasters and make situations more complicated. For example, many fire stations were damaged during hurricane Katrina in New Orleans which drastically limited the ability of fire department to operate effectively (Baker and Refsgaard, 2007). Fire stations were flooded and infested with mold, damaged by wind pressure, storm surge, or a combination of these effects (Mosqueda and Porter, 2007). During Hurricane Ivan both fire stations in Orange Beach, Alabama were substantially damaged (Picou and Martin, 2006). Also, during the 2013 Calgary flooding, critical community services including some of the Calgary Fire Department and Emergency stations were within the flood zones (Reynolds et al., 2014). Finally, as stated by Higgins, the loss of power during the

December 2013 Ice Storm significantly impacted Toronto Fire Services. About 19 fire halls lost power, which also meant they were without heat. "While fire crews were busy responding to emergency calls, staff from our heavy urban search and rescue team began to distribute generators and portable heaters to as many halls as possible. Mechanical staff were called in for the duration of the outage to go from fire hall to fire hall to start up and refuel generators" (Higgins, 2014).

THIS STUDY

This study has been conducted to provide much needed research on fire incidents during major disasters and emergencies to enhance the understanding of the fire related issues. This research has been funded by the Canadian association of Fire Chiefs (NAFC).

The primary goal of this study is to comprehensively examine, enhance and contribute to our understanding of fire incidents during major disasters and emergencies in Canada using the emerging National Fire Incidents Database (NFID). As a result, fire disasters that have been occurred during some of the major disaster and emergency events as listed in the existing disaster databases have been identified. 150 disaster and emergency events in six provinces for which fire incidents data exist in the NFID have been examined. About 5769 fire incidents have been reported on the day or days of 59 of these emergencies. Comparisons between the fire incidents during the disaster and emergency days and normal days have been made. Six major disaster and emergencies were then selected for more detail analysis.

This study contributes to our understanding of fire incidents during major disasters and emergencies in Canada in a number of ways:

1) It provides evidences of fire incident patterns during normal and emergency situations;

2) It enhances our understanding of fire incidents under different types of disaster and emergency situations (i.e. flooding, ice storm, wildfire, large scale explosions, heatwaves, and riots). This study will provide comparison of fire incident volumes, response, and impacts during different disasters types in different locations and environmental conditions, and this will shed light on the expected results during major disaster and emergency events.

2 METHODOLOGY

INTRODUCTION

This study focuses on changes in the volume, nature, response issues, and impacts of fire incidents as recorded in the National Fire Incidents Database during major disaster events in Canada. Although Canada has not experienced major catastrophic events (such as the triple 2011 earthquake, tsunami, and nuclear accident in Japan, Hurricane Irma, or Hurricane Sandy in the USA), it has experienced a significant number of disasters and emergencies that have been significant enough to put extraordinary pressures on local fire departments and emergency services and push them beyond their normal operational conditions.

Fire departments' involvement in disaster and emergency events vary. Their involvement depends on a number of variables such as type (natural, technological, human made), sub type (earthquake, hurricane, ice storm, etc.), size, duration, available resources, and the availability of other resources (Warheit, 1996). This study uses the National Fire Incidents Database (NFID) to answer the following questions:

- What are the fire incidents patterns during normal and emergency situations?
- What are the differences between fire incidents pattern during major disaster and emergency situations?

Answers to these questions will provide fire departments with what they can expect in terms of fire incidents (volume, type, response effectiveness, and impacts) in different types of major disaster and emergency events.

DATA

To investigate the above research questions, it is necessary to identify which fire incidents in the NFID data have occurred during major disaster and emergency situations.

Major disaster and emergency situation in this research refers to the time period when an emergency or disaster has existed in a city, town, region, or jurisdiction. This time period is identified either by the length of a formal state of emergency declaration or by the analysis of fire incidents before or after a major event. In the latter case, particularly when the exact timeline of the emergency declaration is not known, the period in which the number of fire incidents is above the normal levels is considered as disaster and emergency situation.

This study uses the following databases:

1. NFID for fire incidents.
2. EM-DAT (www.emdat.be) for major disasters and emergencies in Canada
3. Canadian Disaster Database (http://cdd.publicsafety.gc.ca/) for major disasters and emergencies in Canada.

Fire Incidents Data

The National Fire Incidents Database (NFID) is used for fire incidents data in this study. The NFID is a pilot project aiming to gather "ten years of data on fire incidents and fire losses from provincial/territorial Fire Marshals and Fire Commissioners Offices across Canada, standardizing the data, and creating a centralized national system for the collection of fire statistics" (Canadian Centre for Justice Statistics, 2017). This pilot project was carried out by the Canadian Centre of Justice Statistics (CCJS), a division of Statistics Canada. The CCJS worked with the Canadian Association of Fire Chiefs (CAFC) and the Council of Canadian Fire Marshalls and Fire Commissioners(CCFMFC) to develop the capacity to collect, standardize, compile and analyze fire incident information on a national basis (Canadian Centre for Justice Statistics, 2017). This database enables the capacity to present fire incident data in a uniform manner across Canada which will cover an important gap in existing knowledge and gaining a greater understanding of the nature and extent of fire incidents across the country (Canadian Centre for Justice Statistics, 2017).

"The NFID will serve to improve analytical capacities for evidence-based research related to fire incidents, public safety and security that can be used by Fire Marshals, Fire Commissioners and Chief Fire Officers and academic researchers to provide policy and operational guidance that responds to trends that are currently unable to be adequately identified. Furthermore, these data will assist fire services in making operational decisions and improving policy and prevention measures in the development of appropriate and efficient methods of fire response, and to help promote public awareness about the dangers of fire" (Canadian Centre for Justice Statistics, 2017)..

The NFID covers six provinces that together accounting for almost three-quarters (72%) of the Canadian population (Canadian Centre for Justice Statistics, 2017). These six provinces are:

- New Brunswick
- Ontario
- Manitoba
- Saskatchewan
- Alberta
- British Columbia

NFID covers fire incidents from 2005 to 2015 for most of these jurisdictions, except Saskatchewan that is from 2012 to 2015 and Ontario that is from 2005-2014. This study uses 2005-2014 as the study period.

Disaster Data

There are several data sources for disaster events. For this study two most relevant and reliable major sources are:

- EM-DAT (www.emdat.org)
- Canadian Disaster Database (http://cdd.publicsafety.gc.ca/)

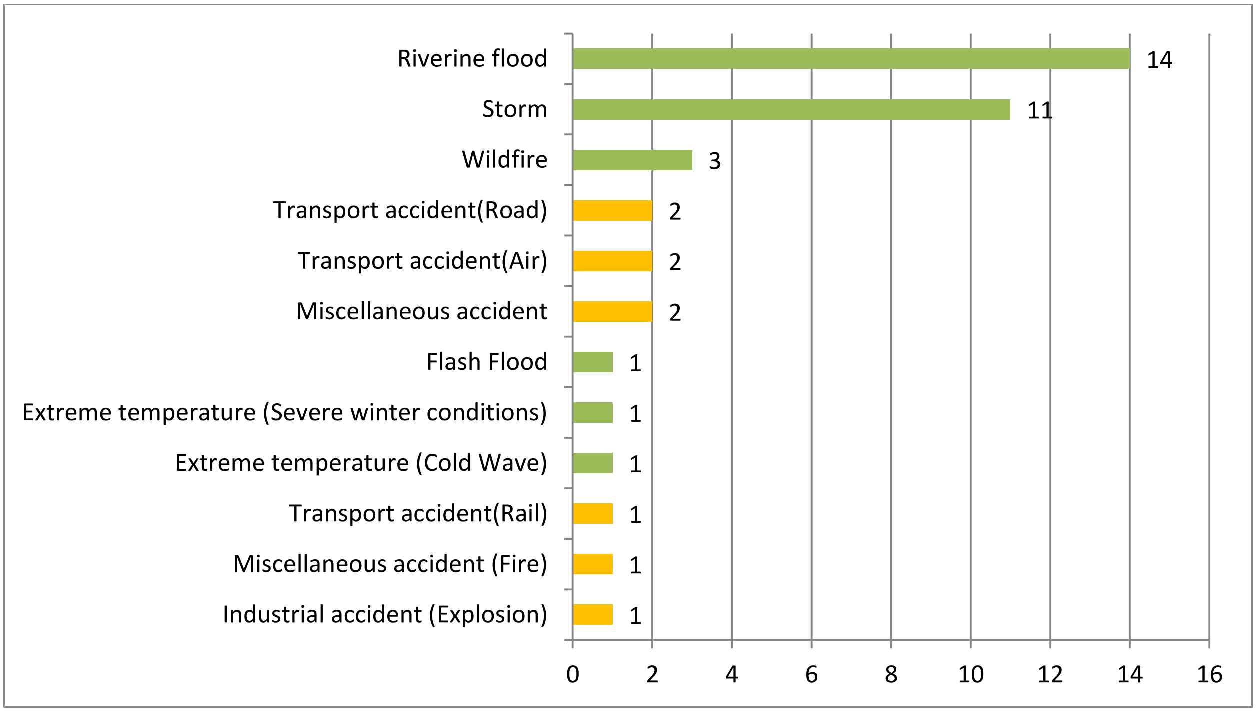
Based on the EM-DAT during the 2005-2014, 31 natural disasters occurred in Canada with 35 fatalities, 130 thousands people affected and more than 11.5 billion USD direct damages. Floods, storms, and wildfire are listed as the most frequent disaster events in this period (Table 2.1 and Figure 2.1). Also, based on the EM-DAT, there are 9 human-made and technological disasters in Canada during this period. These disasters had 120 fatalities, affected 15,283 people, and costed 235 million USD.

TABLE 2.1 OVERVIEW OF NATURAL AND TECHNOLOGICAL DISASTER EVENTS IN THE REPORTING JURISDICTIONS, 2005-2014

Disaster type	Events count	Total deaths	Total affected	Total damage ('000 US$)
Extreme temperature (Cold Wave)	1	0	0	0
Extreme temperature (Severe winter conditions)	1	10	0	200000
Flash Flood	1	0	6904	129000
Riverine flood	14	14	116100	6891000
Storm	11	10	323	2960000
Wildfire	3	1	7000	1500000
Total	**31**	**35**	**130,327**	**11,680,000**
Industrial accident (Explosion)	1	2	12518	0
Miscellaneous accident (Fire)	1	32	0	0
Miscellaneous accident	2	0	661	0
Transport accident(Air)	2	28	4	0
Transport accident(Rail)	1	47	2000	235000
Transport accident(Road)	2	11	100	0
Total	**9**	**120**	**15,283**	**235,000**

Source of data: Source: EM-DAT: The Emergency Events Database - Universite catholique de Louvain (UCL) - CRED, D. Guha-Sapir - www.emdat.be, Brussels, Belgium

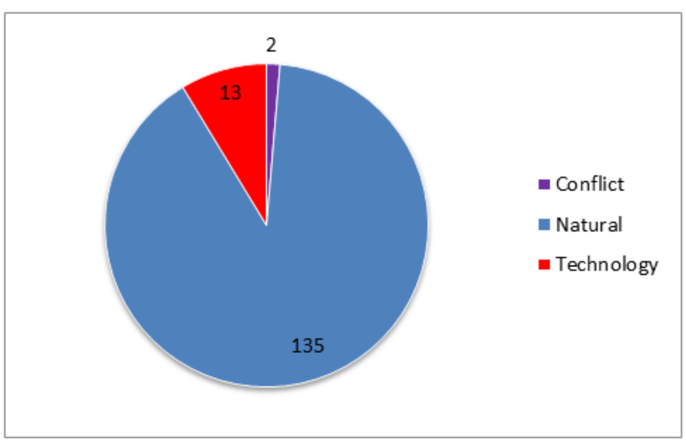
FIGURE 2.1 NUMBER OF NATURAL AND TECHNOLOGICAL DISASTERS IN CANADA, 2005- 2014 (EM-DAT)



Source of data: Source: EM-DAT: The Emergency Events Database - Universite catholique de Louvain (UCL) - CRED, D. Guha-Sapir - www.emdat.be, Brussels, Belgium

According to the CDD there are 1078 cases of disasters and major incidents in Canada from 1900 to 2016. Out of this number, 854 or 79% are classified as natural, 23 or 2% are conflict (human-made), and 201 or almost 19% are technological. During the study period (2005-2014), 150 disasters have been recorded for the reporting jurisdictions (Figure 2.1). 135 out of the 150 disaster events are natural disaster events, and only 13 are technological and 2 are conflict disasters.

FIGURE 2.1 DISASTERS IN REPORTING JURISDICTIONS BY GROUP 2005-2014



Source of data: Canadian Disaster Database

The disaster type with the highest number of incidents is flood events. There were 47 flood event cases reported during the study period, followed by wildfire (31 cases) and storms and severe thunderstorms (25) (Table 2.1).

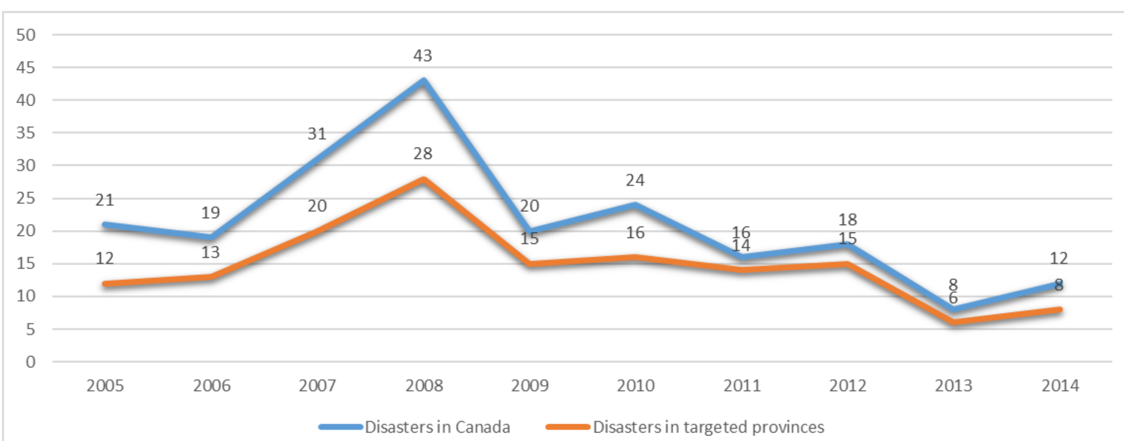
TABLE 2.1 NUMBER OF DISASTER TYPES IN THE REPORTING JURISDICTIONS 2005-2014

DISASTER TYPE	INCIDENTS	DISASTER TYPE	INCIDENTS
Flood	47	Derailment Release	1
Wildfire	31	Drought	1
Storms and Severe Thunderstorms	25	Heat Event	1
Tornado	8	Infestation	1
Winter Storm	7	Landslide	1
Hurricane / Typhoon / Tropical Storm	5	Leak / Spill Release	1
Non-Residential	4	Manufacturing / Industry	1
Epidemic	3	Pandemic	1
Fire	2	Rioting	1
Rail	2	Shootings	1
Residential	2		
Storm - Unspecified / Other	2		
Storm Surge	2		

Source of data: Canadian Disaster Database

A number of disaster events in the reporting jurisdictions vary from year to year (Figure 2.2). The highest number of disaster events is in 2008. There is a similar trend between disasters in this reports' targeted jurisdictions and Canada as a whole. In both cases disaster events had peaked in 2008.

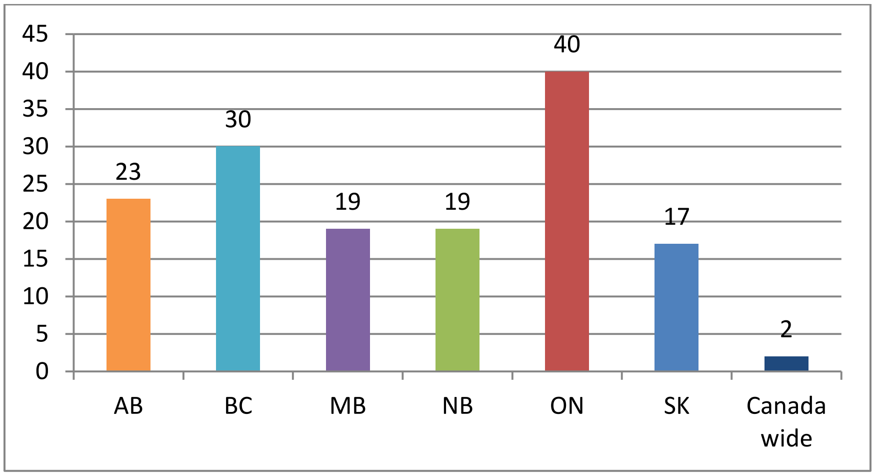
FIGURE 2.2 INCIDENTS OF DISASTERS IN CANADA PROVINCES WITH FIRE INCIDENT DATA FROM 2005-2014



Source of data: Canadian Disaster Database

During the study period (2005-2014), 215 disasters and major incidents were recorded in CDD. 150 of these events occurred in the reporting jurisdictions. Ontario had the highest number of disasters recorded during the study period, with 40 disaster event cases. New Brunswick and Manitoba with 19 events had the lowest number of disasters in the same period (Figure 2.3).

FIGURE 2.3 INCIDENTS OF DISASTERS IN CANADA PROVINCES WITH FIRE INCIDENT DATA FROM 2005-2014



Source of data: Canadian Disaster Database

METHODS

Where possible a number of basic statistical analysis combined with temporal, spatial, and spatiotemporal analyses have been used to explain the data and derive some results about the patterns of fire incidents during normal and emergency situations. Basic statistical analyses provides detailed information about the distribution of fire incidents and their attributes and enables researchers to make simple comparisons between different datasets. Temporal analyses presents data by hour, day, month, and year providing useful insights into fire incidents patterns over time and can establish base lines and reveal new trends. Temporal analyses are often shown in simple line charts and circular plots since they illustrate continuity and chronological order. Temporal patterns typically use one of the four general forms: panel, event-count, event-sequence, or event-history analyses (Asgary et al., 2010). Panel analysis shows the state of a sample of units at two or more points in time. An event-count analysis records and displays the number of different types of events in an interval. Event sequences analysis displays those sequences of events and patterns which occur with a relatively high frequency. An event-history analysis records timing of all changes in a sequence. Apart from the general temporal methods, there are several more sophisticated methods such as weighted time span analysis and percentage change. Different types of fire statistics can be computed and displayed using one of the above temporal methods (Asgary et al., 2010).

Use of data mining techniques such as clustering analysis, association rules, and time series prediction are very common in fire incidents data as well (Zhang and Jiang, 2012). The clustering analysis can be used to group fire incidents records into clusters of incidents with similar characteristics. These groupings are useful for exploring fire incident data, identifying anomalies in the fire incidents data, and making predictions about fire incidents with different characteristics. Clustering enables us to find relationships in fire incident data that cannot be derived from casual observation. Clustering of fire incidents helps better understanding of the various attributes of the incident and the critical impact of the development of the incident (Zhang and Jiang, 2012). There are a number of clustering methods and algorithm available in commercial statistical software packages. Association rules are ideal for finding potential relationship between fire incident attributes. This study is interested in the association between fire incident attributes and the types of disasters and emergencies. Time series analysis can be performed on fire incidents to predict future incidents based on the past. While the data mining methods can be used for predicting fire incidents in a particular community, it is less feasible and possible to apply it in the current database due to some limitations that exist in the data (i.e. many unknown and missing values) and particularly the small number of observations for community level analyses.

Spatial analysis of fire incidents requires spatial information about the incidents. NFID data has a number of fields related to the location of fire incidents (Table 2.2). The database does not provide the address location of the fire incidents and therefore the exact location of fire incidents cannot be considered in spatial analysis. The closest alternative is the "*Postcd*" field. Only 3912 (68 %) out of 5769 fire incidents that have been occurred during the relevant major disasters and emergencies have postal code information. This makes it difficult to conduct a number of GIS and spatial analysis. However, where possible, fire incidents have been geocoded, mapped and analysed using postal code information. Spatial density analysis and spatial correlation analysis have been used and reported.

TABLE 2.2 FIRE INCIDENTS LOCATION FIELDS IN THE NFID DATABASE

CODE	Description	Details
JURIS	Reporting Jurisdiction	Refers to the jurisdiction providing the data file.
INCIDLOC	Incident Location	The incident location is not a standardized variable (i.e., it is for the most part, as the jurisdiction reported it). Typically it represents a city, municipality, town or village, however there may be other location descriptions.
CSD	Census Subdivision Code	Census subdivision (CSD) is the general term for municipalities (as determined by provincial/territorial legislation) or areas treated as municipal equivalents for statistical purposes (e.g., Indian reserves, Indian settlements and unorganized territories).
CSD_NAME	Census Subdivision Name	This field provides the description/name associated with the CSD code. Census subdivision (CSD) is the general term for municipalities (as determined by provincial/territorial legislation) or areas treated as municipal equivalents for statistical purposes (e.g., Indian reserves, Indian settlements and unorganized territories).
CMA Census	Metropolitan/Agglomeration Area Code	A census metropolitan area (CMA) or a census agglomeration (CA) is formed by one or more adjacent municipalities centred on a population centre (known as the core). A CMA must have a total population of at least 100,000 of which 50,000 or more must live in the core. A CA must have a core population of at least 10,000. To be included in the CMA or CA, other adjacent municipalities must have a high degree of integration with the core, as measured by commuting flows derived from previous census place of work data.

CMA_NAME	Census Metropolitan/Agglomeration Area Name	
Postcd	6 digit/character postal code	

Where possible, spatial pattern analysis was used in this study. Kernel density estimation is the most common and well-established method for point data analysis (Asgary et al., 2010) which is very relevant to fire incidents data. Kernel density estimation (KDE) uses information on the spacing of the points to characterize pattern (typically, mean distance to the nearest neighboring point). "Kernel density estimation (KDE) calculates the density of events in a neighborhood around those events. KDE allows some events to weigh more heavily than others, depending on their meaning, or to allow one event to represent several observations. For example, some fires might be weighed more severely than others in determining overall fire patterns. KDE calculates the density of point features around each output raster cell and generates a smoothly curved surface over each point. The surface value is highest at the location of the point and diminishes with increase in distance from the point, reaching zero at the search radius distance from the point" (Asgary et al., 2010).

LIMITATIONS

Only six provinces have provided fire-related data for the pilot NFID project. Out of these six, only British Columbia, Alberta, Manitoba, and Ontario have provided at least 10 years of data for both fire incidents and victims. Although all jurisdictions reported data for 2015, this data does not exist for Ontario. For this reason this study covers the 2005 to 2014 period only.

It should also be noted that New Brunswick has not provided information related to the type of property, or the date and month of the fire incidents, therefore it has not been possible to include this study for the most part.

It should also be noted that the degree of underreporting for Saskatchewan may be higher than in other jurisdictions. This is due to the fact that data was provided for only those municipalities (including towns, cities, villages, etc.) that are using the NFIRS (National Fire Incident Reporting System), a U.S.-based records management system.

This study is limited to the availability of information in the database. Unfortunately information about some of the key fields is missing in the database. Some of them are: "crew size (initial)", "response time of subsequent vehicles", "subsequent crew size", "number of engines", "number of aerials", and "number of tankers".

In addition to many missing values for some variables in the dataset, many registered values are actually categorized as "unknown", "not applicable", or "undetermined", which make it very difficult to make any robust conclusion.

3 DISASTERS IN CANADA

INTRODUCTION

Extended from Atlantic to Pacific and the Arctic Ocean, Canada covers 9.98 million square kilometers. This massive land stretches across six time zones and hosts various weather patterns from Arctic cold to moderate. Seasonal floods, winter storms, hailstorms, wildfires and tornados are among the most common natural hazards in the country. Canada is also exposed to the risk of earthquakes, volcanic eruptions and tsunamis which can potentially harm many Canadians. In addition, Canada has faced cases of pandemics, train derailments, power outage, and social unrest during the past decades[1].

Canadians are not unfamiliar with disaster events. A recent study conducted by Statistics Canada in 2014 found that more than 12.4 million Canadians (15 years of age and older) had personally experienced a major emergency or disaster in their community during their lifetime (Ibrahim, 2016). These experiences are ranging from blizzards, winter storms or ice storms, extended power outages, or floods. Loss of utilities, particularly electricity, disruptions of daily routines and planned activities, displacement, and psychological effects are among the key impacts of these emergencies. Fortunately the direct human impacts of emergencies in terms of loss of life and bodily injures have been relatively low. According to this study only 3% of the study sample endured some form of a physical injury or health consequences.

According to the Public Safety Canada (PSC), a disaster is "essentially a social phenomenon that results when a hazard intersects with a vulnerable community in a way that exceeds or overwhelms the community's ability to cope and may cause serious harm to the safety, health, welfare, property or environment of people; this may be triggered by a naturally occurring phenomenon which has its origins within the geophysical or biological environment or by human action or error, whether malicious or unintentional, including technological failures, accidents and terrorist acts."[2] In other words when a natural hazard affects Canadians to the extent that the community involved needs assistance dealing with the harm that has occurred to people, and possibly the surrounding property and environment, the event becomes known as a "disaster".

To grasp a comprehensive view of the disasters in Canada we explore the frequency and typology of Canadian disasters using two different databases: 1) International Disaster Database, also known as EM-DAT)[3], and 2) Canadian Disaster Database[4]. While these are some of the most reliable available resources for disaster events, it is important to mention that these sources do not necessarily cover all disasters in Canada. Not all events in CDD appear in the EM-DAT and vice versa, suggesting that neither provides a comprehensive listing of major disaster events in Canada. For example, according to Buttle et al. (2016) these sources "sometimes list multiple floods as single events, and some major floods have been categorized as another hydroclimatic event type (e.g. the CDD

[1] For more information refer to: https://www.publicsafety.gc.ca/cnt/mrgnc-mngmnt/ntrl-hzrds/index-en.aspx

[2] https://www.publicsafety.gc.ca/cnt/rsrcs/pblctns/mrgnc-mngmnt-frmwrk/index-en.aspx

[3] http://www.emdat.be/

[4] http://cdd.publicsafety.gc.ca/

categorized the Hurricane Hazel flood as a hurricane). The CDD provides little or no description of some floods, and no indication of information sources used to populate the database" (p. 8).

DISASTERS IN CANADA 1900-2017 (EM-DAT)

According to the EM-DAT, during 1900-2017 there were 131 cases of natural disasters in Canada which had a total of 51,875 fatalities and affected 2,331,116 people. These disasters generated around 32 billion USD damage (Table 3.1 and Figure 3.1). Storms, flooding, and wildfire are the most frequent natural disasters in Canada.

TABLE 3.1 OVERVIEW OF NATURAL DISASTERS HAPPENED IN CANADA FROM 1900 TO 2017

Disaster Type	Events Count	Total deaths	Affected people	Total damage ('000 US$)
Natural Disasters				
Drought	5	0	55000	$4,810,000.00
Earthquake	1	27	0	$0.00
Epidemic	7	50562	2008917	$0.00
Extreme temperature (Cold wave)	4	10	200	$2,200,000.00
Extreme temperature (Heat wave)	1	500	0	$0.00
Flood	40	51	30744	$8,902,900.00
Landslide	3	144	44	$0.00
Mass movement (dry)	5	161	3547	$0.00
Storm	43	301	15587	$5,865,200.00
Wildfire	22	119	217077	$10,462,500.00
Total	**131**	**51,875**	**2,331,116**	**$32,240,600.00**
Technological Disasters				
Industrial accident (Chemical)	5	0	226750	0.00
Industrial accident (Collapse)	1	75	0	0.00
Industrial accident (Explosion)	8	440	12522	0.00
Industrial accident (Fire)	4	0	8300	0.00
Industrial accident (Other)	2	104	0	0.00
Miscellaneous accident (Collapse)	3	106	0	0.00
Miscellaneous accident (Fire)	12	716	8718	2,500.00
Miscellaneous accident (Other)	3	6	2661	0.00
Transport accident (Air)	21	1169	78	0.00
Transport accident (Rail)	10	250	2332	235,000.00
Transport accident (Road)	6	126	156	0.00
Transport accident (Water)	16	3694	15019	0.00
Total	**91**	**6,686**	**276,536**	**237,500.00**

Source of data: Source: EM-DAT: The Emergency Events Database - Universite catholique de Louvain (UCL) - CRED, D. Guha-Sapir - www.emdat.be, Brussels, Belgium

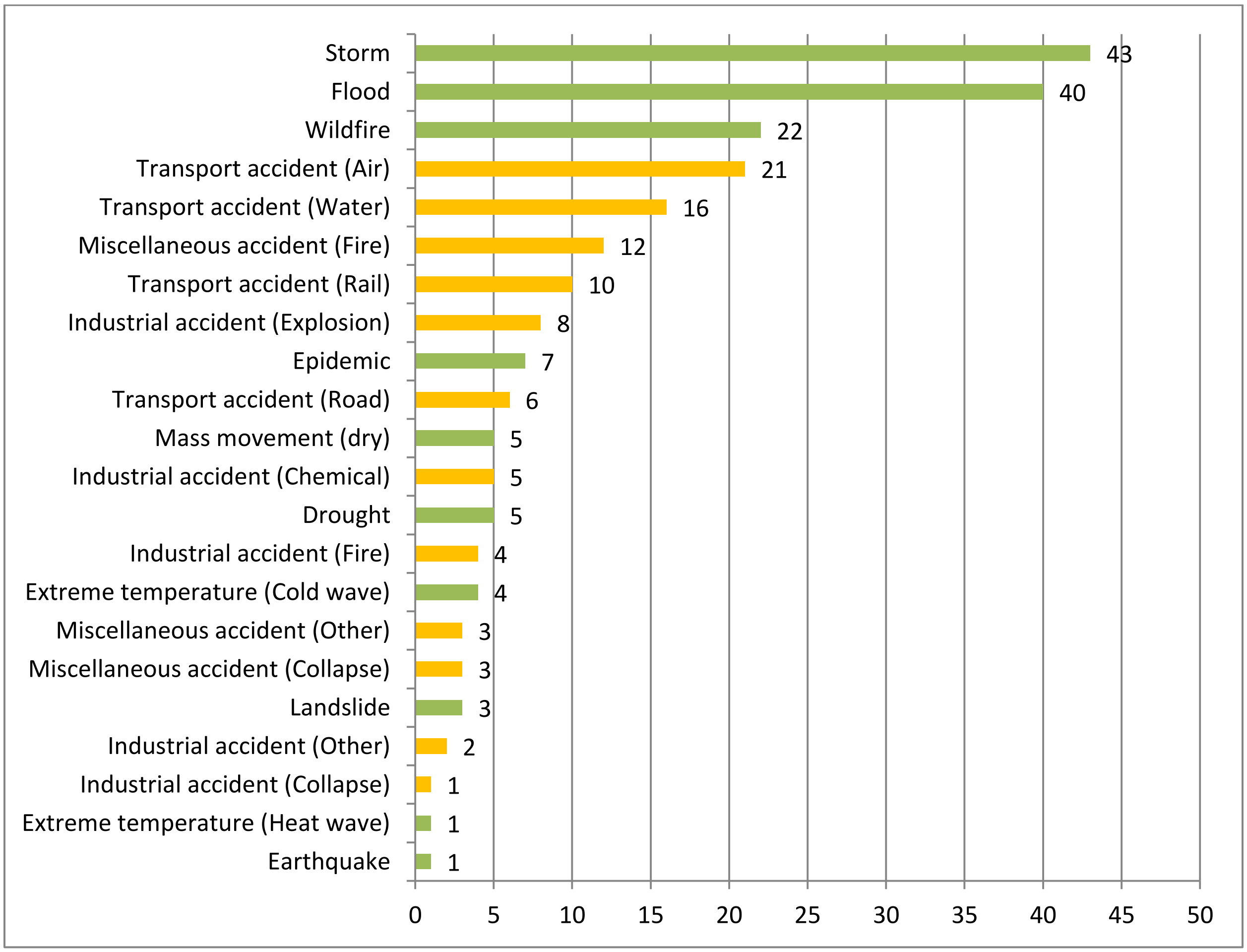
Much of the costs of natural disasters in Canada are attributed to the five costliest ones: Fort McMurry Wildfire (May 2016-$3.58 billion insured losses), Southern Alberta Floods (June-July

2013, 1.72 billion insured losses); the Great Ice Storm of 1998 ($1.49 billion); the Toronto Flood of July 2013 ($943 million); Slave Lake Fire of May 2011 ($700 million) (source: https://www.seafirstinsurance.com/about-us/blog/top-5-most-expensive-natural-disasters-canada).

Based on the EM-DAT, 91 human-made and technological disasters occurred in Canada during the same period. These disasters killed 6,686 people and affected 276,536 (Table 3.2 and Figure 3.2). The overall cost of these disasters was around 237 million USD. Air transportation, water transportation, fires, and rail transportation disasters are among the most frequent technological disasters in Canada.

Altogether, storms, floods, wildfires, transportation accidents (air), transportation accidents (water), miscellaneous accidents (fire), transportation accidents (rail), industrial accidents, and transportation accidents (road) are the top 10 most frequent disasters in Canada (Figure 3.1).

FIGURE 3.1 NATURAL AND TECHNOLOGICAL AND HUMAN MADE DISASTERS IN CANADA, 1900-2017



Source of data: Source: EM-DAT: The Emergency Events Database - Universite catholique de Louvain (UCL) - CRED, D. Guha-Sapir - www.emdat.be, Brussels, Belgium

DISASTERS IN CANADA 1900-2017 (CDD)

The Canadian Disaster Database (CDD) contains information on disasters and major incidents affected Canadians since 1900. The CDD tracks "significant disaster events" which conform to the Emergency Management Framework for Canada definition of a "disaster" and meet one or more of the following criteria:

- 10 or more people killed
- 100 or more people affected/injured/infected/evacuated or homeless
- an appeal for national/international assistance
- historical significance
- significant damage/interruption of normal processes such that the community affected cannot recover on its own[5]

CDD divides events into three main categories: 1) Natural disasters, 2) Conflict incidents, and 3) Technological incidents. According to the CDD[6] there are 1078 cases of disasters and major incidents in Canada from 1900 to 2017. Out of this number, 854 or 79% are natural, 23 or 2% are conflict (human-made), and 201 or almost 19% are technological (Table 3.2 and Figure 3.2).

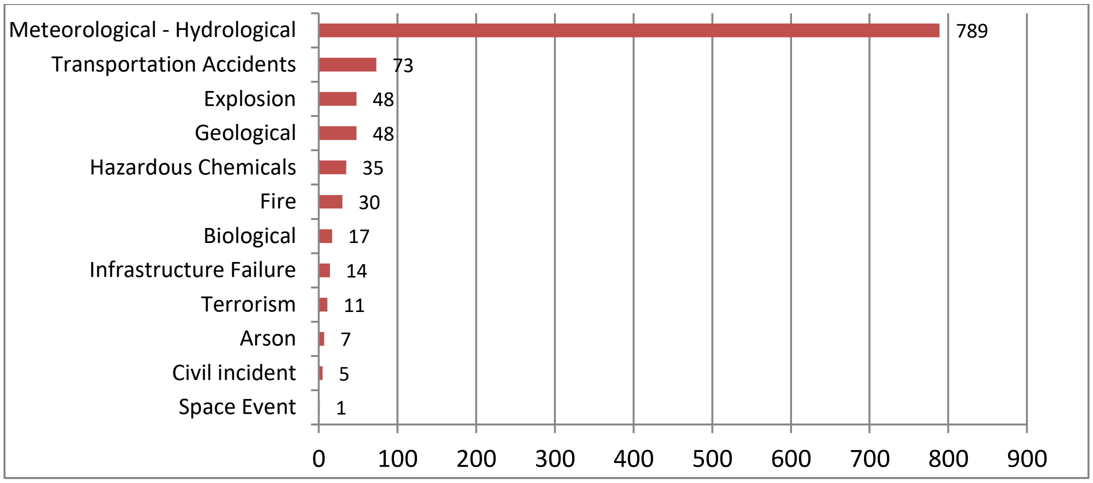
TABLE 3.2 OVERVIEW OF DISASTERS IN CANADA BASED ON CDD (1900-2017)

EVENT CATEGORY	EVENT SUBGATEGORY	FREQUENCY	PERCENT
Natural Disasters		**854**	**79.2**
	Biological	17	1.50
	Meteorological - Hydrological	789	73.2
	Geological	48	4.5
Conflict major incidents		**23**	**2.10**
	Arson	7	0.60
	Civil incident	5	0.50
	Terrorism	11	1.00
Technological major incidents		**201**	**18.6**
	Fire	30	2.80
	Hazardous Chemicals	35	3.20
	Transportation Accidents	73	6.80
	Infrastructure Failure	14	1.30
	Explosion	48	4.50
	Space Event	1	0.10
Total		**1078**	**100.00**

TABLE 3.2 NUMBERS OF DISASTERS IN CANADA BASED ON THE CDD (1900-2017)

[5] For more information refer to: https://www.publicsafety.gc.ca/cnt/rsrcs/cndn-dsstr-dtbs/index-en.aspx

[6] http://cdd.publicsafety.gc.ca/



Source of data: Canadian Disaster Database (http://cdd.publicsafety.gc.ca/)

FIGURE 3.3 DISASTERS/INCIDENTS RECORDS IN CANADA 1900-2017

Source of data: Canadian Disaster Database (http://cdd.publicsafety.gc.ca/)
Note: Numbers in the diomon icons indicate the number of disasters in that location

SUMMARY

In this chapter, the history of disaster and major incidents in Canada since 1900 has been explored. We reviewed the frequency and type of disaster that have occurred in Canada based on The Emergency Events Database (EM-DAT) and Canadian Disaster Database (CDD). Based on EM-DAT the most frequent natural disasters in Canada since 1900 are storm (33%), flood (30%), and wildfire (17%), and during the period of 2005-2014 the most frequent disasters are flood (48%), storm (35%) and wildfire (9%). According to CDD from 1900-2017 the most common disaster types in Canada are Meteorological-Hydrological (73%), Transportation accidents (6%), Geological (4%), and Explosion (4%), during 2005-2014 the most frequent disaster types are Meteorological-Hydrological (85%), Transportation accidents (3%), Geological (1%), and Explosion (1%).

4 FIRE INCIDENTS DURING MAJOR DISASTERS AND EMERGENCIES: An Overview

INTRODUCTION

This section provides an overview of the fire incidents reported by the reporting jurisdictions. The main aim is to provide a brief comparison between the overall patterns of fire incidents in normal days and disaster and emergency days as explained in the methodology section. In doing so some of the key attributes of fire incidents during normal days and disaster and emergency days are compared and analysed.

JURISDICTIONAL DISTRIBUTIONS OF FIRE INCIDENTS

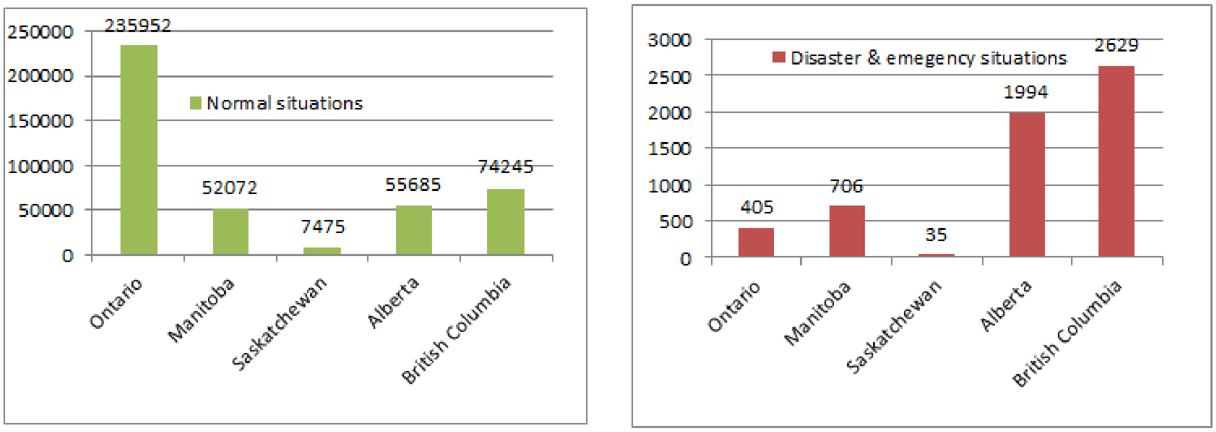
While Ontario with 53.08% has the largest share of fire incidents in the NFID dataset, British Colombia has the largest share of fire incidents (45.6%) during disaster and emergency days, followed by Alberta (34.6%) and Manitoba (12.2%) (Table 4.1 and Figure 4.1). Although Ontario has the largest number of disasters (40) during the study period, most of these disasters had short time span. On the other hand, British Colombia and Alberta with 32 and 23 disaster records between 2005 to 2014 experienced a great share of fire incidents during disaster and emergency days much of which is related to the wildfires. This may suggest that the type and duration of disaster events can have impacts on the number of fire incidents during disaster and emergency situations.

TABLE 4.1 NUMBERS OF FIRE INCIDENTS PER REPORTING JURISDICTION

Jurisdictions	All fire incidents		Fire Incidents during major disasters and emergencies	
	INCIDENTS	PERCENT	INCIDENTS	PERCENT
Ontario	235952	53.08	405	7.0
Manitoba	52072	12.48	706	12.2
Saskatchewan	7475	2.24	35	0.6
Alberta	55685	13.88	1994	34.6
British Columbia	74245	18.31	2629	45.6
Total	**443357**	**100.00**	**5769**	**100**

Note: Lower share of fire incidents in Saskatchewan is mainly due to its limited coverage of fire incidents in the database.
Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 4.1 NUMBER OF INCIDENTS PER REPORTING JURISDICTION



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

TEMPORAL TRENDS OF FIRE INCIDENTS: ALL INCIDENTS

Annual Trends

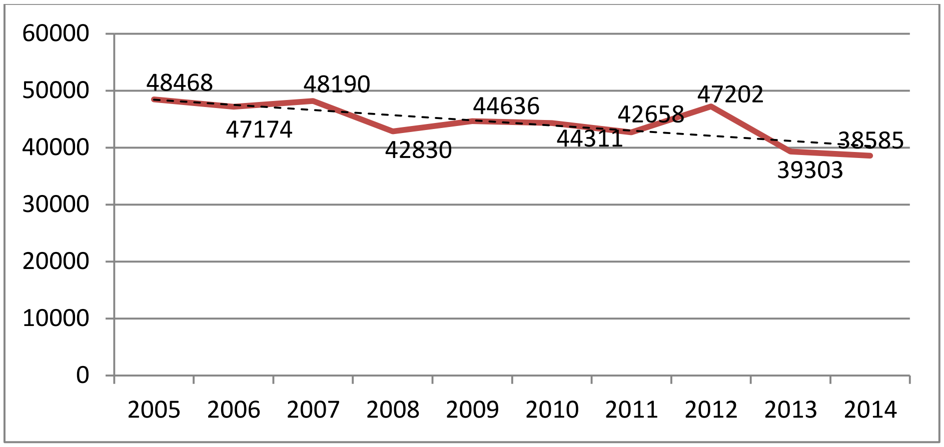
There is a declining trend in the number of fire incidents in the reporting jurisdictions during the study period (2005-2014) (Table 4.2 and Figure 4.2). However, fire incidents during major disasters and emergencies show an increasing trend, particularly in recent years. This increasing trend can be associated to the large wildfire events in British Colombia and Alberta.

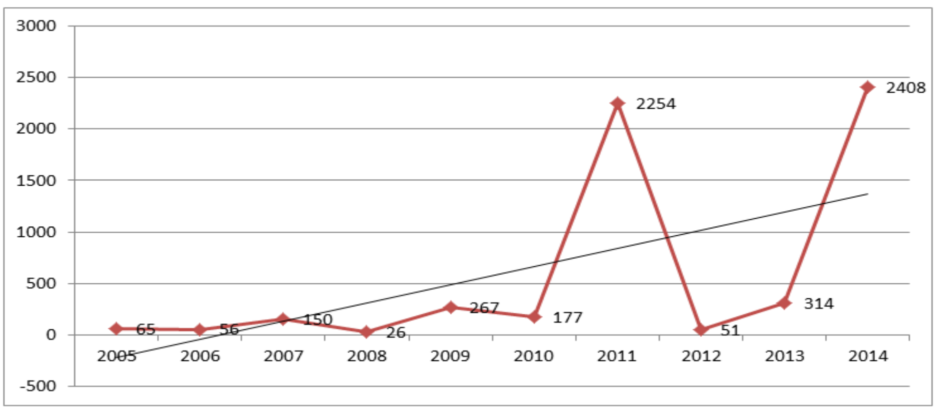
TABLE 4.2 NUMBERS OF FIRE INCIDENTS 2005-2014

Year	Fire incidents during normal situations	Fire incidents during major disasters and emergencies
2005	48468	65
2006	47174	56
2007	48190	150
2008	42830	26
2009	44636	267
2010	44311	177
2011	42658	2254
2012	47202	51
2013	39303	314
2014	38585	2408
Total	**443357**	**5769**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 4.2 NUMBER OF INCIDENTS 2005-2014 (NORMAL SITUATIONS (UP) AND DISASTER AND EMERGENCY SITUATIONS (DOWN)





Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Monthly Trends

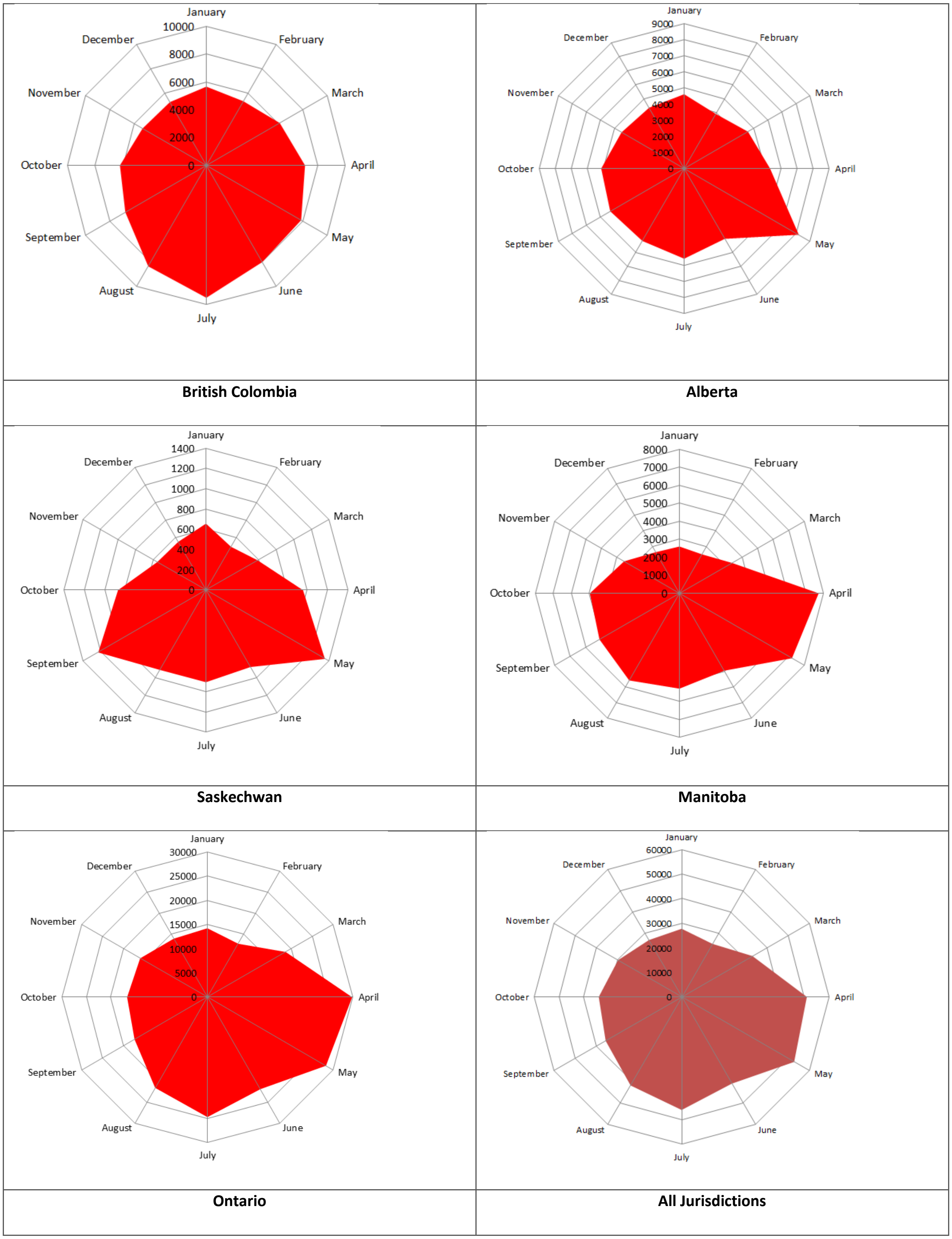
Number of fire incidents varies in different months of the year as well. Overall, number of fire incidents is lower from September to February and higher in other months particularly in April and July (Table 4.2 and Figure 4.2). For tables and figures of each province refer to Appendix 2.

TABLE 4.2 NUMBERS OF FIRE INCIDENTS 2005-2014

Jurisdictions	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**June**	**July**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Ontario	14234	12735	18664	**29883**	28259	21889	24725	21584	17381	16579	16045	13940
Manitoba	2598	2498	3371	**7718**	7201	4960	5290	5580	5123	4969	3548	2636
Saskatchewan	656	494	589	957	**1355**	875	907	908	1227	868	555	549
Alberta	4607	3912	4569	5326	**8205**	5032	5590	5184	5296	5144	4487	4355
British Colombia	5658	5319	6089	7089	7863	8021	**9502**	8365	6730	6215	5301	5247
Total	27753	24958	33282	50973	52883	40777	46014	41621	35757	33775	29936	26727

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 4.2 FIRE INCIDENTS IN DIFFERENT MONTHS OF THE YEAR IN THE REPORTING JURISDICTIONS 2005-2015



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Over the course of 10 years (2005-2015), April has the highest number of fire incidents for Ontario and Manitoba. The month of May has the highest rate of fire incidents in Saskatchewan and Alberta. July has the highest number of fire incidents in British Colombia.

TEMPORAL TRENDS OF FIRE INCIDENTS DURING DISASTER DAYS

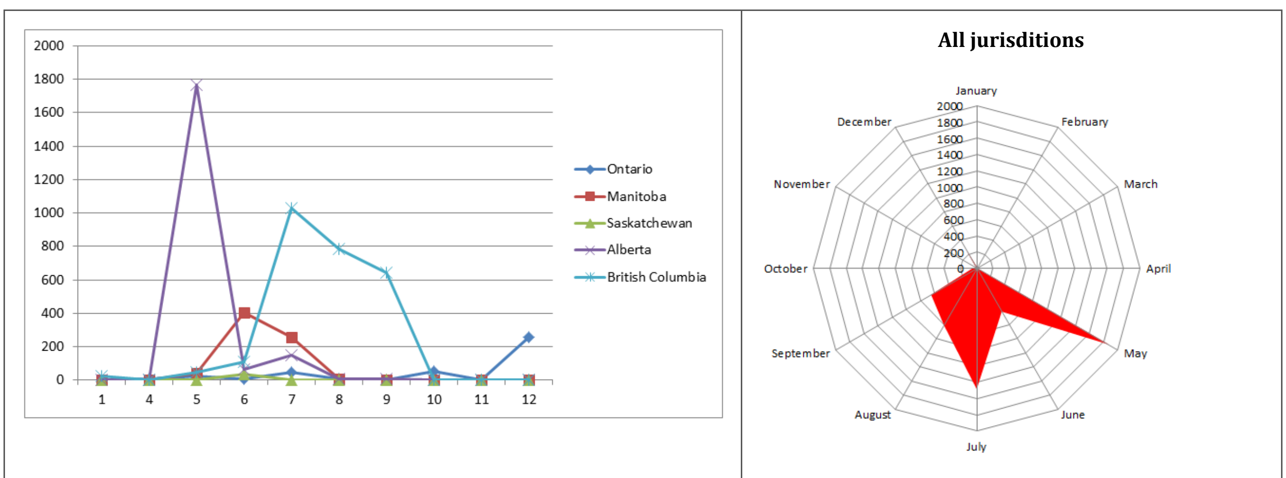
Table 4.3 and Figure 4.3 show the fire incidents during major disasters and emergencies in the reporting jurisdictions. This pattern supports the very different from the overall fire incidents pattern. There is a significant difference between Alberta and British Colombia and other jurisdictions, most of which are attributed to major wildfires and flooding in these jurisdictions.

TABLE 4.3 FIRE INCIDENTS DURING MAJOR DISASTERS AND EMERGENCIES IN REPORTING JURISDICTIONS BY MONTH

MONTH	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia	Total
January	0	0	0	0	22	22
April	9	2	0	0	0	11
May	25	39	0	1766	45	1875
June	5	403	35	64	107	614
July	49	257	0	151	1026	1483
August	8	5	0	8	784	805
September	1	0	0	5	640	646
October	52	0	0	0	0	52
November	0	0	0	0	2	2
December	256	0	0	0	3	259
Total	**405**	**706**	**35**	**1994**	**2629**	**5769**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 4.3 FIRE INCIDENTS DURING MAJOR DISASTERS AND EMERGENCIES IN REPORTING JURISDICTIONS BY MONTH



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIRE INCIDENTS' DEATHS AND INJURIES DURING NORMAL AND EMERGENCY SITUATIONS

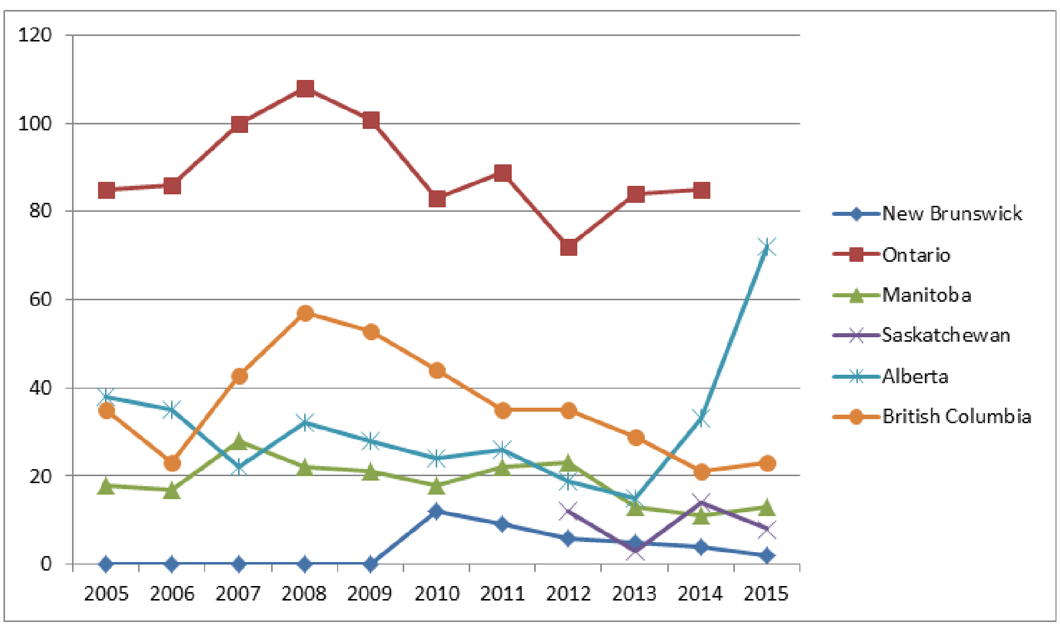
Overall the number of people killed in fire incidents are declining during the study period. However, there are some variations among different jurisdictions. While Manitoba and British Colombia have experienced steady decline in the number of deaths caused by fire incidents particularly after 2008, the declining trend is smoother for Ontario. It is only Alberta that has had increasing trend in the number of deaths in recent years (Table 4.4 and Figure 4.4). Canadian Centre for Justice Statistics (2017) provides more detail analysis of fire incidents deaths in these jurisdictions. Out of 5769 fire incidents that have occurred during major disasters and emergencies, only 10 had involved deaths. Eight of them had one death and two of them had 2 deaths.

TABLE 4.4 NUMBER OF DEATHS IN FIRE INCIDENTS IN REPORTING JURISDICTIONS 2005-2015

Year	New Brunswick	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia	Total	Percent
2005	0	85	18	nd	38	35	176	9.19%
2006	0	86	17	nd	35	23	161	8.40%
2007	0	100	28	nd	22	43	193	10.07%
2008	0	108	22	nd	32	57	219	11.43%
2009	0	101	21	nd	28	53	203	10.59%
2010	12	83	18	nd	24	44	181	9.45%
2011	9	89	22	nd	26	35	181	9.45%
2012	6	72	23	12	19	35	167	8.72%
2013	5	84	13	3	15	29	149	7.78%
2014	4	85	11	14	33	21	168	8.77%
2015	2	nd	13	8	72	23	118	6.16%
Total	**38**	**893**	**206**	**37**	**344**	**398**	1916	
Percent	**1.98%**	**46.61%**	**10.75%**	**1.93%**	**17.95%**	**20.77%**		

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 4.4 NUMBER OF DEATHS IN FIRE INCIDENTS IN REPORTING JURISDICTIONS 2005-2015



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

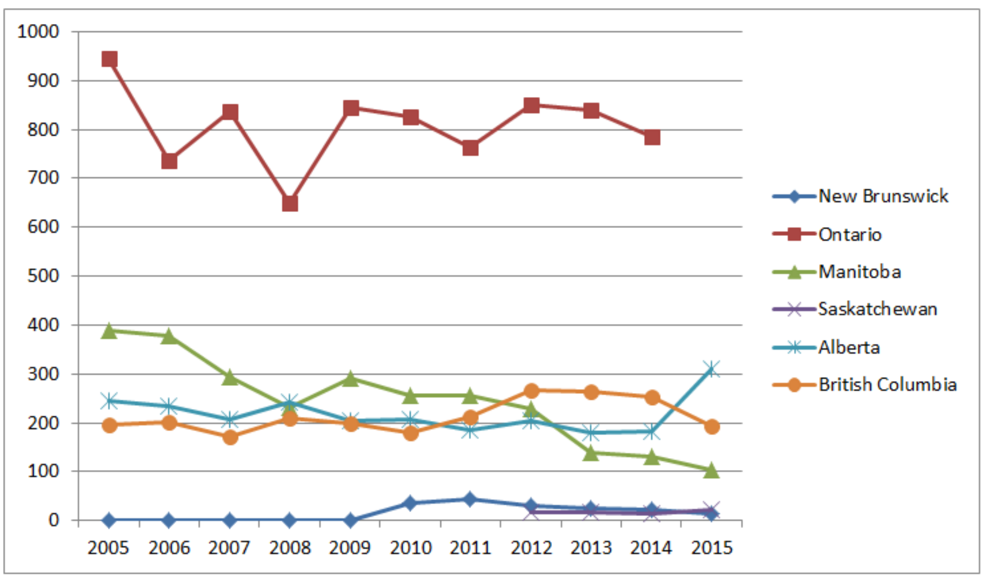
The number of persons injured is much higher than the number of people killed in the fire incidents. Except in Manitoba, there was a significant decline in the number of injuries, other jurisdictions had a relatively steady trend during 2005-2015 (Table 4.5 and Figure 4.5). Out of 5769 fire incidents that have occurred during major disasters and emergencies, 75 had involved injuries; 58 of these incidents involved 1 injured person and 9 of them had 2 injuries.

TABLE 4.5 NUMBERS OF INJURED PERSONS IN FIRE INCIDENTS IN REPORTING JURISDICTIONS 2005-2015

Year	New Brunswick	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia	Total	Percent
2005	0	945	388	nd	246	195	**1774**	**11.25%**
2006	0	736	377	nd	234	201	**1548**	**9.82%**
2007	0	836	294	nd	206	172	**1508**	**9.57%**
2008	0	649	232	nd	241	209	**1331**	**8.44%**
2009	0	844	292	nd	205	200	**1541**	**9.78%**
2010	37	827	257	nd	208	179	**1508**	**9.57%**
2011	44	763	256	nd	185	212	**1460**	**9.26%**
2012	30	851	228	16	203	267	**1595**	**10.12%**
2013	24	839	140	16	181	263	**1463**	**9.28%**
2014	22	784	132	15	183	254	**1390**	**8.82%**
2015	13	nd	104	22	311	194	**644**	**4.09%**
Total	**170**	**8074**	**2700**	**69**	**2403**	**2346**	**15762**	
%	**1.08%**	**51.22%**	**17.13%**	**0.44%**	**15.25%**	**14.88%**		

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 4.5 NUMBER OF INJURED PERSONS IN FIRE INCIDENS IN REPORTING JURISDICTIONS 2005-2015



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIRE INCIDENTS AND PROPERTIES DURING NORMAL AND EMERGENCY SITUATIONS

Major Occupancy Group

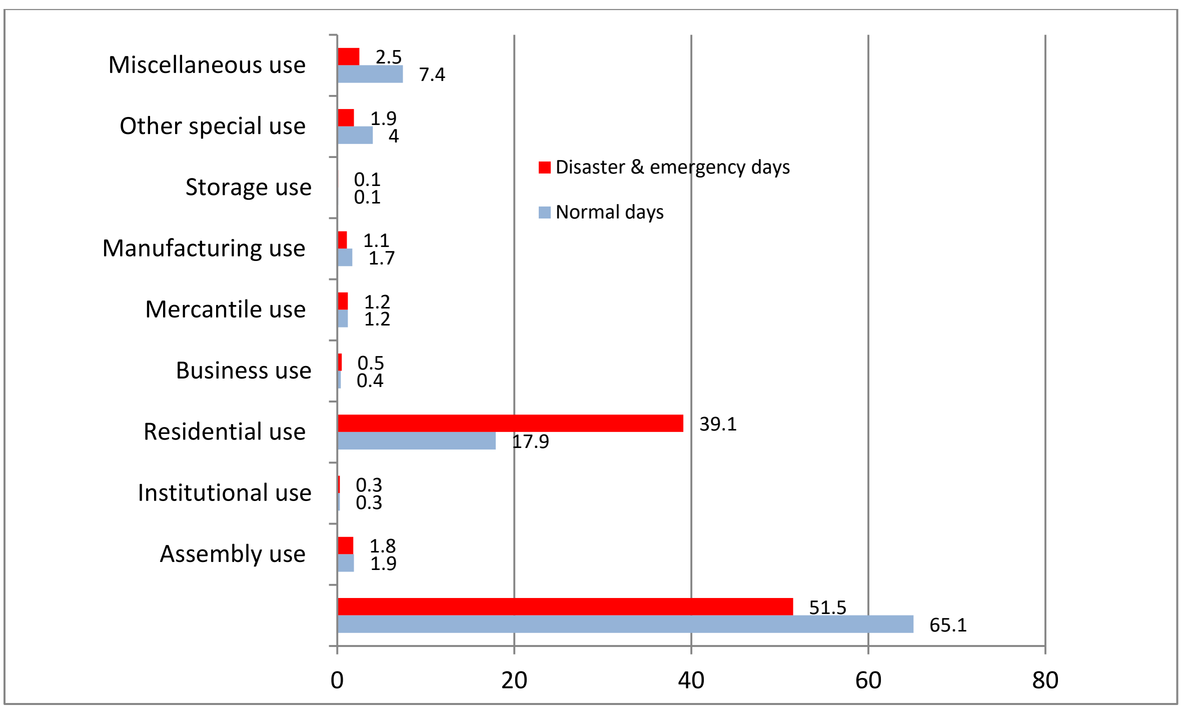
While the occupancy factor is unknown, undermined, or not applicable for more than 64 percent of the fire incidents, majority of fire incidents with known occupancy information occur in residential buildings (Table 4.6 and Figure 4.6). Although, residential buildings are still the most common occupancy groups involved in the reported fire incidents during major disasters and emergencies, a higher percent of these incidents belong to residential uses. Close to 40 percent of the fire incidents with known occupancy group have occurred in residential buildings.

TABLE 4.6 FIRE INCIDENTS DURING MAJOR DISASTERS AND EMERGENCIES BY OCCUPANCY GROUP

Occupancy Group		Fire incidents during normal situations		Fire incidents during major disasters and emergencies	
CODE	DESCRIPTION	INCIDENTS	PERCENT	INCIDENTS	PERCENT
0000	Unknown, undetermined, not applicable, not available	284739	65.1	2970	51.5
100	Assembly use	8359	1.9	106	1.8
200	Institutional use	1147	0.3	16	0.3
300	Residential use	78244	17.9	2257	39.1
400	Business use	1967	0.4	26	0.5
500	Mercantile use	5386	1.2	68	1.2
600	Manufacturing use	7393	1.7	63	1.1
700	Storage use	559	0.1	6	0.1
800	Other special use	17587	4	112	1.9
900	Miscellaneous use	32208	7.4	145	2.5
Total		**437589**	**100**	**5769**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 4.6 FIRE INCIDENTS DURING MAJOR DISASTERS AND EMERGENCIES BY OCCUPANCY GROUP



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Property Classification

A significant number of the fire incidents in the reporting jurisdictions had happened in "*special property and transportation equipment*" properties followed by residential properties. Slightly higher, similar trend are observed for fire incidents during major disasters and emergencies (Table 4.7 and Figure 4.7).

TABLE 4.7 PROPERTY CLASSIFICATIONS IN FIRE INCIDENTS IN REPORTING JURISDICTIONS 2005-2015

Property classification		**Fire incidents during normal days**		**Fire incidents during major disasters and emergencies**	
CODE	**DESCRIPTION**	**INCIDENTS**	**PERCENT**	**INCIDENTS**	**PERCENT**
0000	Unknown, undetermined, not applicable, not available	74356	17	201	3.5
1000	Assembly	12262	2.8	114	2
2000	Institutional	2564	0.6	21	0.4
3000	Residential	126238	28.8	2162	37.5
4000	Business & personal service	2650	0.6	41	0.7
000	5Mercantile	8299	1.9	70	1.2
6000	Industrial manufacturing companies	7531	1.7	54	0.9
7000	Storage properties	15330	3.5	289	5
8000	Special property & transportation equipment	158507	36.2	2589	44.9
9000	Miscellaneous property	29852	6.8	228	4
Total		**437589**	**100**	**5769**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 4.7 PROPERTY CLASSIFICATIONS IN FIRE INCIDENTS IN REPORTING JURISDICTIONS 2005-2015

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

CIRCUMSTANCES CONTRIBUTING TO THE OUTBREAK OF FIRES DURING NORMAL AND EMERGENCY SITUATIONS

Igniting Objects

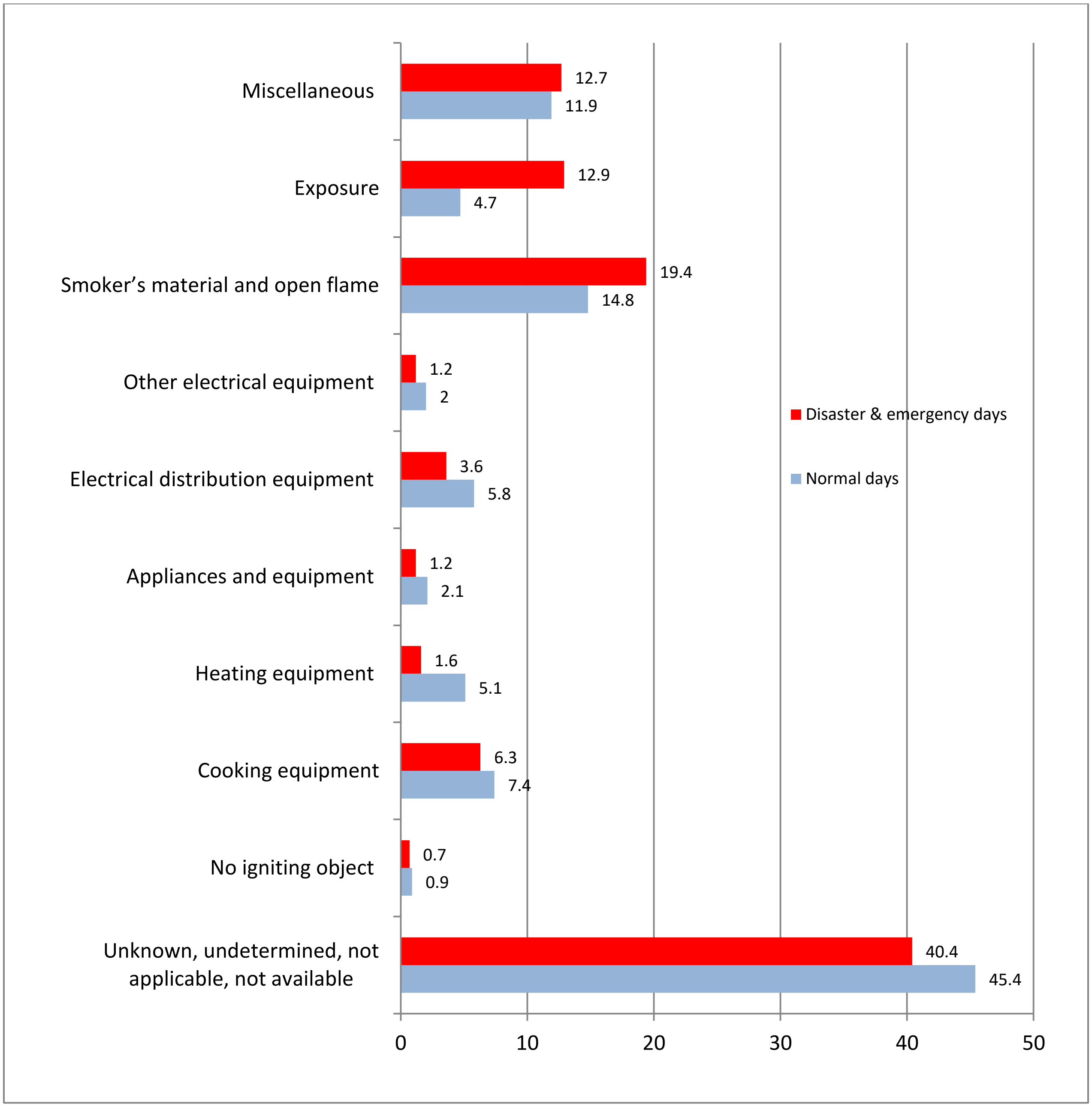
There is an "*unknown or undetermined*" source of ignition for more than 45 percent of the fire incidents in normal conditions and more than 40 percent of the fire incidents during disaster and emergencies (code 0000). While there are minor differences, it appears that the attribute of igniting objects follows a similar pattern for fire incidents during major disaster and emergencies and normal situations. Relatively higher values are observed for fire incidents caused by "*smoker's material and open flame*" and "*exposure*" during major disasters and emergencies. This is understandable considering the significant number of fire incidents during major disasters and emergencies are wildfire related incidents.

TABLE 4.8 IGNITING OBJECT GROUP IN FIRE INCIDENTS IN REPORTING JURISDICTIONS 2005-2015

IGNITING OBJECT GROUP		Fire incidents during normal situations		Fire incidents during major disasters and emergencies	
CODE	DESCRIPTION	INCIDENTS	PERCENT	INCIDENTS	PERCENT
0000	Unknown, undetermined, not applicable, not available	198742	45.4	2331	40.4
0100	No igniting object	3885	0.9	42	0.7
1000	Cooking equipment	32433	7.4	363	6.3
2000	Heating equipment	22524	5.1	91	1.6
3000	Appliances and equipment	8988	2.1	72	1.2
5000	Electrical distribution equipment	25350	5.8	206	3.6
6000	Other electrical equipment	8577	2	68	1.2
7000	Smoker's material and open flame	64807	14.8	1117	19.4
8000	Exposure	20427	4.7	747	12.9
9000	Miscellaneous	51856	11.9	732	12.7
	Total	**437589**	**100**	**5769**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 4.8IGNITING OBJECT GROUP IN FIRE INCIDENTS IN REPORTING JURISDICTIONS 2005-2015



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Materials First Ignited in Fire Incidents

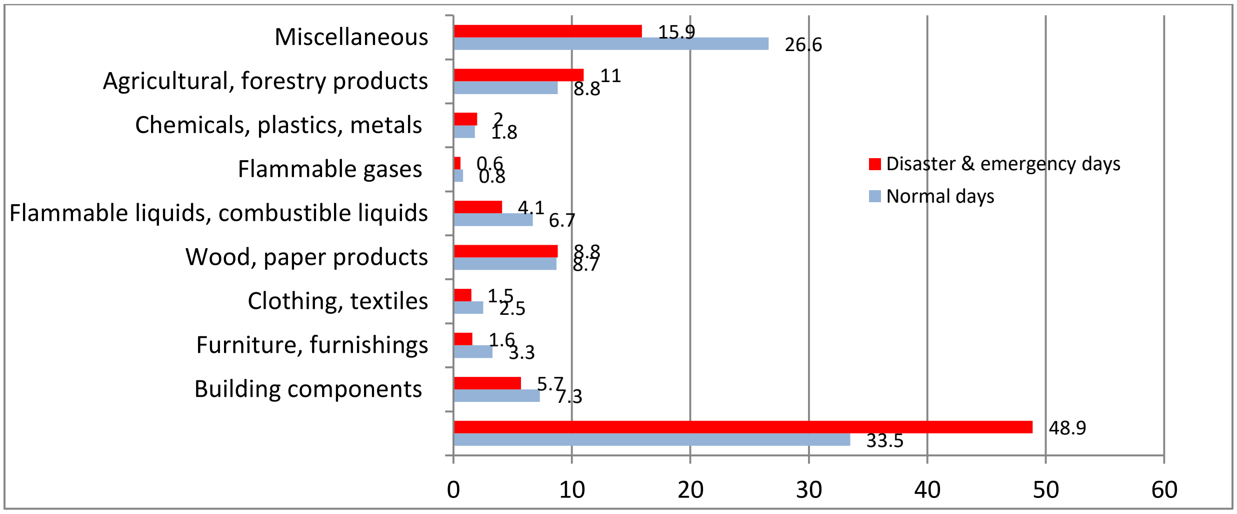
There is no major statistical differences in terms of the material used to first ignite a fire in normal situations and disaster and emergency situations, except the percentage of "unknown or undetermined material", which is higher for fire incidents during disasters and emergencies (Table 4.9 and Figure 4.9). This can possibly be explained by the complex nature of disaster and emergency situations which makes the identification of materials first ignited a little bit more difficult.

TABLE 4.9 MATERIALS FIRST IGNITED IN FIRE INCIDENTS IN REPORTING JURISDICTIONS 2005-2015

MATERIAL FIRST IGNITED GRO		Fire incidents during normal situations		Fire incidents during major disasters and emergencies	
CODE	DESCRIPTION	INCIDENTS	PERCENT	INCIDENTS	PERCENT
0000	Unknown, undetermined, not applicable, not available	146517	33.5	2820	48.9
1000	Building components	31973	7.3	326	5.7
2000	Furniture, furnishings	14430	3.3	95	1.6
3000	Clothing, textiles	10878	2.5	85	1.5
4000	Wood, paper products	38274	8.7	505	8.8
5000	Flammable liquids, combustible liquids	29263	6.7	238	4.1
6000	Flammable gases	3440	0.8	34	0.6
7000	Chemicals, plastics, metals	7968	1.8	116	2
8000	Agricultural, forestry products	38362	8.8	634	11
9000	Miscellaneous	116484	26.6	916	15.9
	Total	437589	100	5769	100

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 4.9 MATERIALS FIRST IGNITED IN FIRE INCIDENTS IN REPORTING JURISDICTIONS 2005-2015



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Act or Omission

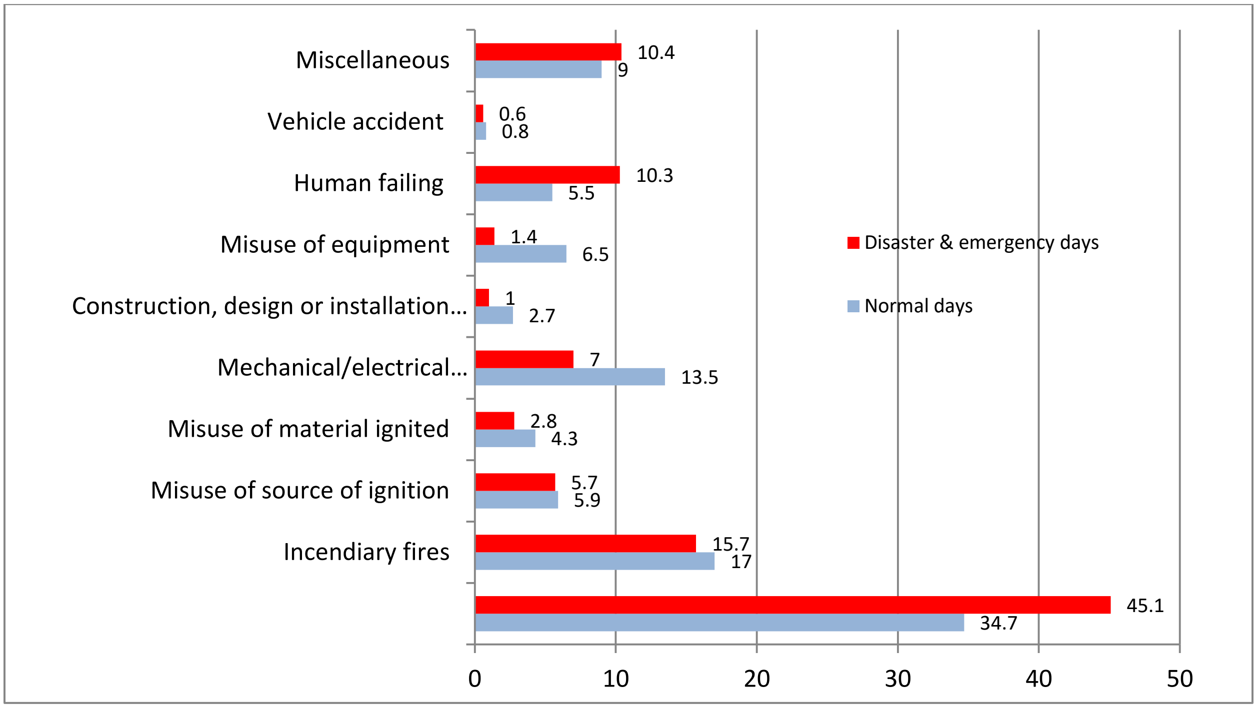
For the most part it appears that fire incidents in disaster and emergency situations follow similar patterns with respect to the Acts or Omission when compared to fire incidents during normal situations (Table 4.10 and Figure 4.10). However, some variation exists such as there are more incidents due to "*human failing"* during emergency situations than there are in normal situations. Alternatively, during normal situations more fire incidents are caused by "*Mechanical and electrical failures"* compared to emergency situations*.* These differences can be explained by the fact that a higher percentage of fire incidents during emergencies are classified under "u*nknown or undetermined"*.

TABLE 4.10 ACTS OR OMISSION IN ALL FIRE INCIDENTS IN REPORTING JURISDICTIONS 2005-2015

Acts or Omission		Fire incidents during normal situations		Fire incidents during major disasters and emergencies	
CODE	**DESCRIPTION**	**INCIDENTS**	**PERCENT**	**INCIDENTS**	**PERCENT**
0000	Unknown, undetermined, not applicable, not available	151980	34.7	2600	45.1
1000	Incendiary fires	74457	17	907	15.7
2000	Misuse of source of ignition	25811	5.9	331	5.7
3000	Misuse of material ignited	18992	4.3	160	2.8
4000	Mechanical/electrical failure/malfunction	59212	13.5	401	7
5000	Construction, design or installation deficiency	11619	2.7	56	1
6000	Misuse of equipment	28357	6.5	80	1.4
7000	Human failing	24060	5.5	596	10.3
8000	Vehicle accident	3560	0.8	36	0.6
9000	Miscellaneous	39541	9	602	10.4
	Total	151980	34.7	5769	100

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 4.1 ACTS OR OMMISSION IN ALL FIRE INCIDENTS IN REPORTING JURISDICTIONS 2005-2015



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

ORIGIN AND SPREAD OF FIRES DURING NORMAL AND EMERGENCY SITUATIONS

Areas of Fire Origins

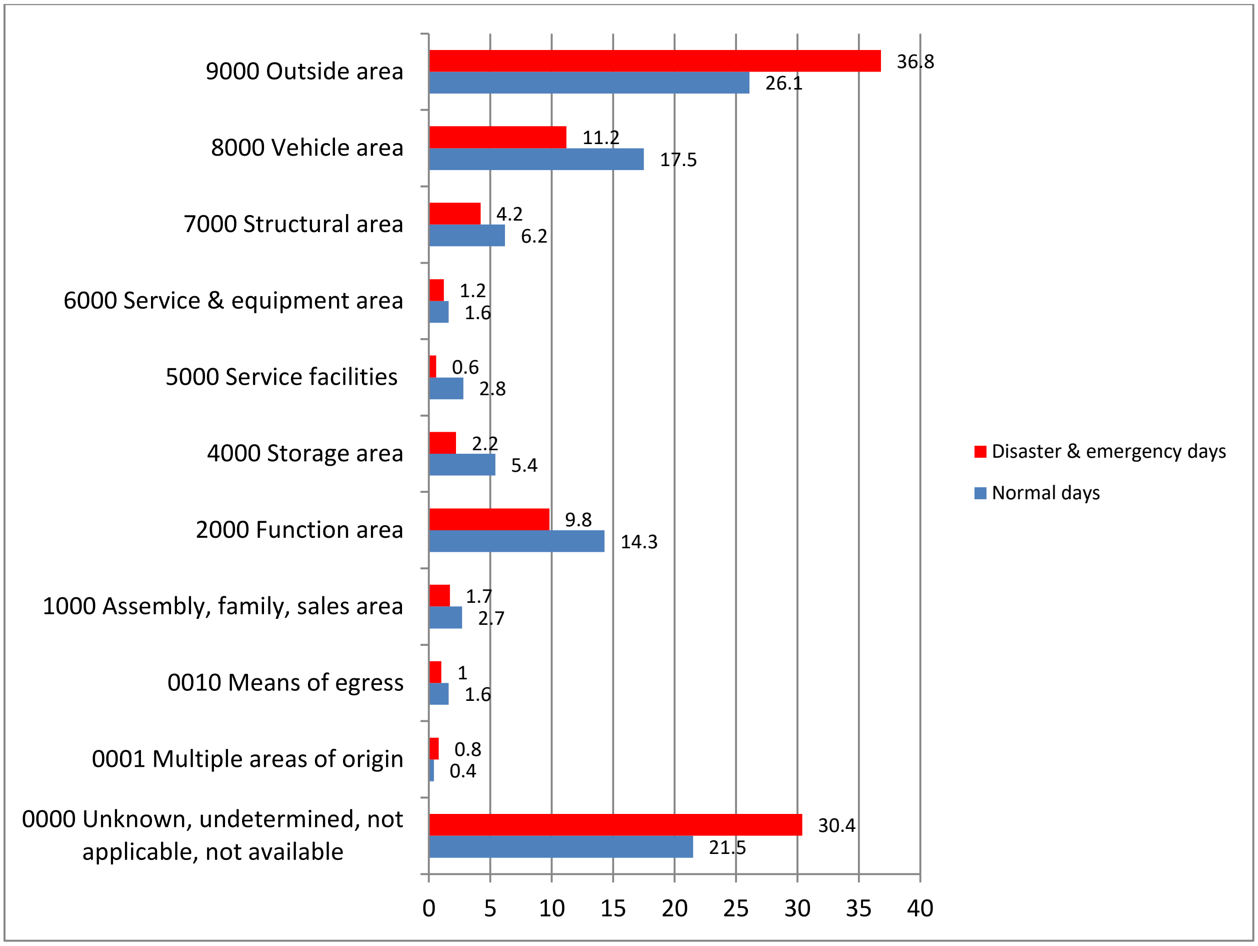
Interesting variations appear to exist between fire incidents during normal situations and during disaster and emergency situations (Table 4.11 and Figure 4.11). One important difference is that the percentage of fire incidents originating in "*outside area*" is larger in emergency situations. It can be explained by the fact that most fire incidents during emergencies constituted as wildfires, contributing to a significant amount of these fire incidents originating in outside area. On the other hand, fire incidents in "*function area", "vehicle area", "structural area", "service area", and "storage area*" are higher for fire incidents during normal situations.

TABLE 4.11 AREAS OF FIRE ORIGIONS FIRE INCIDENTS IN REPORTING JURISDICTIONS 2005-2015

AREA OF ORIGIN GROUP		Fire incidents during normal situations		Fire incidents during major disasters and emergencies	
CODE	DESCRIPTION	INCIDENTS	PERCENT	INCIDENTS	PERCENT
0000	Unknown, undetermined, not applicable, not available	100389	21.5	1755	30.4
0001	Multiple areas of origin	1798	0.4	45	0.8
0010	Means of egress	7373	1.6	60	1
1000	Assembly, family, sales area	12485	2.7	99	1.7
2000	Function area	66804	14.3	568	9.8
4000	Storage area	25117	5.4	127	2.2
5000	Service facilities	13293	2.8	34	0.6
6000	Service & equipment area	7589	1.6	69	1.2
7000	Structural area	28945	6.2	242	4.2
8000	Vehicle area	82115	17.5	647	11.2
9000	Outside area	122021	26.1	2123	36.8
	Total	467929	100	5769	100

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 4.11 AREAS OF FIRE ORIGIONS IN ALL FIRE INCIDENTS IN REPORTING JURISDICTIONS 2005-2015



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIRE LOSSES DURING NORMAL AND EMERGENCY SITUATIONS

Extent of Fire

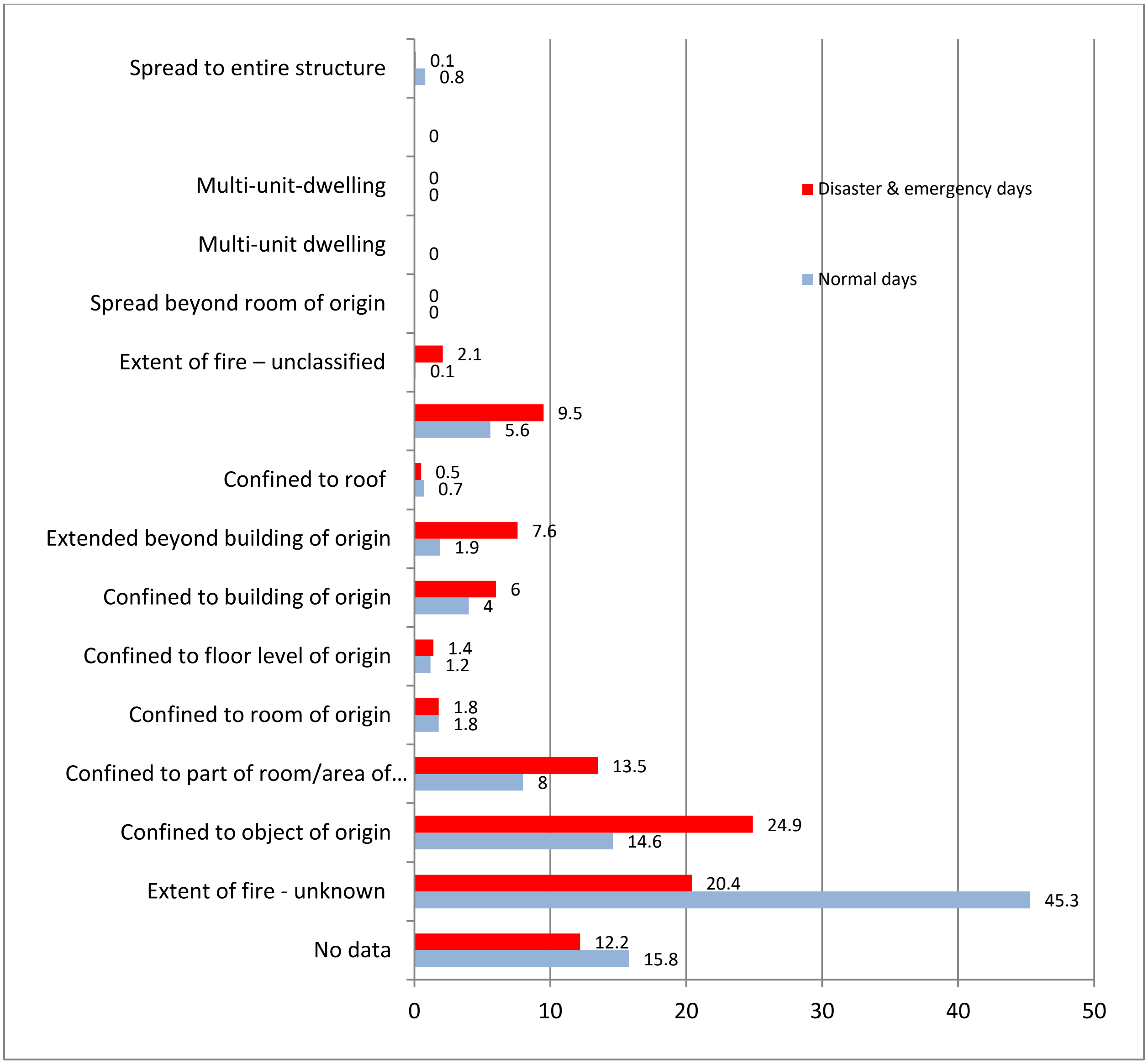
Some variations were observed when comparing the extend of fire data among the two sets of fire incidents (Table 4.12 and Figure 4.12). The most obvious difference is the lower percentage (20.4%) of "*unknowns*" for the fire incidents during emergency situations. Apart from this, the percent of fire incidents "*confined to object of origin*" and "*confined to part of room/area of origin*" are much higher for fire incidents during emergencies compared to normal situations. These figures also show that more fire incidents "*extended beyond building of origin*" during major emergencies. The "*extent of fire"* is the actual extent of burning or charring and does not include browning or blistering of paint. It is coded according to the classifications listed below.

TABLE 4.12 EXTENT OF FIRE IN FIRE INCIDENTS IN REPORTING JURISDICTIONS 2005-2015

EXTENT OF FIRE		Fire incidents during normal situations		Fire incidents during major disasters and emergencies	
CODE	DESCRIPTION	INCIDENTS	PERCENT	INCIDENTS	PERCENT
	No data	69295	15.8	706	12.2
00	Extent of fire - unknown	198360	45.3	1174	20.4
01	Confined to object of origin	63734	14.6	1435	24.9
02	Confined to part of room/area of origin	34933	8	780	13.5
03	Confined to room of origin	7726	1.8	105	1.8
04	Confined to floor level of origin	5464	1.2	80	1.4
05	Confined to building of origin	17495	4	348	6
06	Extended beyond building of origin	8527	1.9	439	7.6
07	Confined to roof	2882	0.7	28	0.5
08	Not applicable - vehicle or outside area	24554	5.6	548	9.5
09	Extent of fire – unclassified	421	0.1	120	2.1
14	Spread beyond room of origin	150	0	1	0
15	Multi-unit dwelling	149	0		
16	Multi-unit-dwelling	202	0	2	0
17	Spread beyond floor of fire origin, different floor	49	0		
18	Spread to entire structure	3648	0.8	3	0.1
Total		**437589**	**100**	**5769**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 4.12 EXTENT OF FIRE IN ALL FIRE INCIDENTS IN REPORTING JURISDICTIONS 2005-2015



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Extent of Damage in Fire Incidents

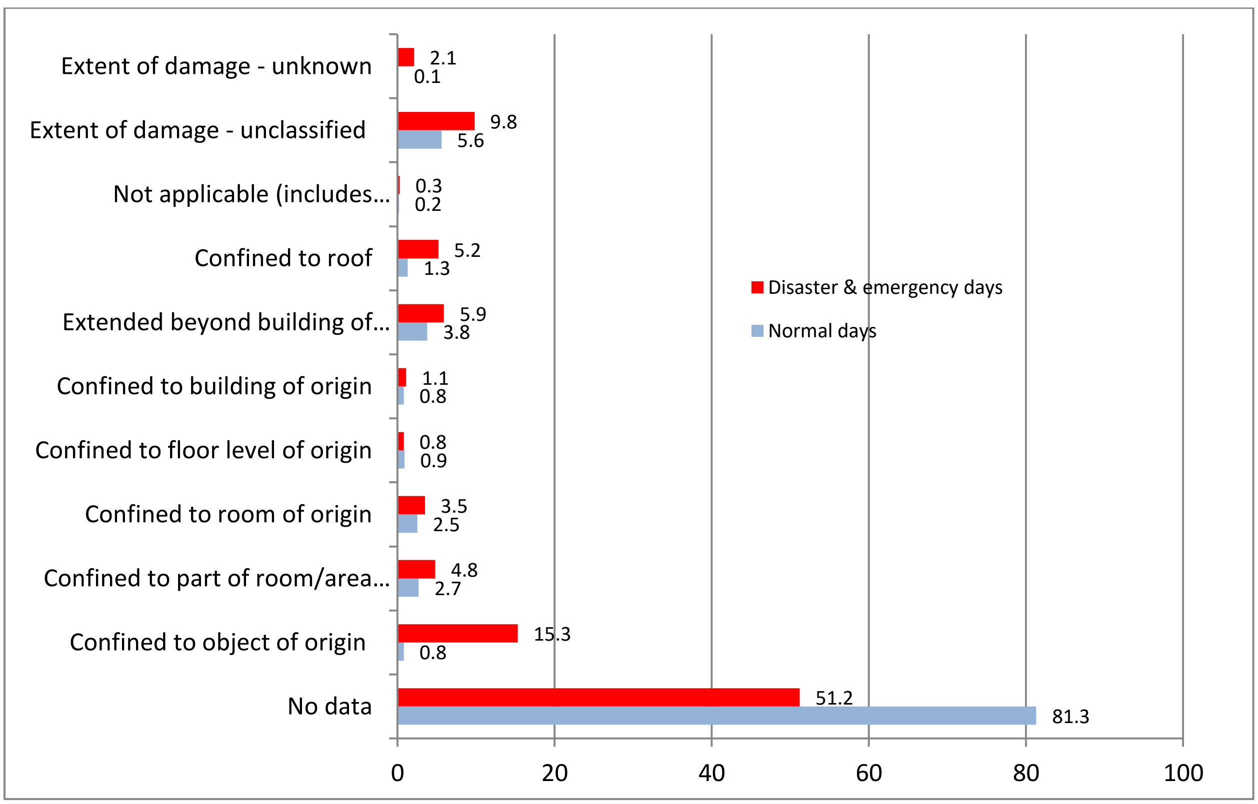
Extent of damage is an attribute of fire incidents that has very high missing values in the NFID. More than 80 % of fire incidents in normal situations do not have information about the extent of damage (Table 4.13 and Figure 4.13). For 2955 fire incidents during emergency situations (51.2%) this information is available. While about 15% of fire incidents during emergency situations are confined to an object of origin, only 1.2 % of fire incidents in normal situations are confined to an object of origin. Noticeable differences also exist on "*confined to roof*". Again these differences can be associated to wildfire disasters.

TABLE 4.13 EXTENT OF DAMAGE IN FIRE INCIDENTS IN REPORTING JURISDICTIONS 2005-2015

EXENT OF DAMAGE		Fire incidents during normal situations		Fire incidents during major disasters and emergencies	
CODE	**DESRIPTION**	**INCIDENTS**	**PERCENT**	**INCIDENTS**	**INCIDENTS**
	No data	355745	81.3	2955	51.2
0	Confined to object of origin	3663	0.8	883	15.3
1	Confined to part of room/area of origin	11839	2.7	276	4.8
2	Confined to room of origin	11066	2.5	200	3.5
3	Confined to floor level of origin	4069	0.9	47	0.8
4	Confined to building of origin	3595	0.8	63	1.1
5	Extended beyond building of origin	16431	3.8	342	5.9
6	Confined to roof	5529	1.3	298	5.2
7	Not applicable (includes vehicle, outside area)	722	0.2	18	0.3
8	Extent of damage - unclassified	24526	5.6	567	9.8
9	Extent of damage - unknown	404	0.1	120	2.1
Total		**437589**	**100**	**5769**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 4.13 EXTENT OF DAMAGE IN ALL FIRE INCIDENTS IN REPORTING JURISDICTIONS 2005-2015



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

METHOD OF FIRE CONTROL DURING NORMAL AND EMERGENCY SITUATIONS

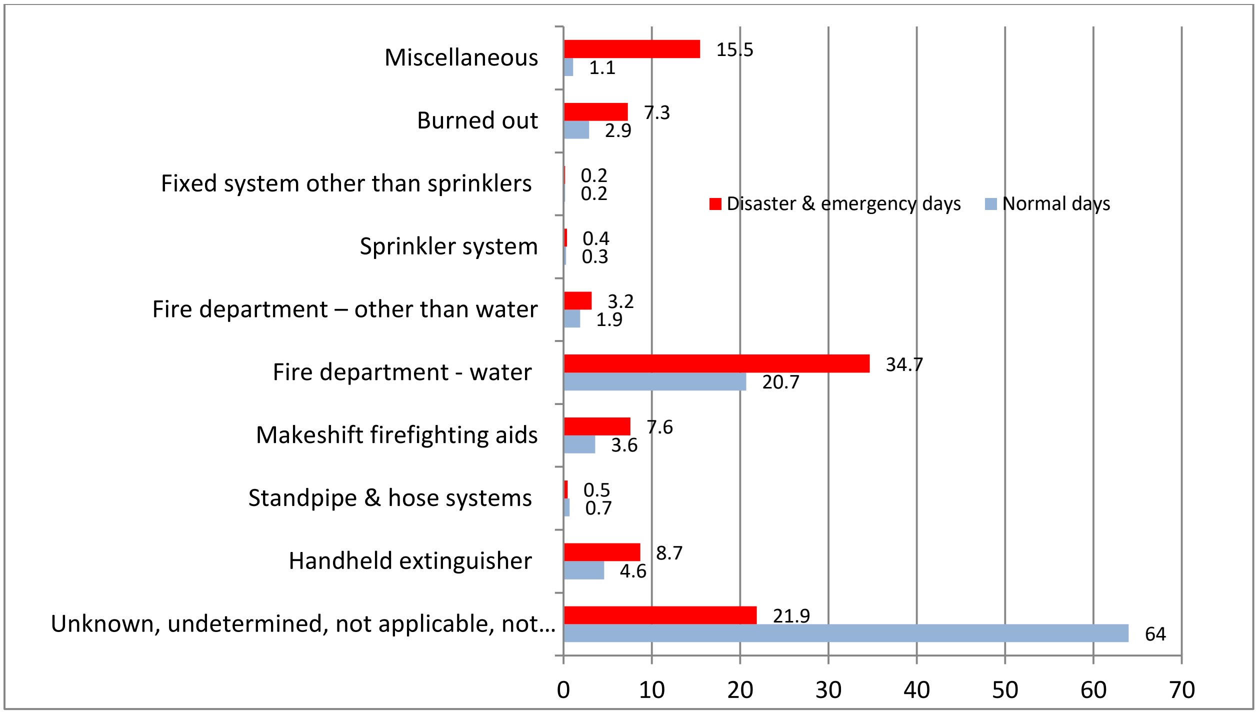
A number of significant differences exist between fire incidents during normal and emergency situations (Table 4.14 and Figure 4.14). A higher percentage of fire incidents have been controlled and extinguished through the use of water by fire departments in emergency situations (37.0 %) compared with normal situations (20.7%). Also a higher percentage of fire incidents during emergency situations have been classified as "Burnt out" (7.3 %) compared to normal situations (.9%). Use of handheld fire extinguishers is also higher for fire incidents during emergency situations.

TABLE 4.14 METHOD OF FIRE CONTROL AND EXTINGUISHMENT IN ALL FIRE INCIDENTS IN REPORTING JURISDICTIONS 2005-2015

METHOD OF FIRE CONTROL AND EXTINGUISHMENT GROUP		Fire incidents during normal situations		Fire incidents during normal situations	
CODE	DESCRIPTION	INCIDENTS	PERCENT	INCIDENTS	PERCENT
000	Unknown, undetermined, not applicable, not available	280161	64	1266	21.9
100	Handheld extinguisher	20240	4.6	504	8.7
200	Standpipe & hose systems	2878	0.7	30	0.5
300	Makeshift firefighting aids	15832	3.6	438	7.6
400	Fire department - water	90728	20.7	2002	34.7
500	Fire department – other than water	8135	1.9	182	3.2
600	Sprinkler system	1241	0.3	22	0.4
700	Fixed system other than sprinklers	668	0.2	11	0.2
800	Burned out	12748	2.9	420	7.3
900	Miscellaneous	4958	1.1	894	15.5
Total		437589	100	5769	100

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 4.14 METHOD OF FIRE CONTROL AND EXTINGUISHMENT IN ALL FIRE INCIDENTS IN REPORTING JURISDICTIONS 2005-2015



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

SUMMARY

In this section a brief overview of the fire incidents reported by each jurisdiction was compared and analyzed. After comparing the distribution of fire incidents in each jurisdiction, Ontario had the largest share of fire incidents (53.08%), but when looking at fire incidents during major disasters and emergencies British Columbia had the highest percentage of fire incidents (45.6%) followed by Alberta (34.6%) and Manitoba (12.2%). While fire incidents during normal situations seem to be decreasing, fire incidents during major disasters and emergencies are increasing, especially in British Columbia and Alberta. It is thought that the increasing trend could be associated with the wildfire events that have occurred in those areas. Most fire incidents are also occurring between April and July, with a lower amount of incidents occurring between September and February. Overall, the number of deaths and injuries due to fire incidents have declined between 2005 and 2015, only Alberta has had an increase in the number of deaths during recent years.

This section also compared and contrasted fire incidents during normal and emergency situations. The first similarity between fires in normal situations and fire incidents in disaster and emergency situations is that the highest occupancy factor for fire incidents was "*unknown or undetermined*". The majority of fire incidents with known occupancy information occurred in residential buildings for fire incidents in normal situations (17.9%) and during emergency situations (39.1%). However, when comparing property classifications a significant number of fire incidents occur in "*special property and transportation*" for both normal and emergency situations. Majority of the time, in both normal (45%) and emergency situations (40%) the ignition object was "*unknown or*

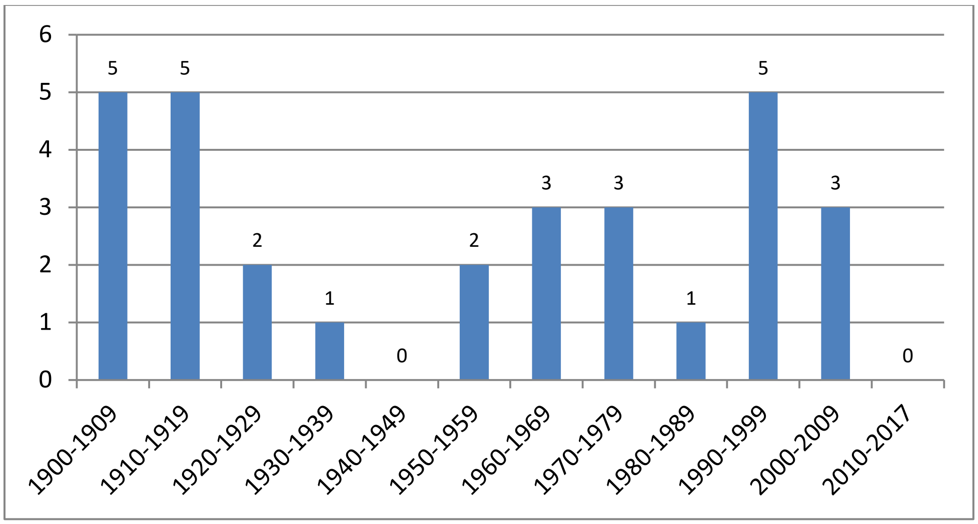
undetermined". High values were also found for "*smoker's material*" in normal (14.8%) and emergency situations (19.4%). Similar results were found for material first ignited in fire incidents during both normal and emergency situations, however a higher percentage of "*unknown or undetermined"* material was found for disaster and emergency situations. Fire incidents caused by "*industrial and electrical failures*" were more common during normal emergencies, whereas fires caused by "*mechanical and electrical failures"* were higher for emergency situations. Majority of fire incidents originated in outside areas during emergency situations, unlike fire incidents in normal situations which occurred in "*function area", "vehicle area", "structural area", "service area", and "storage area*". More fires in disaster situations were "*confined to object of origin" and "confined to part of a room/area or origin".* The most common method to control a fire is through the use of water by fire departments in both emergency (37.0%) and normal (20.7%) situations.

5 FIRE INCIDENTS DURING SUNRISE PROPOANE EXPLOSION

INTRODUCTION

Sunrise propane explosion has been the latest disaster in the category of explosions under technological disasters in the Canadian Disaster database. In the CDD, explosions are classified under non-residential and residential. A non-residential explosion is "an explosion affecting a non-residential area, resulting in partial or total destruction of the structure and/or bodily injury, smoke inhalation or death"(CDC, 2017). A residential explosion is "an explosion affecting a home or housing complex, resulting in partial or total destruction of the structure and/or bodily injury, smoke inhalation or death." According to the CDD, there have been a total of 30 technological explosions in Canada since 1900 (Figure 5.1).

FIGURE 5.1 NUMBER OF TECHNOLOGICAL EXPLOSIONS INCIDENTS IN CANADA 1900-2017



Source of data: Canadian Disaster Database

Out of these 30 incidents, 50 percent of them have occurred during the month of January (Table 5.1). 12 of the incident that occurred in January happened in British Colombia.

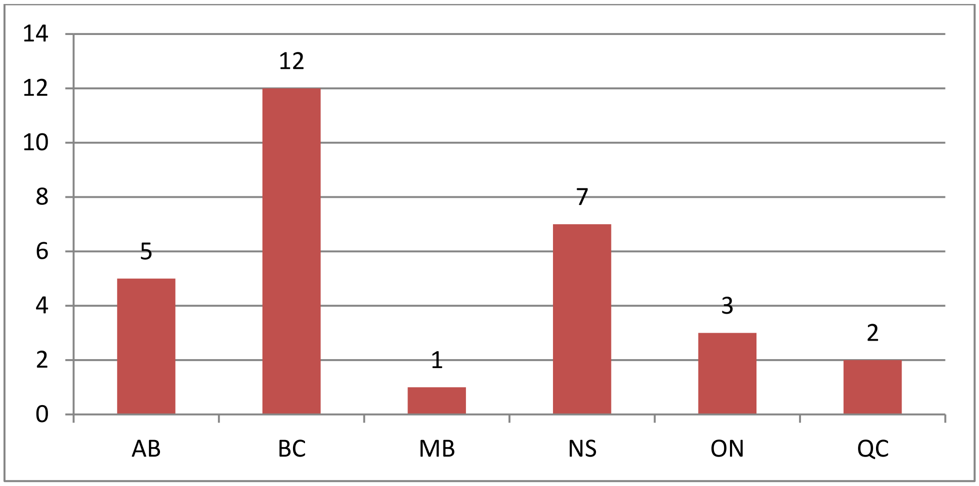
TABLE 5.1 TECHNOLOGICAL EXPLOSIONS IN CANADA BY JURISDICTIONS, 1900-2017

JURISDICTIONS	Non-Residential	Residential	TOTAL	PERCENT
Alberta	5	0	5	16.7
British Colombia	12	0	12	40
Manitoba	1	0	1	3.3
Nova Scotia	7	0	7	23.3
Ontario	2	1	3	10
Quebec	1	1	2	6.7
Total	28	2	30	100

Source of data: Canadian Disaster Database

Majority (28) of these incidents have been non-residential explosions. British Colombia with 40 percent and Nova Scotia with 23.3 percent have the highest number of these incidents (Figure 5.2).

FIGURE 5.2 TECHNOLOGICAL EXPLOSIONS IN CANADA BY JURISDICTIONS, 1900-2017



Source of data: Canadian Disaster Database

Overall these 30 incidents had 903 fatalities, 289 injuries, and 16700 evacuees (Table 5.2). British Colombia has the highest rate of fatalities in these incidents (46.29 %) followed by Nova Scotia (27.57 %). About 35 % of injured persons in these incidents belong to Nova Scotia and 23 % to Ontario. With 72.25 % of the evacuees, Ontario has had the largest share of evacuated persons in these types of incidents, majority of these are related to the August 10, 2008 Sunrise Propane Explosion in Toronto (Figure 5.3).

TABLE 5.2 HUMAN IMPACTS OF TECHNOLOGICAL EXPLOSIONS IN CANADA BY JURISDICTIONS

JURISDICTIONS	FATALITIES		INJURIES		EVACUEES	
	FREQUENCY	PERCENT	FREQUENCY	PERCENT	FREQUENCY	PERCENT
Alberta	193	21.37	53	18.34	2000	11.98
British Colombia	418	46.29	15	5.19	1200	7.19
Manitoba	0	0		0	100	0.60
Nova Scotia	249	27.57	103	35.64	500	3.00
Ontario	13	1.44	68	23.53	12900	77.25
Quebec	30	3.32	50	17.30	0	0
Total	903	100.00	289	100.00	16700	100.00

Source of data: Canadian Disaster Database

SUNRISE PROPANE EXPLOSION

On August 10, 2008 (03:50 ET), a series of explosions occurred at North York's Sunrise Propane Industrial Gases Plant located near Keele Street and Wilson Avenue. The explosion followed by fires forced the evacuation of 12,000 people living inside a 1.6 kilometre radius of the area (CDD, 2017). Evacuation was needed mostly due to concerns about the air quality in the surrounding areas. The explosion produced a huge mushroom-shaped fireball that blew out windows and shook the houses of nearby residents. In total, the explosion destroyed 100 homes. Paramedics treated 40 people on site, six people were taken to the hospital and 18 admitted themselves. Many homes and offices were damaged, windows were shattered, and doors were ripped from their hinges. About 200 firefighters were involved in fighting against the seven-alarm fire that resulted from the explosions. Emergency crews feared another major explosion as two rail tankers continued to burn more than five hours after the initial explosion. The explosion killed one Sunrise employee as well as a 25-year veteran of the Toronto Fire Service who died from heart attacked while fighting the fire"(CDD, 2017). The blasts cost CAD$1.8 million to clean up, half of which was paid by the province of Ontario. Further investigations by government agencies suggested that the explosion has been caused by the release of liquid propane from a hose during a "tank-to-tank transfer".

PATTERNS OF FIRE INCIDENTS DURING THE SUNRISE PROPANE EXPLOSION

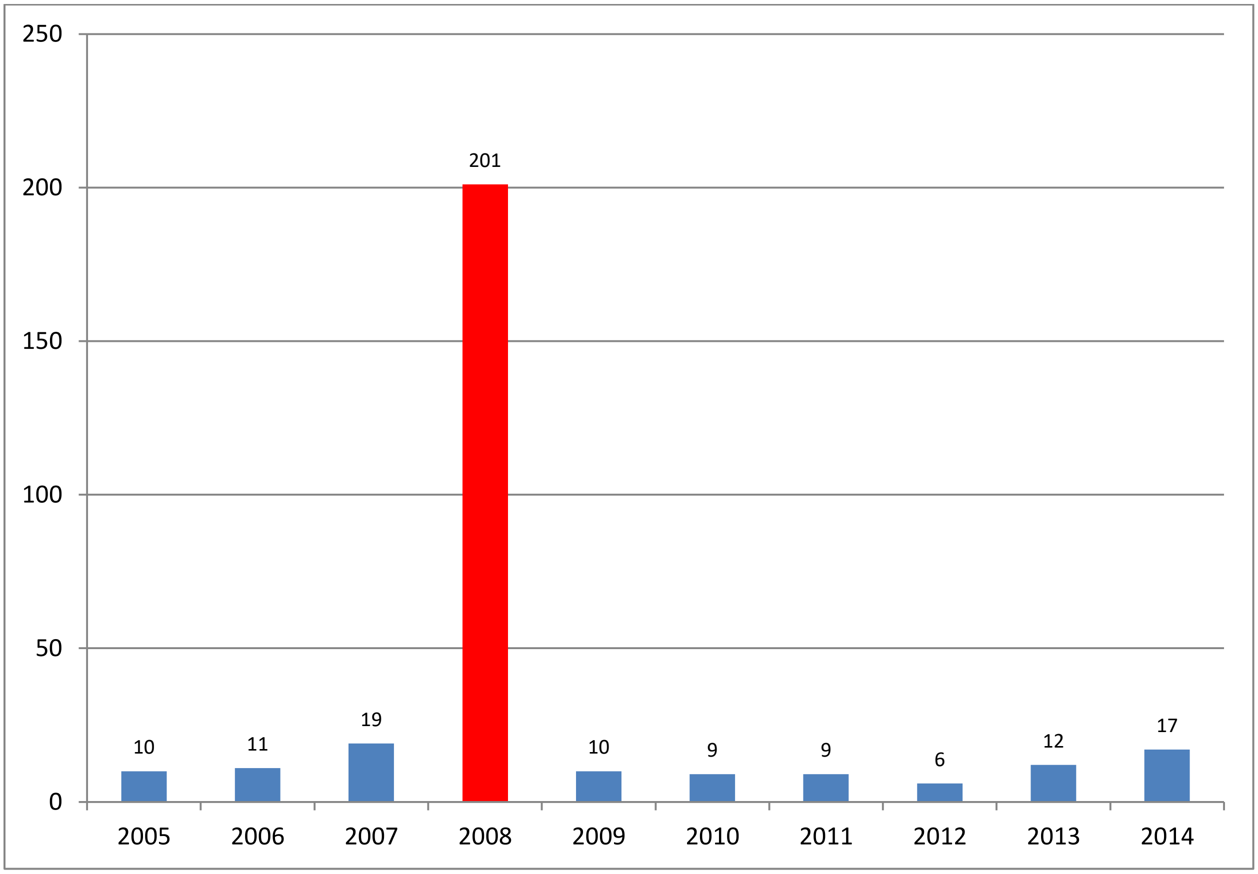
This section examines the fire incidents patterns by comparing the number of fire incidents on August 10 in different years as well as days before and after August 10 in Toronto on 2008. As expected the number of fire incidents in August 10 of 2008 is almost 20 times more than average number of fire incidents (10.3) in the city on this day over a 10 year period (2005 to 2014, excluding 2008) (Figure 5.3). These figures can suggest that about 200 of these incidents could have been caused by the explosion incident.

TABLE 5.3 NUMBER OF FIRE INCIDENTS IN THE CITY OF TORONTO ON AUGUST 10

YEAR	FIRE INCIDENTS
2005	10
2006	11
2007	19
2008	201
2009	10
2010	9
2011	9
2012	6
2013	12
2014	17

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 5.3 NUMBER OF FIRE INCIDENTS IN THE CITY OF TORONTO ON AUGUST 10



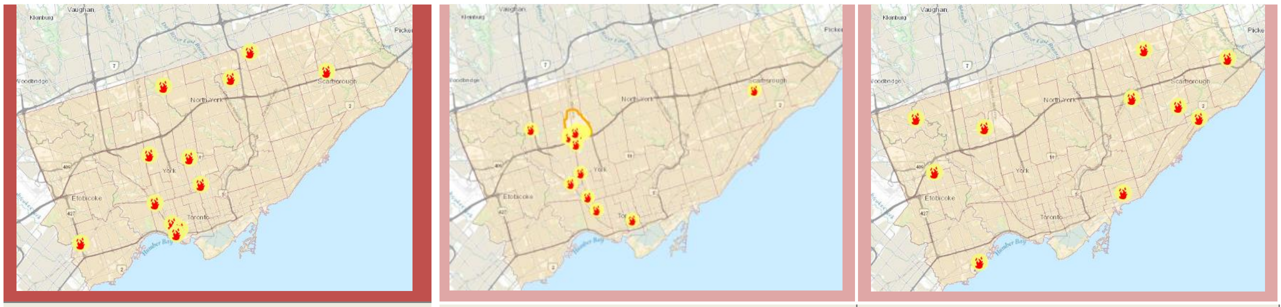
Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Figure 5.4 presents the spatial patterns of fire incidents on August 10 for 2008 as well as 2007 and 2009. While there is no particular spatial clustering of fire incidents in the city for 2007 and 2009, a cluster of fire incidents exist around the explosion site area and more fire incidents across the city. The overall pattern seems very unusual, even if the incidents near the propane explosion site are excluded, the number of fire incidents in other parts of the city looks very different from 2007 and 2009.

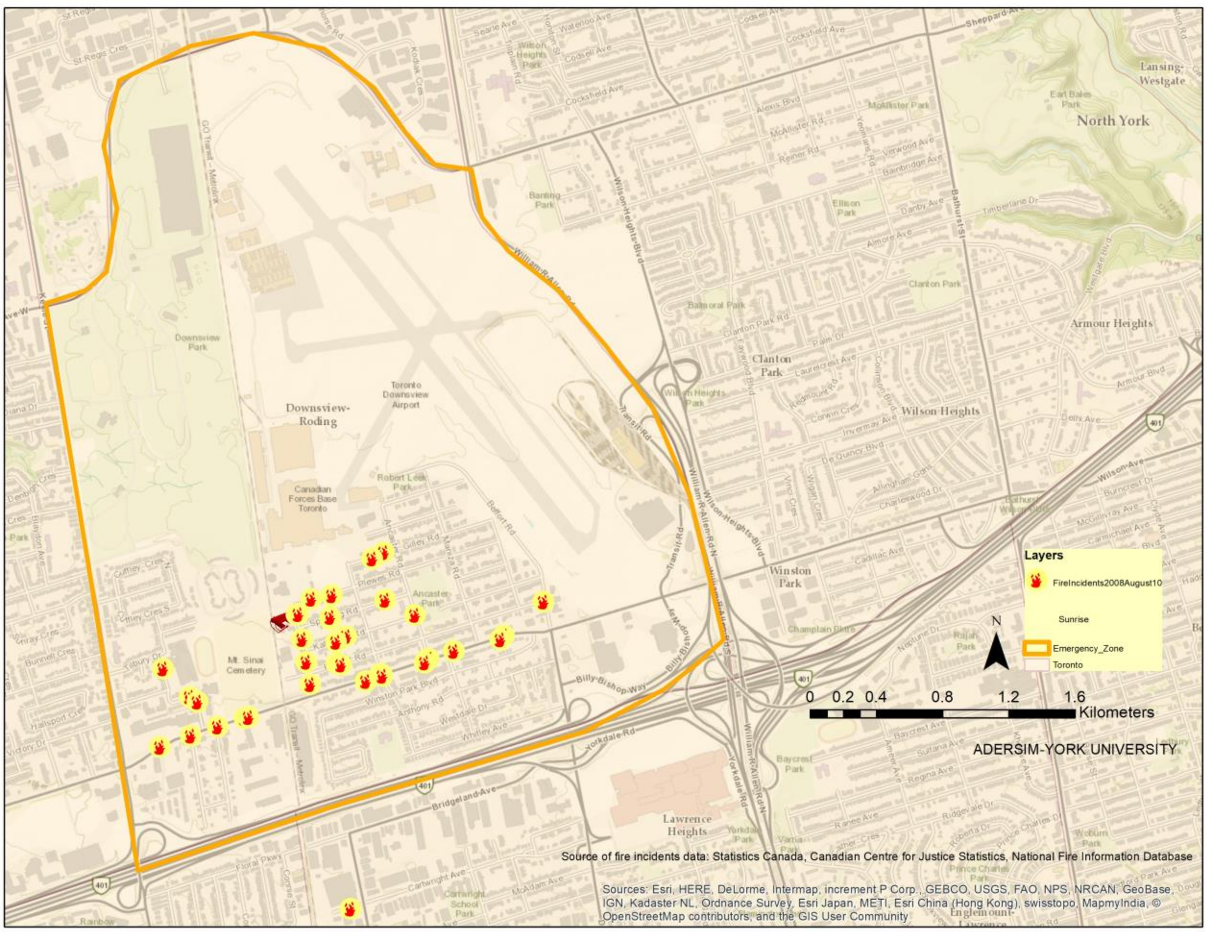
If we select only the fire incidents that are within the sunrise propane explosion zone and the nearby area, a total of 153 fire incidents are within the emergency zone or the nearby areas. The remaining fire incidents (7) are scattered around the city. Considering that the average number of fire incidents on a typical August 10 is around 10, it can be suggested that none of these fire incidents might be linked to the disaster situation.

FIGURE 5.4 SPATIAL DISTRIBUTIONS OF FIRE INCIDENTS IN THE CITY OF TORONTO

August 10, 2007	August 10, 2008	August 10, 2009



August 10, 2007	August 10, 2008	August 10, 2009
Number of incidents located: 13 Total number of incidents: 19	Number of incidents located: 153 Total number of incidents located: 201	Number of incidents located: 10 Total number of incidents : 10



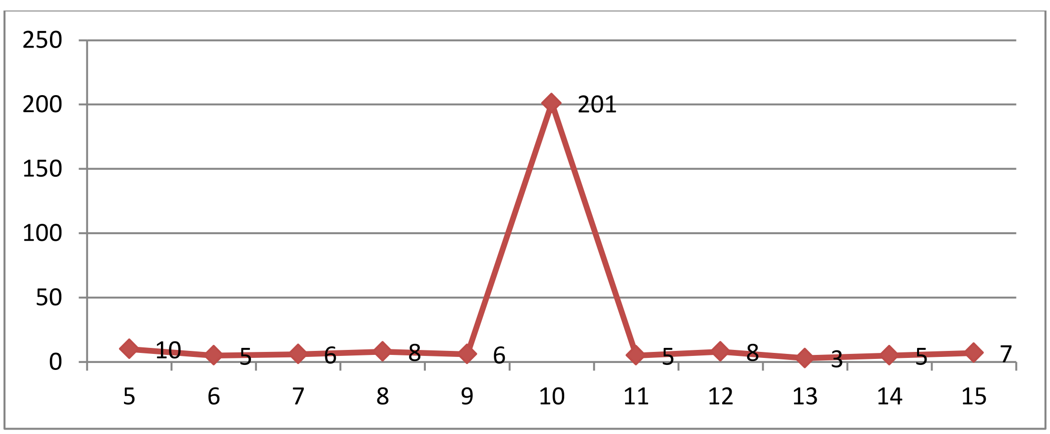
Similar pattern can be observed by comparing the number of fire incidents in the city a few days before and after the explosion (Table 5.4 and Figure 5.4A). While the average number of incidents is 6.3 during these days (excluding August 10), is close to 32 time more than the average for these days.

TABLE 5.4 FIRE INCIDENTS IN THE CITY OF TORONTO IN DIFFERENT DAYS OF AUGUST 2008

Date in August 2008	Fire Incidents
5	10
6	5
7	6
8	8
9	6
10	201
11	5
12	8
13	3
14	5
15	7
Total	264

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 5.4A FIRE INCIDENTS IN THE CITY OF TORONTO IN DIFFERENT DAYS OF AUGUST 2008



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIRE INCIDENTS BY PROPERY DESCRIPTIONDURING THE SUNRISE PROPANE EXPLOSION

The fire incidents in the City of Toronto during the August 10, 2008 are examined in more detail. By reviewing the frequency and percentage values of different attributes of the fire incidents. Where possible and useful, spatial distribution of fire incidents based on the attributes are also presented. It has to be mentioned that a number of key attributes of fire incidents are either missing or coded as unknown, which makes their analysis impossible or invaluable.

Fire Incidents by Property Class Group

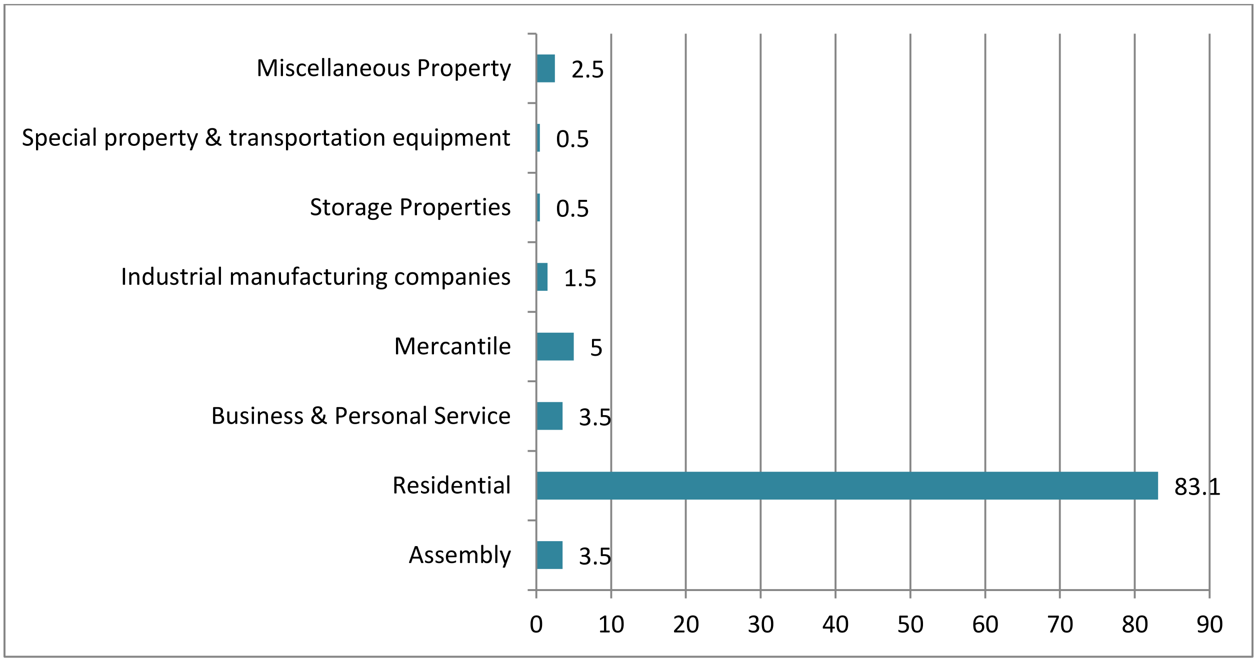
Majority of fire incidents during the August 10 explosion were residential fires (Table 5.5 and Figure 5.5). This is also true for fire incidents in the emergency zone.

TABLE 5.5 FIRE INCIDENTS IN THE CITY OF TORONTO BY PROPERTY CLASS IN AUGUST 10 2008

Code	Property Class Group	Frequency	PERCENT
1000	Assembly	7	3.5
3000	Residential	167	83.1
4000	Business & Personal Service	7	3.5
5000	Mercantile	10	5
6000	Industrial manufacturing companies	3	1.5
7000	Storage Properties	1	0.5
8000	Special property & transportation equipment	1	0.5
9000	Miscellaneous Property	5	2.5
Total		**201**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

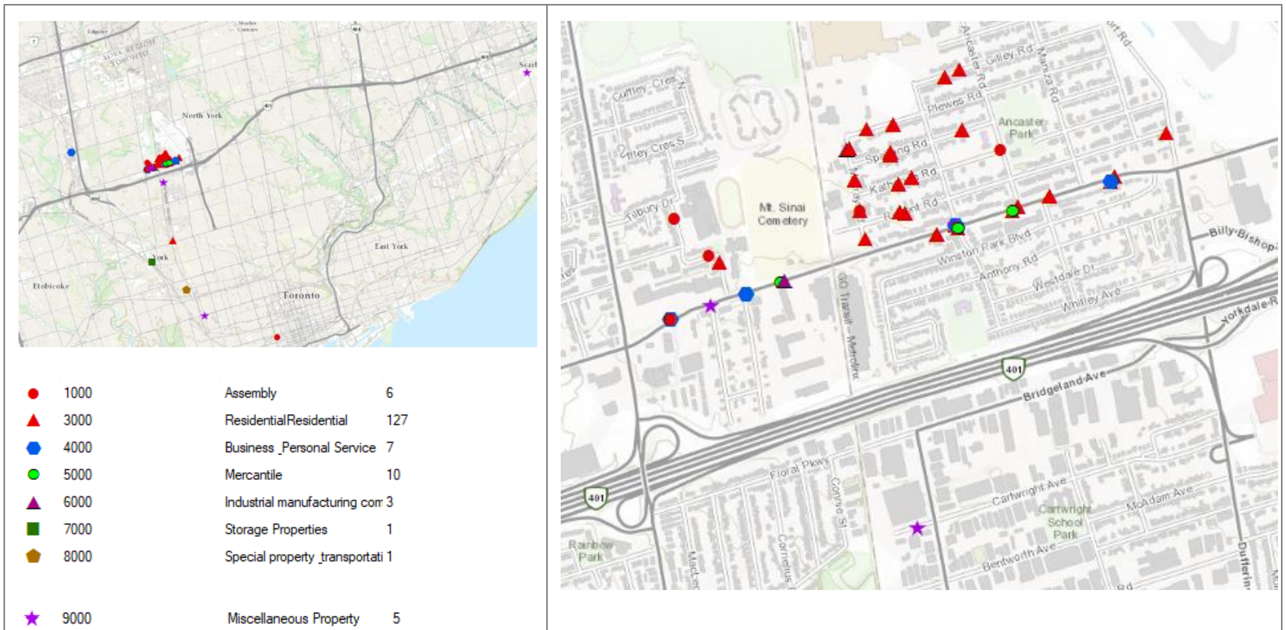
FIGURE 5.5 FIRE INCIDENTS IN THE CITY OF TORONTO BY PROPERTY CLASS IN AUGUST 10 2008



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Significant numbers of fire incidents were clustered around the emergency zone. A Moran's spatial autocorrelation test with Z Score of 2.274 and P Value of 0.0229 also confirms the existence of spatial correlation in fire incidents based on property class group. This basically means that fire incidents were not randomly distributed in the space considering their property class types.

FIGURE 5.5 FIRE INCIDENTS IN THE CITY OF TORONTO AND THE SUNRISE PROPANE EXPLOSION AREA BY PROPERTY CLASS IN AUGUST 10 2008



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Fire Incidents by Property Height

More than 97 percent of the fire incidents on August 10 2008 in the City of Toronto were incidents in one story (0 height) buildings (Table 5.6).

TABLE 5.6 FIRE INCIDENTS DURING THE AUGUST 10 2008 PROPANE EXPLOSION BY PROPERTY HEIGHT

Height (Building height refers to the number of storeys between the floor of the first storey and the roof)	ALL INCIDENTS		GEOCODED BY POSTAL CODE	
	FREQUENCY	PERCENT	FREQUENCY	PERCENT
0	196	97.5	155	96.8
1	1	0.5	1	0.6
2	4	2	4	2.5
Total	201	100	160	100

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

The geocoded incidents using postal code also shows that majority of geocoded incidents are 0 buildings (Figure 5.6).

FIGURE 5.6 FIRE INCIDENTS DURING THE AUGUST 10 2008 PROPANE EXPLOSION BY PROPERTY HEIGHT

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

CIRCUMSTANCES CONTRIBUTING TO THE OUTBREAK OF FIRE DURING THE SUNRISE PROPANE EXPLOSION

Fire Incidents by Igniting Object Group

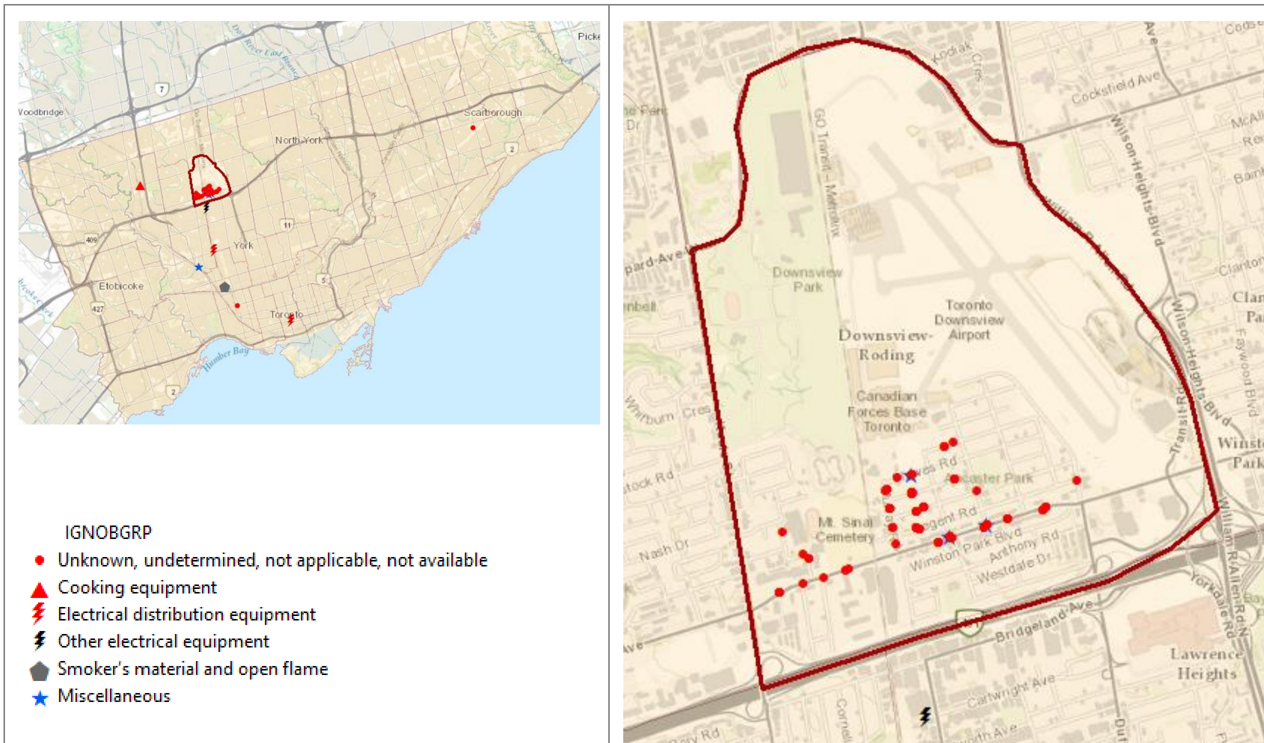
Close to 95.5 percent of the fire incidents have "u*nknown, undetermined, not applicable, and not available*" ignition source (Table 5.7 Figure 5.7). Majority of the fire incident cases in the emergency zone that directly relate to the explosion also fall under this category. Only 2 fire incidents in the area have been grouped under "*miscellaneous*".

TABLE 5.7 FIRE INCIDENTS DURING THE AUGUST 10 2008 PROPANE EXPLOSION BY IGNITING OBJECT GROUP

IGNITING OBJECT GROUP		ALL INCIDENTS		GEOCODED BY POSTAL CODE	
CODE	**DESCRIPTION**	**FREQUENCY**	**PERCENT**	**FREQUENCY**	**PERCENT**
0	Unknown, undetermined, not applicable, not available	192	95.5	151	94.375
1000	Cooking equipment	1	0.5	1	0.625
5000	Electrical distribution equipment	2	1	2	1.25
6000	Other electrical equipment	1	0.5	1	0.625
7000	Smoker's material and open flame	1	0.5	1	0.625
9000	Miscellaneous	4	2	4	2.5
Total		**201**	**100**	**160**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

TABLE 5.7 FIRE INCIDENTS DURING THE AUGUST 10 2008 PROPANE EXPLOSION BY IGNITING OBJECT GROUP



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

SUMMARY

The Sunrise Propane Explosion that occurred on August 10, 2008 was the most devastating technological disaster in Ontario and caused fire incidents to increase by 20 times on that day. On a typical August 10 there is about 10 fires within the City of Toronto however on the day of the propane explosion there were an additional 153 fire incidents within the city. These statistics suggest that there was an increase in fire incidents on August 10, 2008 due to the explosion incident. The occurrence of this one disastrous event caused thousands of people to evacuate their homes and millions of dollars to be spent cleaning up after the incident occurred.

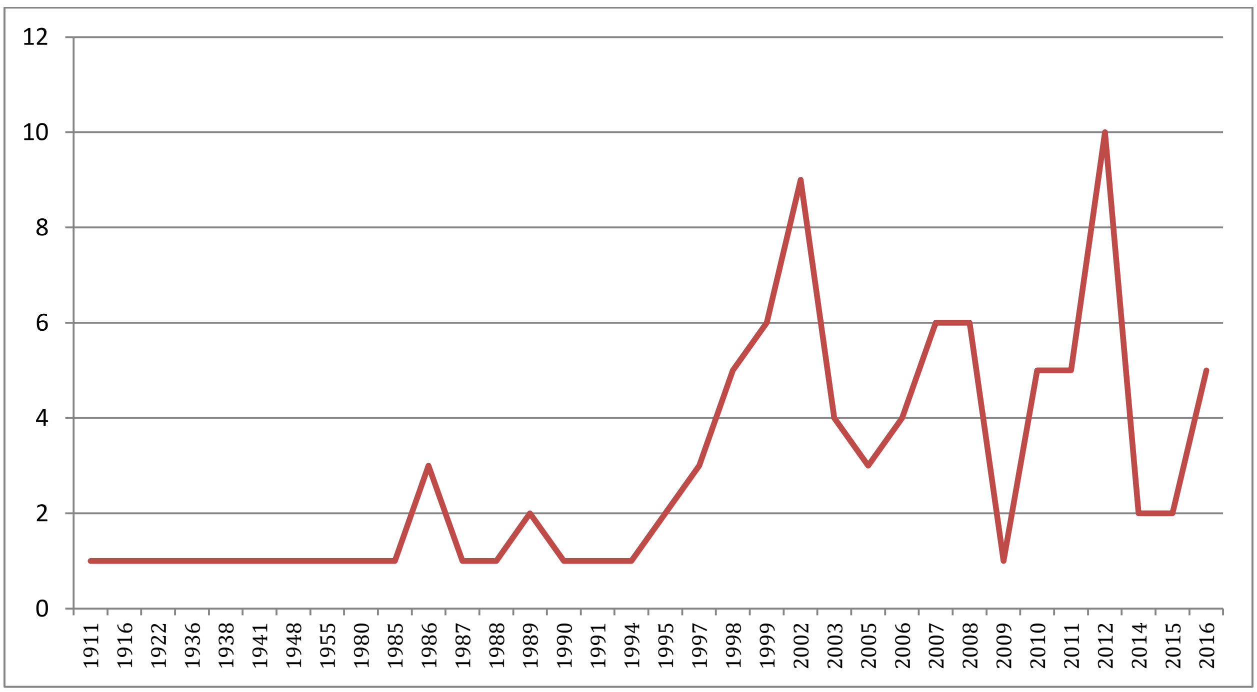
6 FIRE INCIDENTS DURING THE SLAVE LAKE WILDFIRE

INTRODUCTION

With more than 10 percent of the world's forests (Natural Resources Canada, 2012), Canada is subject to a large number of wildfires annually. "On average, about 8,400 wildfires consume over two million ha of forested lands each year" (McGee, 2014: 36). Canadian Disaster Database defines wildfire as "a naturally triggered fire which affects forested or grassland regions. Wildfire in the wildland-urban interface can cause significant damage in developed areas, although it is an important natural component of ecosystem renewal" (CDD, 2017).

According to the Canadian Disaster Database, 98 wildfire disasters have occurred in Canada during 1900-2016. This data shows an overall increasing trend in the number of wildfire disasters in Canada (Figure 6.0).

FIGURE 6.0 WILDFIRES TRENDS IN CANADA 1900-2016



Source of data: Canadian Disaster Database

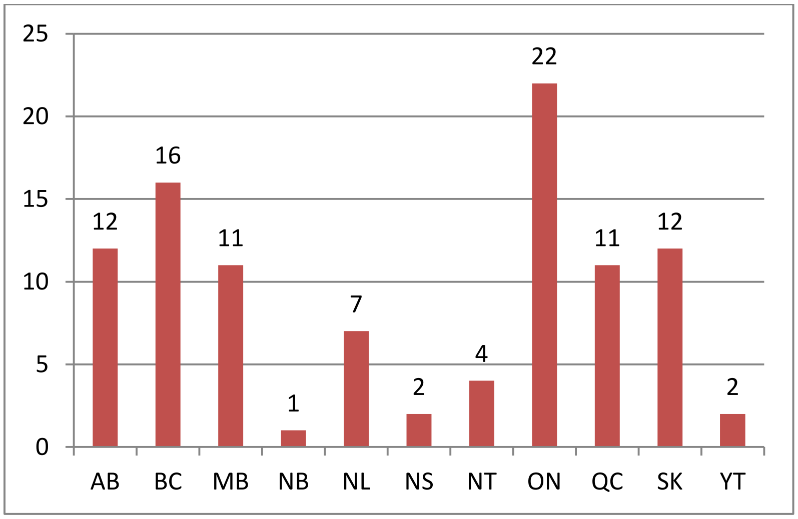
Altogether these wildfires have had a total of 372 fatalities, two injuries and about 388,325 people evacuated; about 366 of the overall fatalities belong to four different wildfires in Quebec. Majority of these evacuees belong to the most recent wildfire in Alberta (Fort McMurray, Slave Lack, Kelowna and Kamloops). It is important to note that these numbers may not reflect the actual number of wildfires and their human impacts in Canada. Wildfires have occurred in each jurisdiction, but statistics show that this type of disaster is more common in Ontario, British Colombia, Alberta, Saskatchewan, Manitoba, and Quebec (Table 6.1 and Figure 6.1).

TABLE 6.1 WILDFIRES IN CANADA BY JURISDICTIONS 1900-2016

Jurisdictions	Frequency	Percent
AB	12	12
BC	16	16
MB	11	11
NB	1	1
NL	7	7
NS	2	2
NT	4	4
ON	22	22
QC	11	11
SK	12	12
YT	2	2
Total	100	100

Note: the total in this table is 100 because two disaster cases have been listed for two different provinces
Source of data: Canadian Disaster Database

FIGURE 6.1 WILDFIRES IN CANADA BY JURISDICTIONS, 1900-2016



Source of data: Canadian Disaster Database

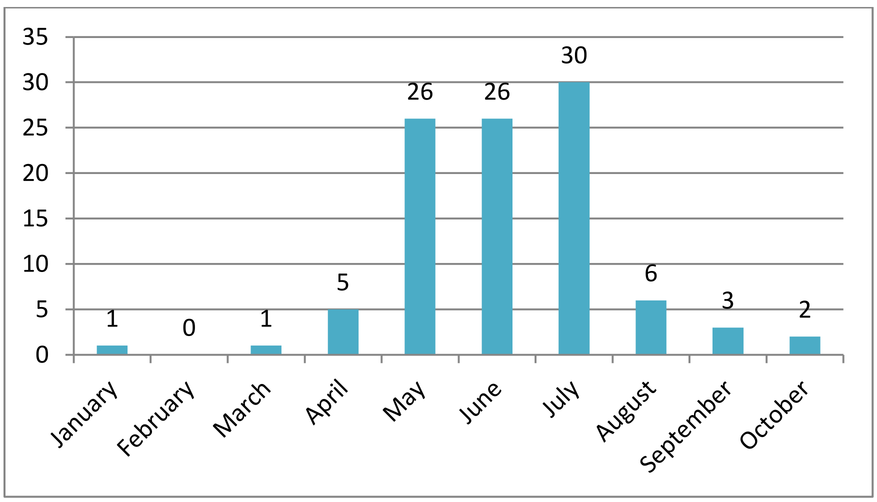
Majority of the Canadian wildfire disaster events have occurred during the months of July, June and May (Table 6.2 and Figure 6.2) respectively. In the CDD no wildfire disaster has been reported for the months of November, December, and February.

TABLE 6.2 WILDFIRES IN CANADA BY MONTH, 1900-2016

MONTH	FREQUENCE	PERCENT
January	1	1
March	1	1
April	5	5
May	26	26
June	26	26
July	30	30
August	6	6
September	3	3
October	2	2
Total	**100**	**100**

Source of data: Canadian Disaster Database

FIGURE 6.2 WILDFIRES IN CANADA BY MONTH, 1900-2016



Source of data: Canadian Disaster Database

SLAVE LAKE WILDFIRE

Slave Lake Wildfire is one of the most destructive wildfires in Canadian history. Between May 15 and May 22, 2011, wildfires burned much of the Lesser Slave River Region. Despite efforts by Alberta Sustainable Resource Development (SRD) to control the wildfire, the fire entered the Town of Slave Lake. A state of emergency was declared by the Municipal District of Lesser Slave River on May 15. The Lesser Slave Lake Regional Fire Service worked to save the town and homes in the surrounding Municipal District of Lesser Slave River. The Government of Alberta activated its Provincial Operations Centre (POC) to coordinate a provincial response to the wildfires. The wildfire was upgraded to a level four emergency, the highest possible designation that involves a sustained government-wide response (The Government of Alberta, 2011).

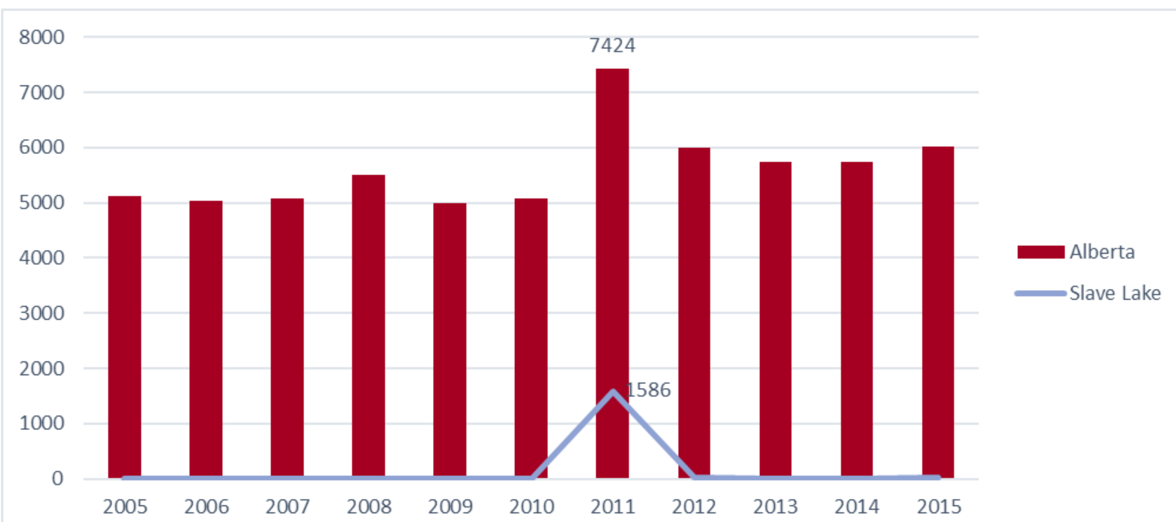
The wildfire did not cause any fatalities, however, a helicopter pilot, was killed on May 20, 2011 while flying in support of Alberta's wildfire fighting efforts. In the Town of Slave Lake, 374 buildings were destroyed and 52 damaged. Approximately 12,055 people were evacuated from the wildfire zones. Before the Fort McMurray wildfire in 2016, Slave Lake was considered to be one of the largest displacements of residents in Alberta's history. A mandatory evacuation lasted for two weeks and was lifted on May 27, 2016. In total, 59 buildings were destroyed and 32 were damaged outside the town. High Prairie, Little Buffalo, Red Earth Creek, Loon Lake First Nation (FN), Whitefish Lake FN and Woodland Cree FN were some of the communities that were impacted by the wildfire (The Government of Alberta, 2011). Wildfire disrupted economic activities including the Canadian Natural Resources Ltd. drilling and Canadian National (CN) Railway transportation (Canadian Disaster Database, 2017).

At least 30 different organizations and 30 fire departments from across the province and Canada were dispatched to the Slave Lake wildfire. Each fire departments' support was essential in combating the quickly spreading wildfire (KPMG, 2012). As fire entered the Town of Slave Lake and other communities, structural firefighting resources were urgently needed. Altogether, 38 different fire departments and over 200 structural firefighters contributed, drawn from as far as Lethbridge and High Level (KPMG, 2012).

FIRE INCIDENTS IN ALBERTA AND THE SLAVE LAKE REGION IN 2011

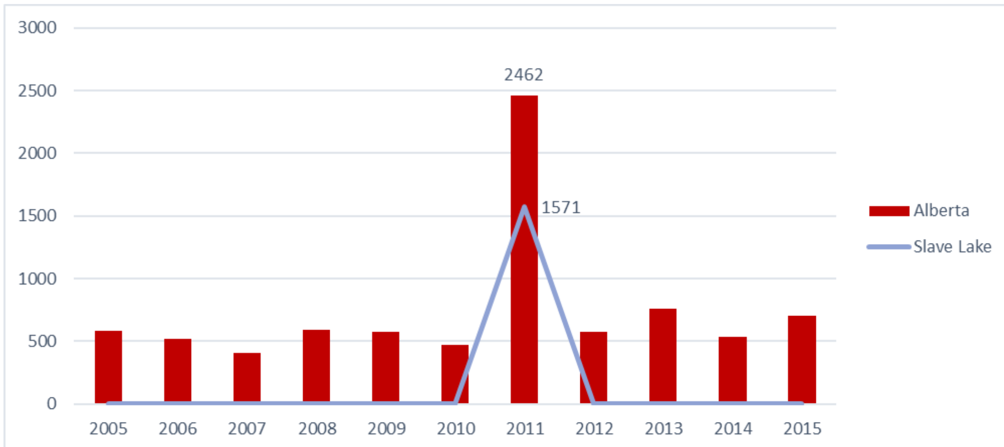
Figure 6.3 shows the number of fires in different years for Alberta and the Slave Lake Region. Except for the year 2011, the total number of fire incidents in both the province and the Slave Lake Region are steady. However, the number of fire incidents sharply increased in 2011 which is attributed to the spread of wildfire in some parts of the province particularly the Slave Lake Region.

FIGURE 6-3 NUMBER OF FIRE INCIDENTS IN SLAVE LAK AND ALBERTA, 2005-2015



It should be noted that even the spike's magnitude for the overall incidents is proportional to the spike´s magnitude observed for Slave Lake during May from 2005 to 2015 (Figure 6.4).

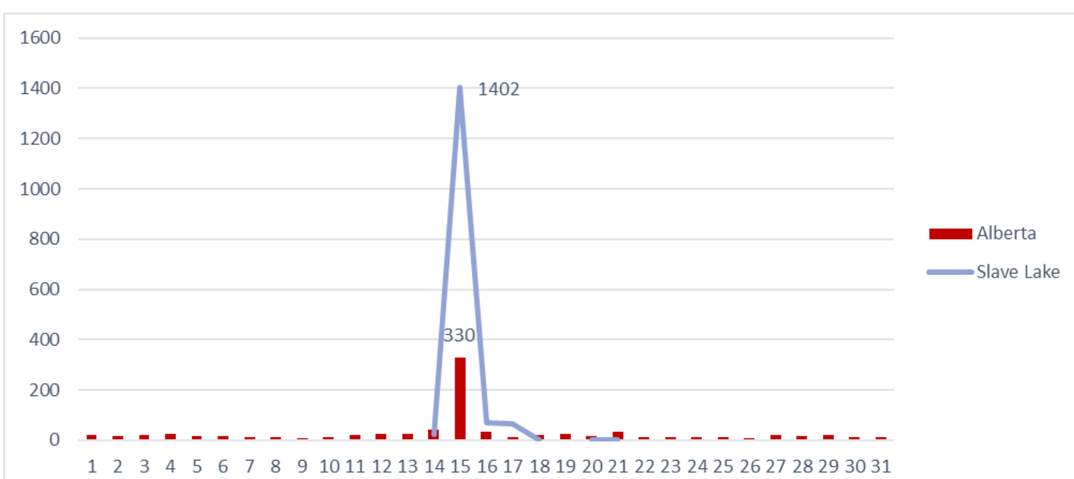
FIGURE-6.4 FIRE INCIDENTS IN ALBERTA IN THE MONTH OF MAY 2005 TO 2015 IN COMPARISON WITH FIRE INCIDENTS IN SLAVE LAKE



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Figure 6.5 provides a detailed view of the incidents recorded during May 2011. From the values observed within the entire month of May, it is easy to detect the time frame that encompassed the spike for both (Slave Lake and Alberta without considering the Slave Lake incidents). However, the Slave Lake fire incidents on May 15th represent more than 80% of all Alberta incidents on that specific date. It should also be noted that accumulated fire incidents on that day represent more than 23% of the total number of incidents recorded for all the province during all 2011.

FIGURE 6.5 FIRE INCIDENTS IN ALBERTA DURING MAY 2011 WITHOUT INCLUDING SLAVE LAKE IN COMPARISON WITH FIRE INCIDENTES IN SLAVE LAKE (WILDFIRE MAY 14-17)



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIRE INCIDETS INFORMATION DURING THE SLAVE LAKE FIRE

Mutual Aid

Due to the high number of fire incidents which occurred during the Slave Lake wildfire, mutual aid was heavily used in the Slave Lake fire incidents. More than 48% of the fire incidents had been responded with mutual aid (Table 6.3).

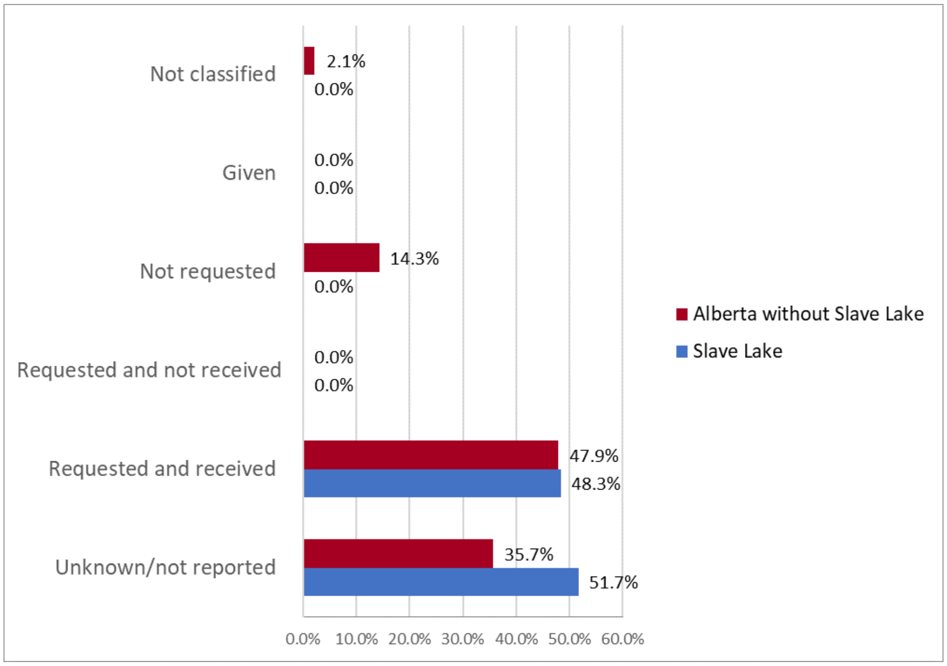
TABLE 6.3 FIRE INCIDENTS IN ALBERTA AND SLAVE LAKE DURING MAY FOR 14-17, 2011

Mutual Aid	Slave Lake		Alberta without Slave Lake	
	INCIDENTS	PERCENT	INCIDENTS	PERCENT
Unknown/not reported	814	51.8	316	35.5
Requested and received	757	48.2	228	25.6
Requested and not received	0	0	4	0.4
Not requested	0	0	303	34.0
Not classified	0	0	39	4.4
Given	0	0	1	0.1
Total	**1571**	**100.0**	**891**	**100.0**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Mutual assistance was also requested for other fire incidents in the province (Alberta without Slave Lake incidents), on Figure 6.6, it is shown that almost the same percent of mutual aid was used during the wildfire for incidents in Slave Lake and within Alberta (around 48%).

FIGURE 6.6 PERCENT OF FIRE INCIDENTS WITH MUTUAL AID DURING SLAVE LAKE FIRE (MAY 14-17)



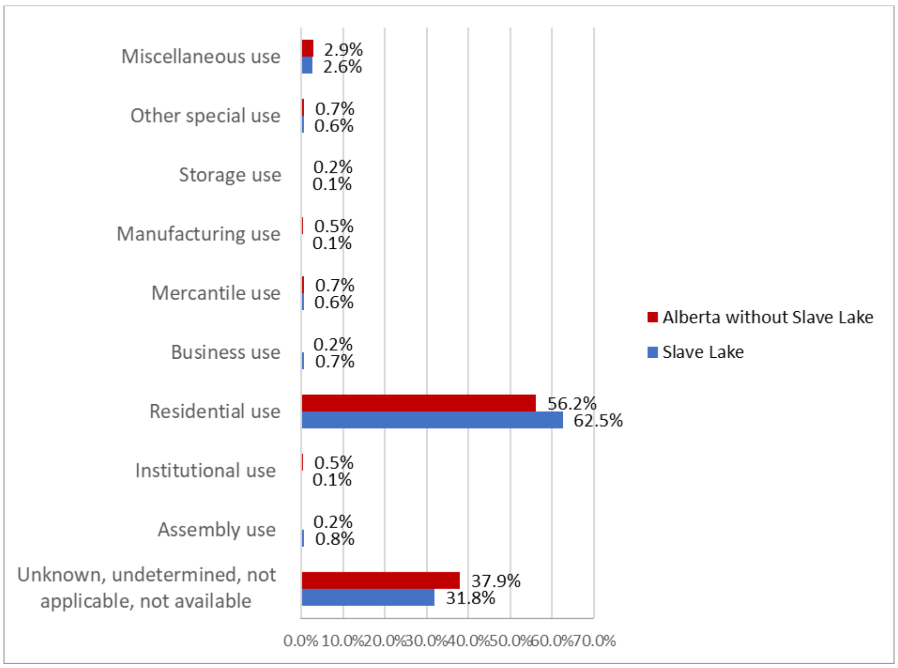
Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIRE INCIDENTS AND PROPERTY DESCRIPTION DURING THE SLAVE LAKE WILDFIEW

Major Occupancy Group

Despite the significant percent of unknown or undetermined cases, it is evident that more fire incidents with residential use have occurred in the Slave Lake Region (52.5 %) compared to the fire incidents in the other parts of the province (56.2%). No other significant differences are observed in terms of occupancy (Figure 6.7).

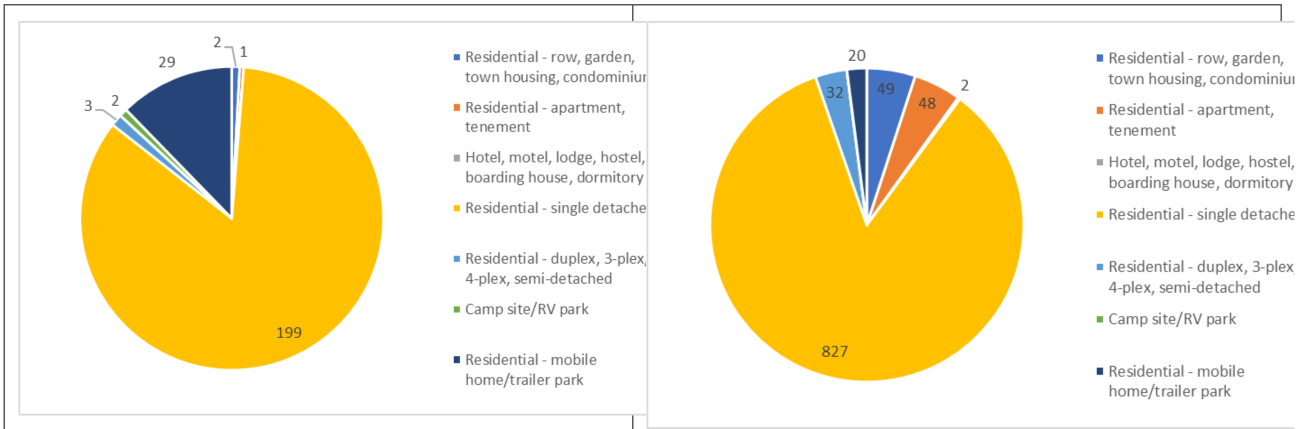
FIGURE 6.7 PERCENT OF FIRE INCIDENTS PER MAJOR OCCUPANCY GROUPS, SLAVE LAKE MAY 14-17, 2011



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

The breakdown of the residential building/structure/facilities that were affected is presented in Figure 6.8 where Single detached houses represent around 84% of the affected properties for both cases.

FIGURE 6.8 FIRE INCIDENTS IN RESIDENTIAL OCCUPANCY GROUP IN ALBERTA AND SLAVE LAKE (MAY 14-17, 2011)



Alberta (excluding slave lake region)	Slave Lake

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

CIRCUMSTANCES CONTRIBUTING TO THE OUTBREAK OF FIRE DURING THE SLAVE LAKE WILDFIRE

Igniting Object Group

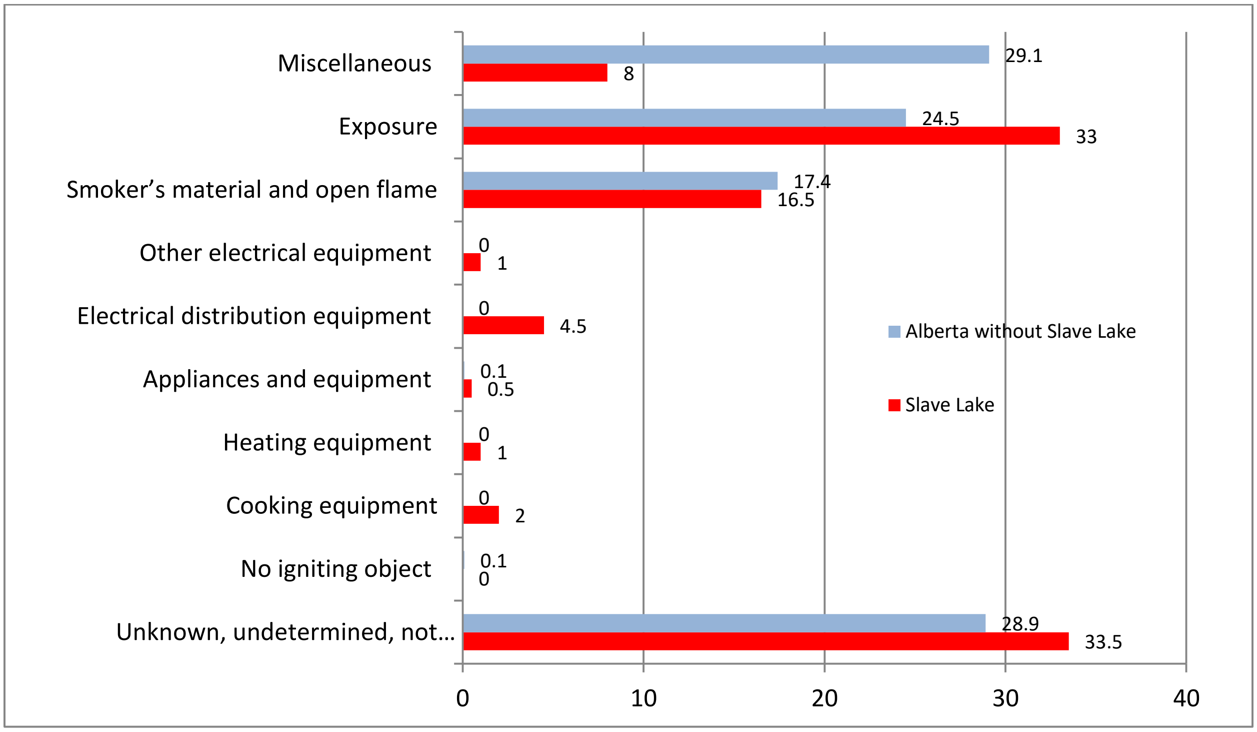
A very high percentage of fires in the Slave Lake region have been ignited first through "*exposure*" (33%) which is much higher than the Alberta fires excluding the Slave Lake region, suggesting that exposure is the leading ignition source for fire incidents during the wildfire emergencies (Table 6.4 and Figure 6.9). "*smoker's material and open flame*" is also an important igniting object for both Alberta and Slave Lake fires during these days.

TABLE 6.4 PERCENT OF ENERGY CAUSING IGNITION FOR FIRE INCIDENTS IN SLAVE LAKE MAY 14-17, 2011

Igniting Object Group		Slave Lake		Alberta without Slave Lake	
CODE	**DESCRIPTION**	**INCIDENTS**	**PERCENT**	**INCIDENTS**	**PERCENT**
0	Unknown, undetermined, not applicable, not available	67	33.5	515	28.9
100	No igniting object	0	0	1	0.1
1000	Cooking equipment	4	2	0	0
2000	Heating equipment	2	1	0	0
3000	Appliances and equipment	1	0.5	1	0.1
5000	Electrical distribution equipment	9	4.5	0	0
6000	Other electrical equipment	2	1	0	0
7000	Smoker's material and open flame	33	16.5	311	17.4
8000	Exposure	66	33	437	24.5
9000	Miscellaneous	16	8	519	29.1
Total		**200**	**100**	**1784**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 6.9 PERCENT OF ENERGY CAUSING IGNITION FOR FIRE INCIDENTS IN SLAVE LAKE MAY 14-17, 2011

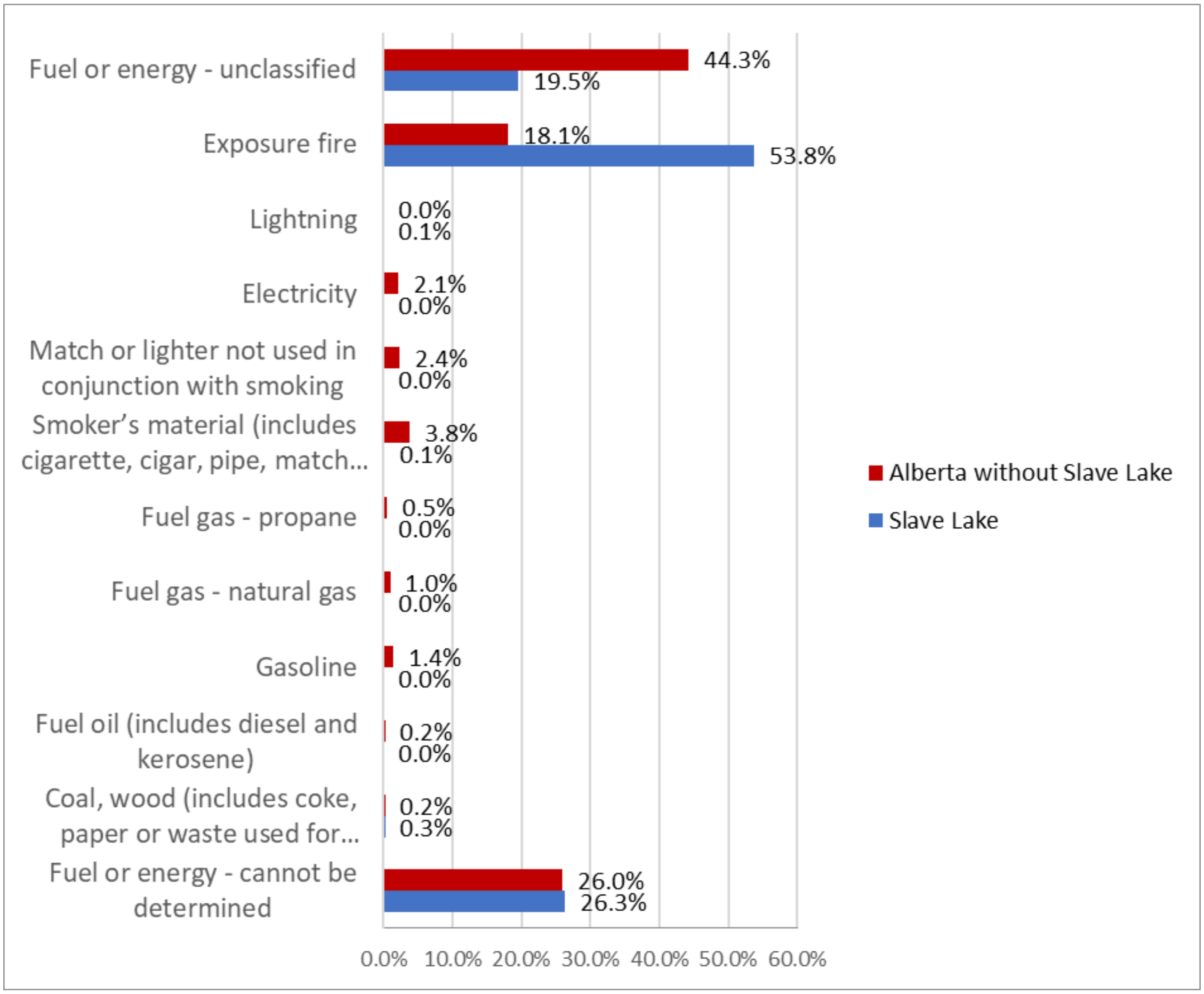


Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Energy Causing Ignition

Energy Causing Ignition refers to the energy which associates the Igniting Object with the Material First Ignited and is coded to one of the classifications listed in Figure 6.10. Despite the significant percent of unclassified and undetermined cases, it is consistent with the nature of the disaster occurred (wildfire) that 53.8% of the fire incidents reported during May 14-17 in the Slave Lake region were caused by "*exposure fire*".

FIGURE 6.10PERCENT OF ENERGY CAUSING IGNITION FOR FIRE INCIDENTS IN SLAVE LAKE MAY 14-17, 2011



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIRE LOSS DURING THE SLAVE LAKE WILDFIRE

Extent of Fire

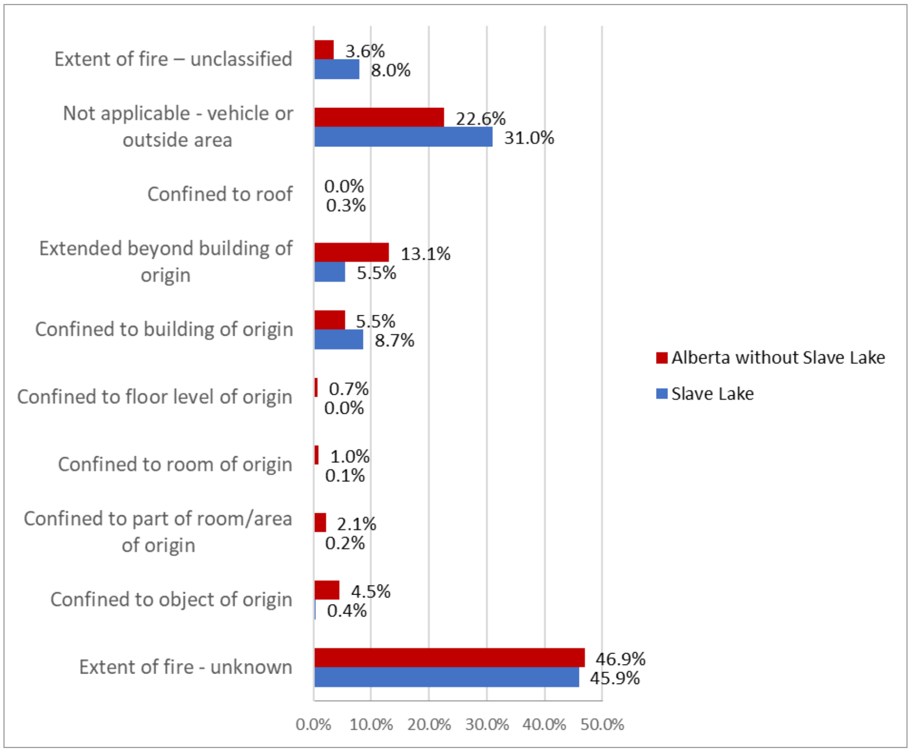
Disregarding that almost a half of the incidents are reported as "*unknown*", it is relevant that for Slave Lake, 31% of the incidents burned outside areas and 22.6% for the remaining incidents (Table 6.5 and Figure 6.11).

TABLE 6.5 EXTENT OF FIRE IN FIRE INCIDENTS IN ALBERTA MAY 14-17, 2011

EXTENT OF FIRE	Slave Lake		Alberta excluding Slave Lake	
	INCIDENTS	**PERCENT**	**INCIDENTS**	**PERCENT**
Extent of fire – unknown	718	45.9%	197	46.9%
Confined to object of origin	6	0.4%	19	4.5%
Confined to part of room/area of origin	3	0.2%	9	2.1%
Confined to room of origin	1	0.1%	4	1.0%
Confined to floor level of origin		0.0%	3	0.7%
Confined to building of origin	136	8.7%	23	5.5%
Extended beyond building of origin	86	5.5%	55	13.1%
Confined to roof	4	0.3%	0	0.0%
Not applicable - vehicle or outside area	485	31.0%	95	22.6%
Extent of fire – unclassified	125	8.0%	15	3.6%
Total	**1564**	**100.0%**	**420**	**100.0%**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 6.11 EXTENT OF FIRE IN FIRE INCIDENTS, SLAVE LAKE, MAY 14-17, 2011 (PERCENT OF FIRE INCIDENTS)



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Extent of damage

About the same percentage of fire incidents in both Alberta without the Slave Lake and the Slave Lake have unknown damage extent (Table 6.6).

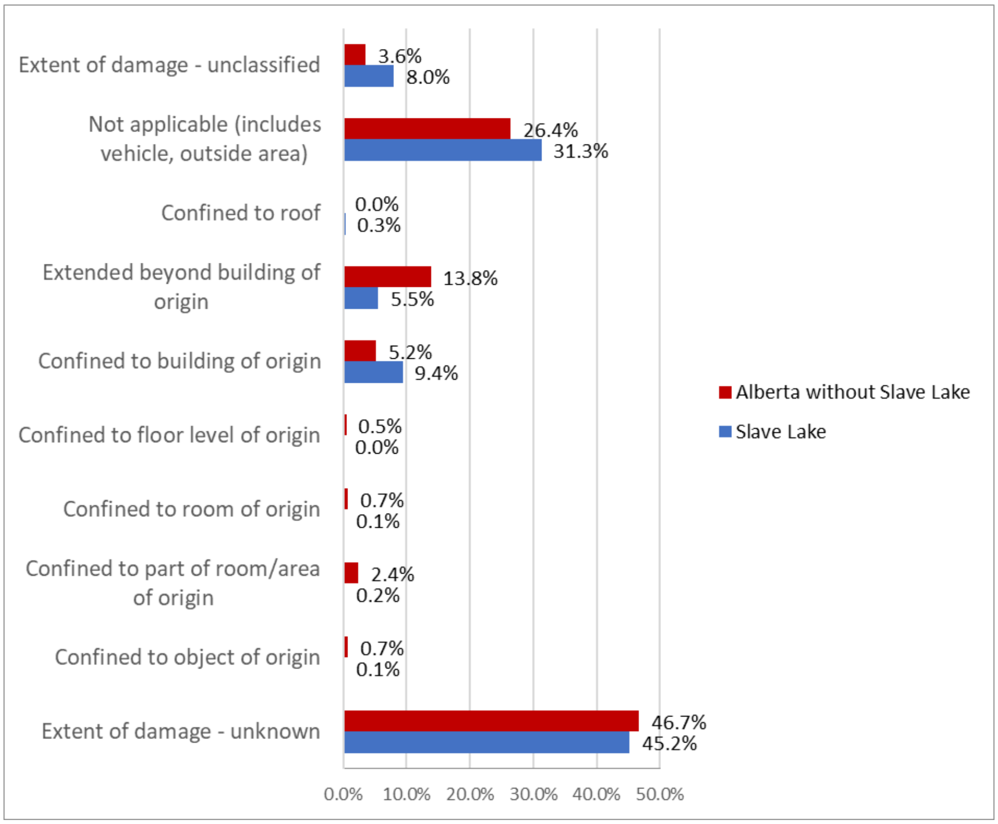
TABLE 6.6 EXTENT OF DAMAGE IN FIRE INCIDENTS IN ALBERTA MAY 14-17, 2011

EXTENT OF DAMAGE	Slave Lake		Alberta without Slave Lake	
	INCIDENTS	PERCENT	INCIDENTS	PERCENT
Extent of damage - unknown	707	45.2%	196	46.7%
Confined to object of origin	1	0.1%	3	0.7%
Confined to part of room/area of origin	3	0.2%	10	2.4%
Confined to room of origin	1	0.1%	3	0.7%
Confined to floor level of origin		0.0%	2	0.5%
Confined to building of origin	147	9.4%	22	5.2%
Extended beyond building of origin	86	5.5%	58	13.8%
Confined to roof	5	0.3%	0	0.0%
Not applicable (includes vehicle, outside area)	489	31.3%	111	26.4%
Extent of damage - unclassified	125	8.0%	15	3.6%
Total	**1564**	**100.0%**	**420**	**100.0%**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Disregarding that almost a half of the incidents are reported as "*unknown*", there are some differences between the two datasets (Figure 6.12). More percentages of fire with damage extent are classified as "*Not applicable*" which includes vehicle and outside area is observed for the Slave Lake fires (31.3 %) compared to the rest of Alberta fires (26.4%). Also it appears that more fire incidents have been "*confined to the building of origin*" in the Slave Lake fires (9.4%) compared with the Alberta fires (5.2%). The opposite is true for the "*Extended beyond building of origin*"

FIGURE E-6.12 EXTENT OF DAMAGE IN FIRE INCIDENTS, SLAVE LAKE, MAY 14-17, 2011 (PERCENT OF FIRE INCIDENTS)



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

DISCOVERY OF FIRE AND ACTIONS TAKEN DURING THE SLAVE LAKE WILDFIRE

Initial Detection

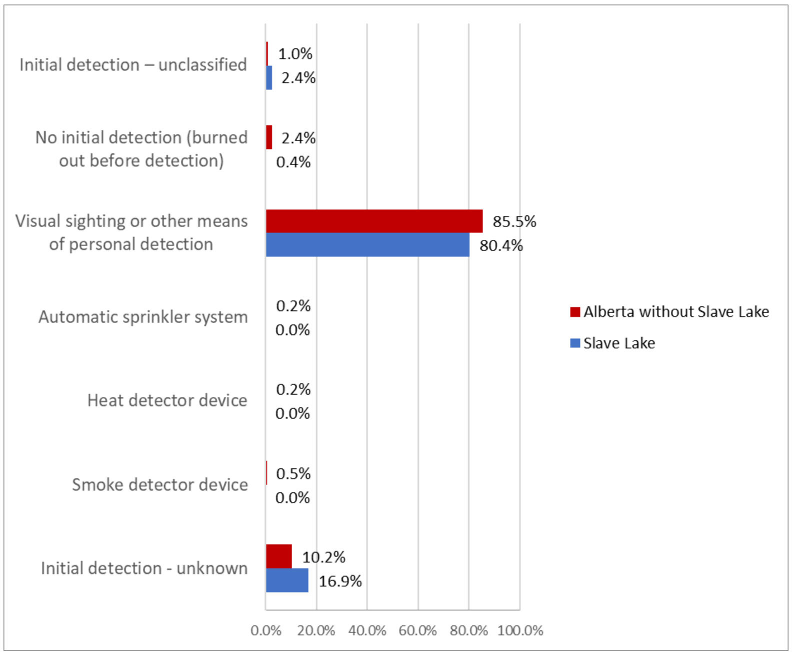
Majority of fire incidents in both the Slave Lake Region and the Alberta as a whole (excluding the Slave Lake) have been initially detected by the "Visual sighting or other means of personal detection" (Table 6.7 and Figure 6.13). This pattern may correspond to the inexistence of smoke detectors or other devices, which is verified later in this report.

TABLE 6.7 INITIAL DETECTION OF FIRE INCIDENTS, SLAVE LAKE, MAY 14-17, 2011 (PERCENT OF FIRE INCIDENTS)

INITIAL DETECTION	Slave Lake		Alberta without Slave Lake	
	INCIDENTS	PERCENT	INCIDENTS	PERCENT
Initial detection - unknown	264	16.9%	43	10.2%
Smoke detector device		0.0%	2	0.5%
Heat detector device		0.0%	1	0.2%
Automatic sprinkler system		0.0%	1	0.2%
Visual sighting or other means of personal detection	1257	80.4%	359	85.5%
No initial detection (burned out before detection)	6	0.4%	10	2.4%
Initial detection – unclassified	37	2.4%	4	1.0%
Total	**1564**	**100.0%**	**420**	**100.0%**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 6.12 INITIAL DETECTION OF FIRE INCIDENTS, SLAVE LAKE, MAY 14-17, 2011 (PERCENT OF FIRE INCIDENTS)



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

CONCLUSION

Wildfires emergencies are among the most common weather and climate related disasters in Canada. Slave Lake Wildfire in May 2011 was one of the largest wildfire in Canadian disaster history. The Slave Lake Wildfire created a significantly high number of fire incidents that required response by fire fighters from various fire departments in Alberta and beyond. Alberta fire incidents records have significantly changed as a result of this wildfire. Although not covered in this study, the Fort McMurray fire added to these records even further. Comparing the fire incidents that occurred in Alberta without considering the Slave Lake Region, it was highlighted that during wildfire emergencies, even when an evacuation is in place, majority of fire incidents will be those related to residential buildings in smaller towns.

It has to be mentioned that due to large volumes of unknowns for many of the fire incidents attributes, it was not possible to examine all attributes in detail. Also, due to unavailability of exact locations for fire incidents in the Slave Lake Region, it was not possible to carry out any spatial analysis on the data. Availability of such information could provide opportunities for more complex statistical and spatial analyses.

7 FIRE INCIDENTS DURING THE VANCOUVER RIOT

INTRODUCTION AND BACKGROUND

Riots are complex social events that involve people and violence (Davies and Dawson, 2015) and are classified under the human made or conflict category in most disaster databases. Violence frequently occurs after major sporting events (particularly hockey and soccer) in many parts of the world and can sometimes turn into riots. Historically Canada has experienced some sports-related riots in several cities. Overall four riot disasters (incidents) have been reported in the Canadian Disaster Database (Table 7-1). The Vancouver Riot, which occurred on June 15, 2011 is the latest major riot in Canada. It has to be mentioned that this list may not cover all riot events in Canada. For example the 1994 riot in Vancouver and the 1986 riot in Montreal are not listed in the Canadian Disaster Database. In 1986, the Montreal Canadiens won the Stanley Cup and after the game, crowds moved through the downtown core looting, burning and destroying properties (Roberts and Benjamin, 2000). In 1994, and after the Vancouver hockey team lost to New York in New York City, some people took to the streets and a riot formed (Roberts and Benjamin, 2000).

As stated by Roberts and Benjamin (2000), Canadian riots are significantly different from the soccer-related riots in Europe. They argue that Canadian riots do not involve the clash of opposing fans. In other words, the riots in Canadian cities were not provoked by the spectators' frustration of the field players or excessive use of alcohol, instead most riots were 'celebratory riots'.

TABLE F-1 RIOT DISASTERS IN CANADA 1900 TO 2017

PLACE	PROVINCE	EVENT START DATE	FATALITIES	INJURED	SHORT DESCRIPTION
VANCOUVER	BRITISH COLOMBIA	15-JUN-2011	0	144	Vancouver BC, June 15-16, 2011. Following the loss of game seven in the Stanley Cup finals to the Boston Bruins, Vancouver Canucks fans took to the streets and rioting ensued. There were 140 people taken to hospital with minor injuries while four people sustained serious injuries. Businesses along Robson St. and West Georgia St. were damaged (smashed windows, looting, and vandalism) while cars nearby were set on fire.
MURDOCHVILLE	QUEBEC	8-MAR-1957	1	2	Murdochville QC, March 8, 1957. 924 mining employees in Murdochville, Québec, strike concerning the refusal of the company to recognize and negotiate with the union; on March 8, violence and property damage arose, one striker was killed and two seriously injured.
REGINA	SASKACHEAWAN	1-JUN-1935	1	0	Regina SK, June-July 1935. One person was killed on July 1 during a clash between police and 1000 unemployed workers taking part in the "On to Ottawa" trek.
ESTEVAN	SASKACHEAWAN	8-SEP-1931	3	23	Estevan SK, September 8-29, 1931. The miners of the Souris coal field walked off the job to reinforce demands for increased wages and improved working conditions; involved 22 coal operators and 600 miners; on September 29, some 300 to 400 miners and their families clashed with police, resulting in three deaths, 23 injuries, and a number of arrests.

Source: Canadian Disaster Database (http://cdd.publicsafety.gc.ca/)

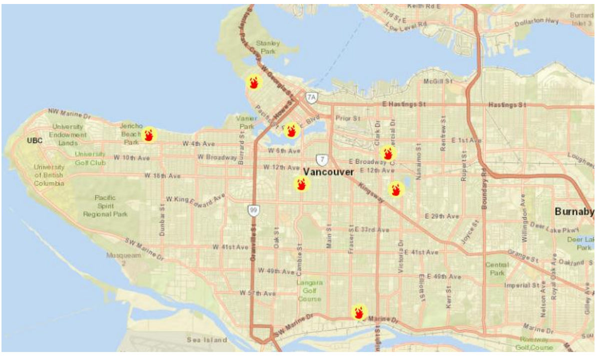
THE VANCOUVER RIOT

On June 15, 2011 a major riot occurred in Vancouver. The riot happened soon after the Vancouver Canucks lost to the Boston Bruins in the Stanley Cup Finals in New York. Crowds that had been gathered in designated viewing areas in downtown spilled out onto downtown streets. It is believed that more than 100,000 people were in the designated viewing areas in the downtown area (Furlong and Keefe, 2011). The riot lasted about five hours and is one of the most well documented riots globally due to the presence of social media outlets and widespread access to smart phones. While Vancouver Police Department had deployed more than 600 officers to the area, following the game some of those who had gathered in downtown set fires, overturned cars, smashed windows, and even looted retail establishments (Schneider and Trottier, 2012).

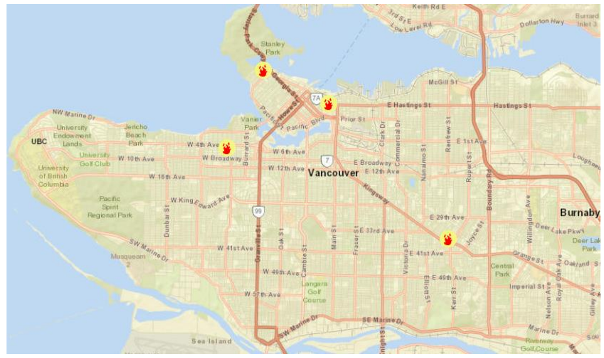
During the riot, fights broke out among the crowd in deteriorated viewing areas conditions. Bottles were being thrown at the viewing screens, cars were overturned and set on fire, members of the public and police officers were assaulted and many downtown shops and properties were looted and damaged (Davies and Dawson, 2015). As a result 140 people and 9 police officers were injured during the riot. The first car was overturned and was set afire at 7:46 pm, a second vehicle in the same area was lit ablaze. Firemen were able to put it out, but the truck was again set afire after it was overturned. In a nearby parking lot, two Vancouver Police squad cars were later also set on fire. In total, 17 cars were burned, including police cars.

Since riots are expected to occur after major sport and similar events, fire departments need to have ideas about potential implications for them. A review of fire incidents during the 2011 Vancouver riot will provide some insights into these situations.

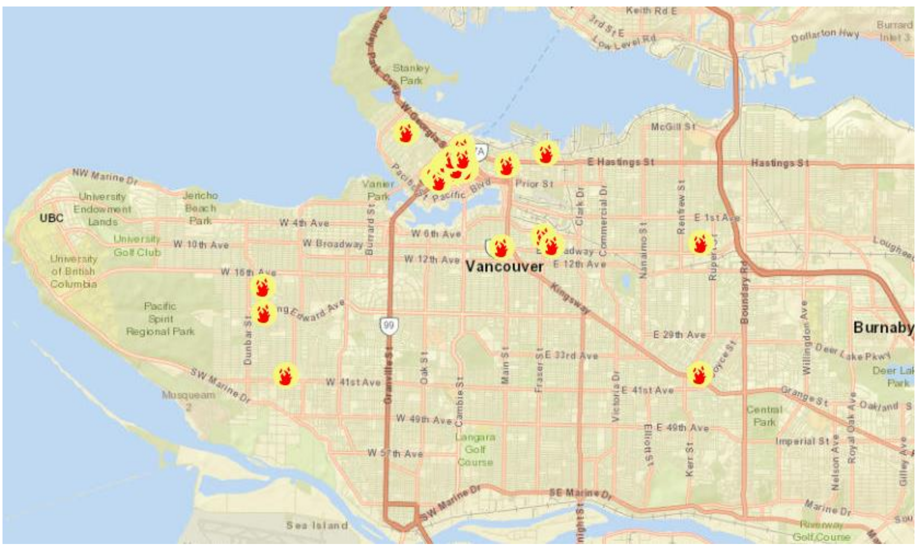
FIGURE 7.1 DISTRIBUTION OF FIRE INCIDENTES IN VANCOUVER DURING THE 2011 VANCOUVER RIOT (JUNE 15-16) AND SIMILAR DAYS IN OTHER YEARS



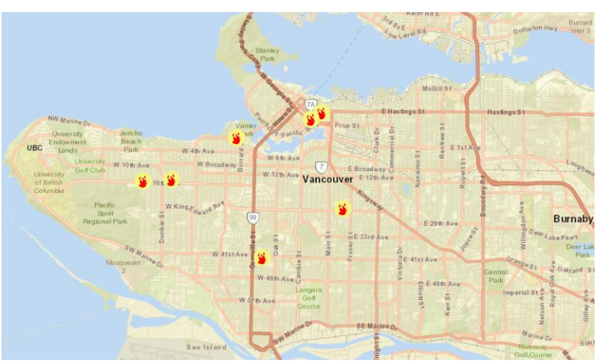
June 15-16, 2009



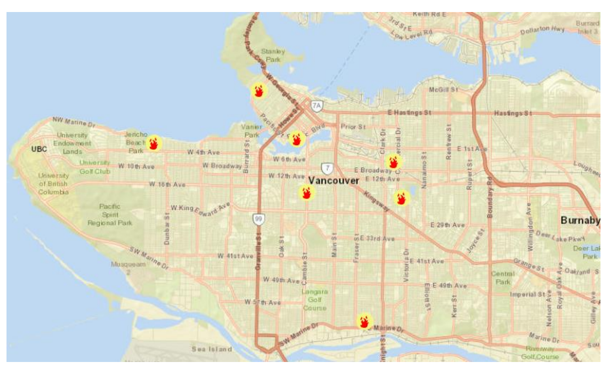
June 15-16, 2010



June 15-16, 2011



June 15-16, *2012*



June 15-16, *2013*

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

In this chapter fire incidents that occurred in the City of Vancouver during the Vancouver riot on June 15 and 16 are compared with fire incidents that occurred in the same days in other parts of British Colombia. The main reason for this comparison is that the number of fire incidents in the city during the same days of the previous year (2010) or the following year (2012) are very small, which makes the comparison impossible. There were only 5 fire incidents in the city on these days in 2010 and 8 in 2012.

FIRE INCIDENTS AND PROPERTY DURING THE VANCOUVER RIOT

Major occupancy

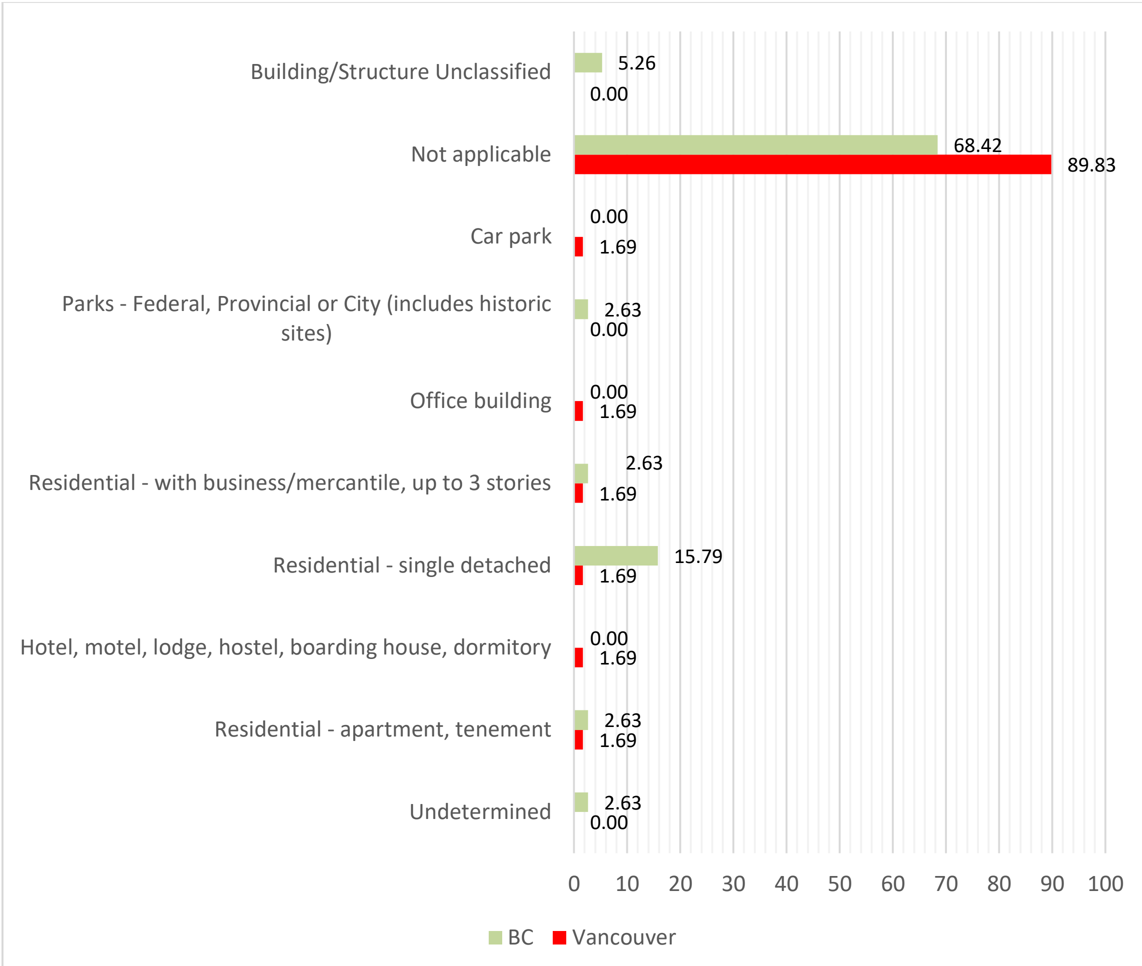
There is an obvious difference between the number of fire incidents in the single detached houses during the riot days in Vancouver and the rest of BC in the same days (Table 7-2, Figure 7-2). While only 1% of fire incidents in Vancouver were related to "*residential- single detached houses*", for the rest of British Columbia this number is 15%. This indicates that the majority of fire incidents are riot related incidents.

TABLE 7-2 FIRE INCIDENTS BY OCCUPANCY GROUP DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER

Major Occupancy		Vancouver on June 15-16, 2011		BC except Vancouver	
Code	DESCRIPTION	INCIDENTS	PERCENT	INCIDENTS	PERCENT
00	Undetermined	0	0.00	1	2.63
32	Residential - apartment, tenement	1	1.69	1	2.63
33	Hotel, motel, lodge, hostel, boarding house, dormitory	1	1.69	0	0.00
34	Residential - single detached	1	1.69	6	15.79
39	Residential - with business/mercantile, up to 3 stories	1	1.69	1	2.63
41	Office building	1	1.69	0	0.00
81	Parks - Federal, Provincial or City (includes historic sites)	0	0.00	1	2.63
86	Car park	1	1.69	0	0.00
95	Not applicable	53	89.83	26	68.42
99	Building/Structure Unclassified	0	0.00	2	5.26
	Total	**59**	**100**	**38**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 7-2 PERCENTAGE OF FIRE INCIDENTS BY MAJOR OCCUPANCY DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Property Classification

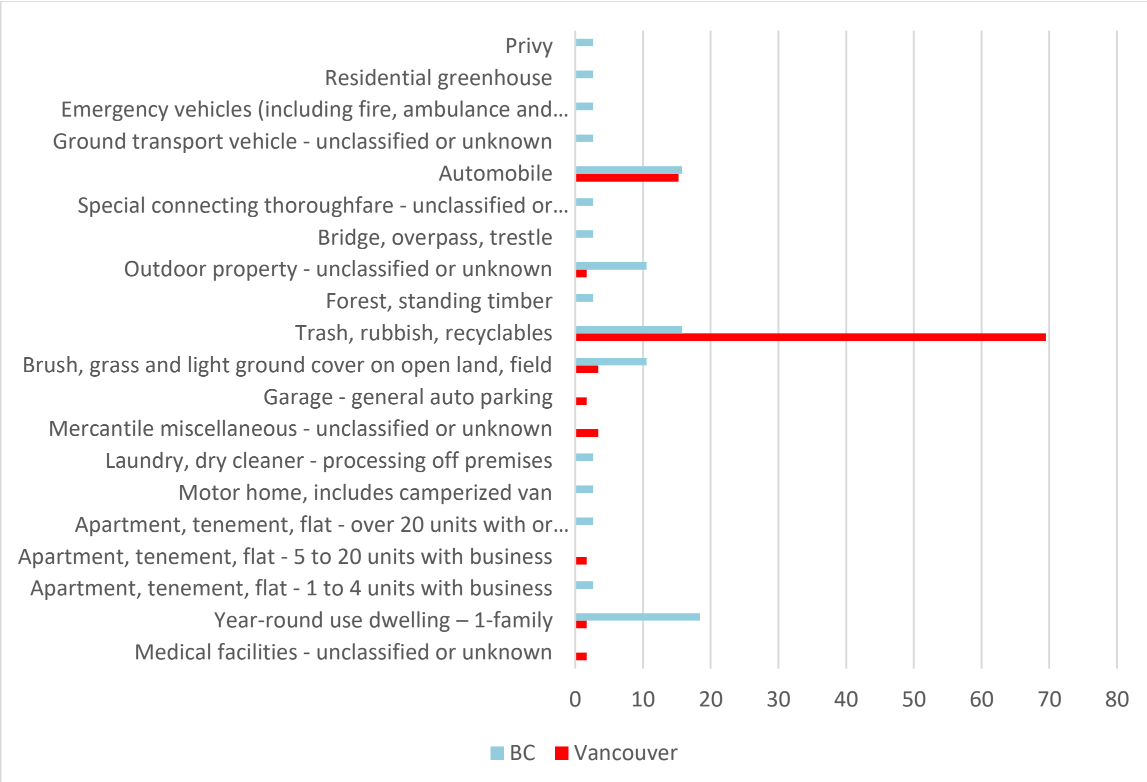
An obvious difference can be observed between the number of fire incidents in "*trash, rubbish and recyclables*" in the riot and none riot data sets (Table 7.3 and Figure 7.3). While only 15% of the fire incidents, which occurred in BC (excluding Vancouver) is classified in the "*trash, rubbish and recyclables*" class, more than 70% of the fire incidents in Vancouver fall under this class. Given the nature of riot at these days in Vancouver, this difference can be interpreted as the result of social unrest and spectators' behaviour after the game. Another noticeable difference is the percentage of fire incidents by property classification, particularly "*year-round use dwelling – 1 family*", for the riot dataset it is around 1%, while this number for non-riot dataset is more than 18%.

TABLE 7.3 FIRE INCIDENTS AT DIFFERENT PROPERTY CLASSS DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER

Property Class		Vancouver on June 15-16, 2011		BC except Vancouver	
CODE	DESCRIPTION	INCIDENTS	PERCENT	INCIDENTS	PERCENT
2490	Medical facilities - unclassified or unknown	1	1.69	0	0.00
3110	Year-round use dwelling – 1-family	1	1.69	7	18.42
3210	Apartment, tenement, flat - 1 to 4 units with business	0	0.00	1	2.63
3230	Apartment, tenement, flat - 5 to 20 units with business	1	1.69	0	0.00
3250	Apartment, tenement, flat - over 20 units with or without business	0	0.00	1	2.63
3750	Motor home, includes camperized van	0	0.00	1	2.63
5640	Laundry, dry cleaner - processing off premises	0	0.00	1	2.63
5990	Mercantile miscellaneous - unclassified or unknown	2	3.39	0	0.00
7820	Garage - general auto parking	1	1.69	0	0.00
8110	Brush, grass and light ground cover on open land, field	2	3.39	4	10.53
8150	Trash, rubbish, recyclables	41	69.49	6	15.79
8180	Forest, standing timber	0	0.00	1	2.63
8190	Outdoor property - unclassified or unknown	1	1.69	4	10.53
8210	Bridge, overpass, trestle	0	0.00	1	2.63
8290	Special connecting thoroughfare - unclassified or unknown	0	0.00	1	2.63
8610	Automobile	9	15.25	6	15.79
8690	Ground transport vehicle - unclassified or unknown	0	0.00	1	2.63
8880	Emergency vehicles (including fire, ambulance and police)	0	0.00	1	2.63
9315	Residential greenhouse	0	0.00	1	2.63
9320	Privy	0	0.00	1	2.63
Total		59	100	38	100

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 7.3 PERCENTAGES OF FIRE INCIDENTS BY PROPERTY CLASSIFICATION DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Ground Floor Area

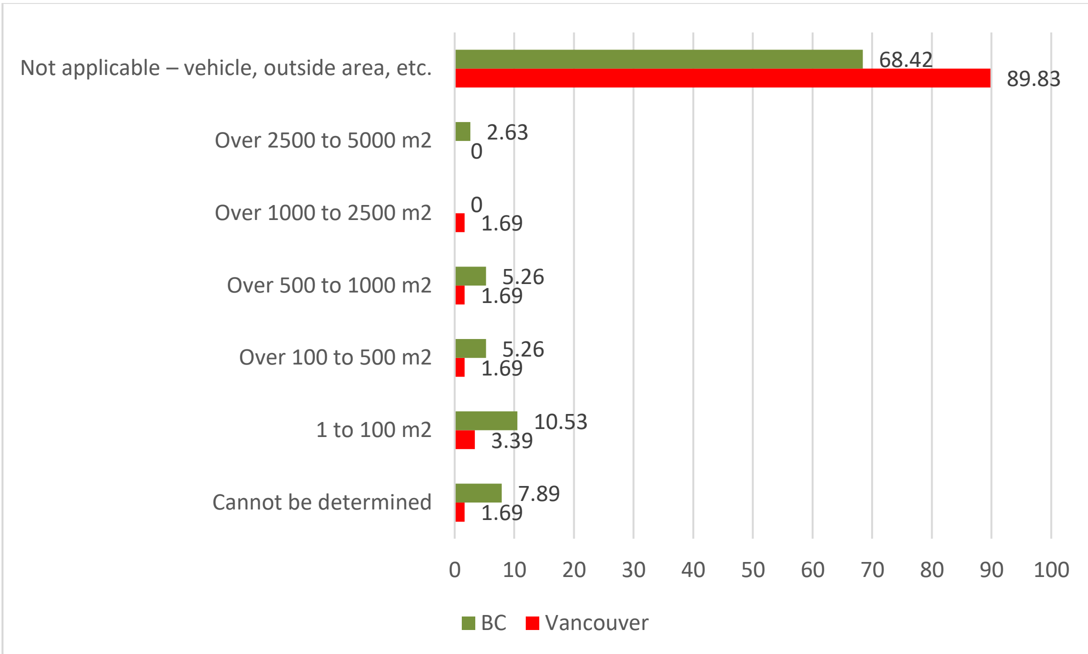
The amount of fire incidents in outside areas and vehicles in Vancouver is considerably greater than the similar amount for BC (Table 7.4 and Figure 7.4). Moreover, for all other items (mainly building areas) the numbers for Vancouver dataset is smaller than BC. It shows that overall at the time of Riot in Vancouver very small cases of fire incidents occurred in buildings, and most of the reported fire incidents happened in open spaces and cars. On the other hand, almost 90% of the cases in Vancouver are related to vehicles and outside area while this number for BC is less than 70%.

TABLE 6.4 FIRE INCIDENTS BY GROUND FLOOR AREA DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER

Ground Floor Area		Vancouver on June 15-16, 2011		BC except Vancouver	
CODE	DESCRIPTION	INCIDENTS	PERCENT	INCIDENTS	PERCENT
0	Cannot be determined	1	1.69	3	7.89
1	1 to 100 m²	2	3.39	4	10.53
2	Over 100 to 500 m²	1	1.69	2	5.26
3	Over 500 to 1000 m²	1	1.69	2	5.26
4	Over 1000 to 2500 m²	1	1.69	0	0
5	Over 2500 to 5000 m²	0	0	1	2.63
8	Not applicable – vehicle, outside area, etc.	53	89.83	26	68.42
Total		**59**	**1**	**38**	**1**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 6.4 PERCENTAGE OF FIRE INCIDENTS BY GROUND FLOOR AREA DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIRE PROTECTION FEATURES AND FIRE INCIDENTS DURING THE VANCOUVER RIOT

Manual Fire Protection Facilities

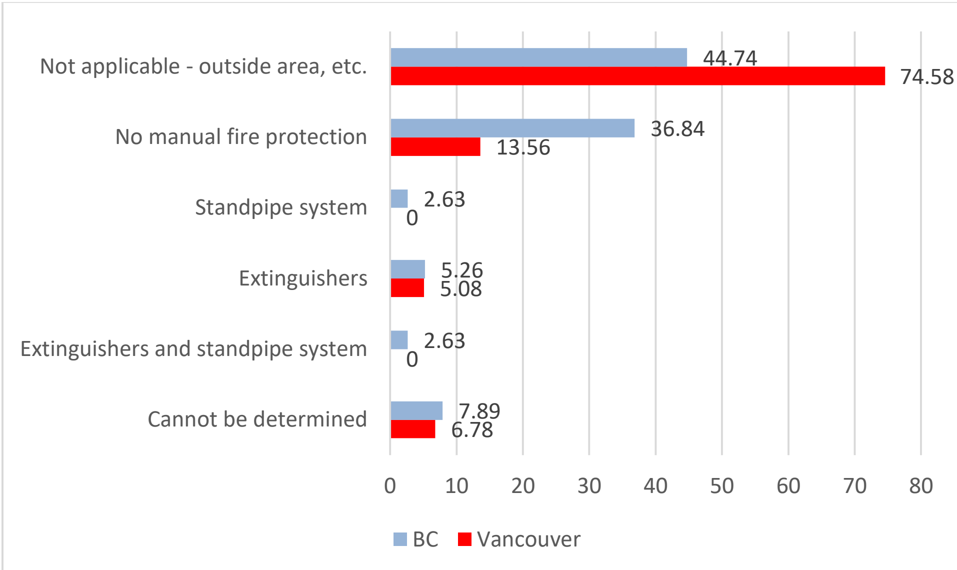
Since a larger percent of fire incidents in Vancouver (74.58 %) are classified under code 8 or "*Not applicable - outside area, etc.*", it appears that these fires are riot related fire incidents (Table 7.5 and Figure 7.5). Also, a lower percentage of fire incidents under the "*No manual fire protection*" in the Vancouver dataset (13.56%) compare to BC dataset (36.84%) can explain that under riot situations more fire incidents with no manual fire protection can occur.

TABLE 7.5 FIRE INCIDENTS BY FIRE PROTECTION FACILITY DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER

Fire Protection Facility		Vancouver on June 15-16, 2011		BC except Vancouver	
CODE	DESCRIPTION	INCIDENTS	PERCENT	INCIDENTS	PERCENT
0	Cannot be determined	4	6.78	3	7.89
2	Extinguishers and standpipe system	0	0	1	2.63
4	Extinguishers	3	5.08	2	5.26
6	Standpipe system	0	0	1	2.63
7	No manual fire protection	8	13.56	14	36.84
8	Not applicable - outside area, etc.	44	74.58	17	44.74
Total		59	100	38	100

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE F-5 PERCENTAGE OF FIRE INCIDENTS BY FIRE PROTECTION FACILITY DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Sprinkler Protection

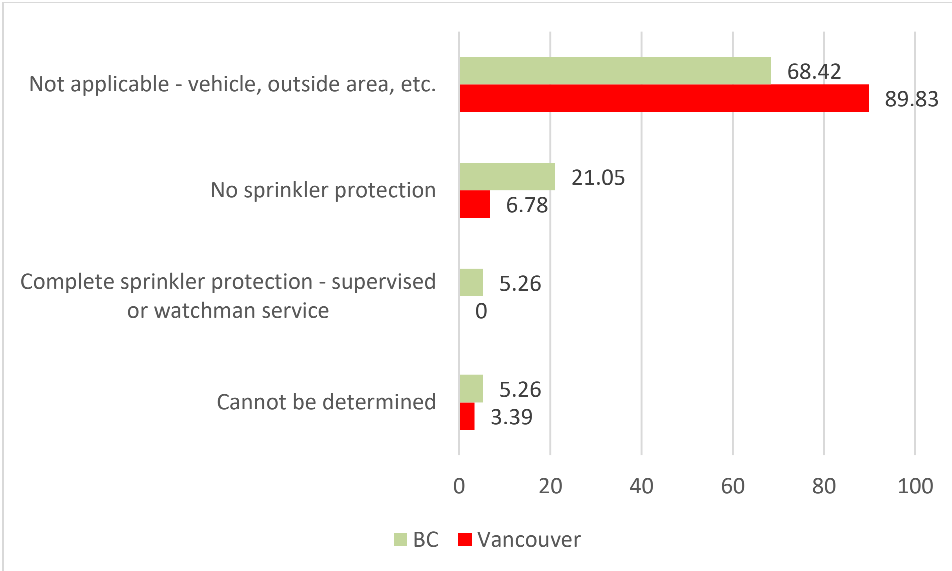
Similar to the previous cases the main difference between the fire incidents during the riot and fire incidents in other parts of BC is higher volumes of fires in outside areas and vehicle which means sprinkler protection does not apply to them (Table 7.6 and Figure 7.6). The higher percentage of "*No sprinkler protection*" in non-riot dataset (21%) compared to the riot dataset (7%) could be due to the fact that more buildings in Vancouver are equipped with sprinkler systems than the rest of BC.

TABLE 7.6 FIRE INCIDENTS BY SPRINKER PROTECTION DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER

Sprinkler Protection		Vancouver on June 15-16, 2011		BC except Vancouver	
CODE	DESCRIPTION	INCIDENTS	PERCENT	INCIDENTS	PERCENT
0	Cannot be determined	2	3.39	2	5.26
1	Complete sprinkler protection - supervised or watchman service	0	0	2	5.26
7	No sprinkler protection	4	6.78	8	21.05
8	Not applicable - vehicle, outside area, etc.	53	89.83	26	68.42
Total		**59**	**100**	**38**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 7.6 PERCENTAGES OF FIRE INCIDENTS BY SPRINKLER PROTECTION DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Automatic Fire Detection System

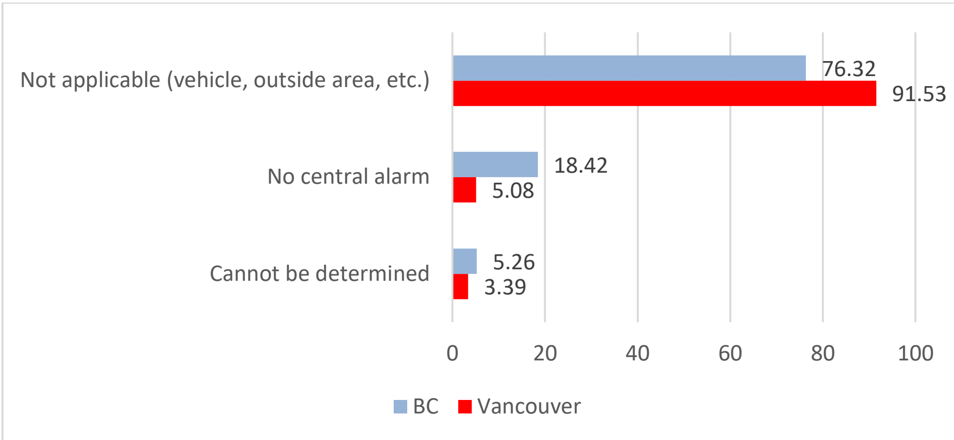
Since the majority of fire incidents in Vancouver during the riot were outdoor fires, a very high percentage of fire incidents are of the types with no automatic fire detection system. According to Table 7.7 and Figure 7.7 there more than 91% of fire incidents in the riot dataset occurred in outdoor areas and cars while this number for non-riot dataset is 76%. Moreover, there are only 5% of fire incidents in the riot dataset under to "*No central alarm*" this number for non-riot dataset is 18%. This confirms that during the riot most fire incidents happened outside the building areas where there is no central alarm.

TABLE 7.7 FIRE INCIDENTS BY AUTOMATIC FIRE DETECTION SYSTEM DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER

Automatic Fire Detection		Vancouver on June 15-16, 2011		BC except Vancouver	
CODE	**DESCRIPTION**	**INCIDENTS**	**PERCENT**	**INCIDENTS**	**PERCENT**
0	Cannot be determined	2	3.39	2	5.26
1	No central alarm	3	5.08	7	18.42
8	Not applicable (vehicle, outside area, etc.)	54	91.53	29	76.32
Total		**59**	**100**	**38**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 7.7 PERCENTAGE OF FIRE INCIDENTS BY AUTOMATIC FIRE DETECTION DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Fire Service

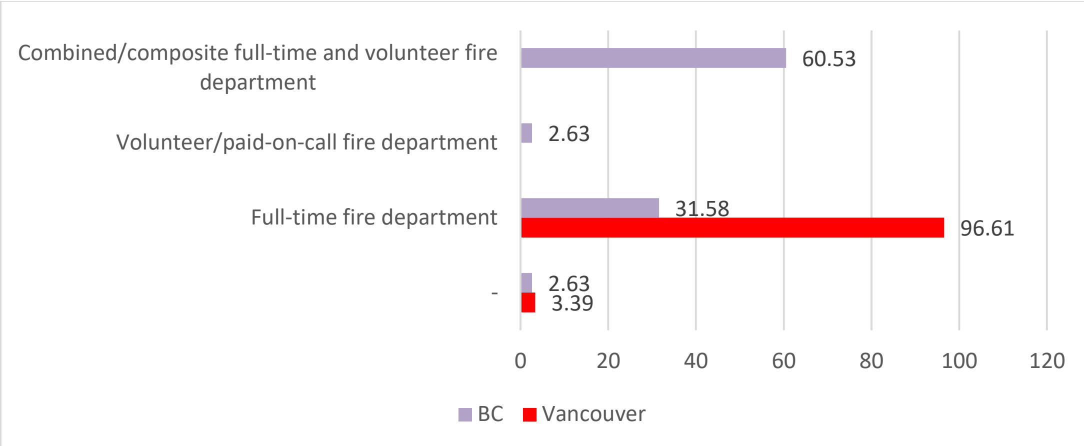
There is a significant difference between the riot dataset and non-riot dataset when comparing "*full time fire department*" and "*combined full time and volunteer fire department*" (Table 7.8 and Figure 7.8). While more than 96% of the fires in Vancouver were responded to by full time fire department, this number for the rest of BC is 31% (more than three times less than Vancouver). Also, the percentage of combined/composite full time and volunteer fire department for Vancouver dataset is 0 while this number for the BC (except Vancouver) dataset is more than 60%. These differences are mostly due to the different style of fire marshal settings in various jurisdictions.

TABLE 7.8 FIRE INCIDENTS BY FIRE SERVICE DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER

Fire service		Vancouver on June 15-16, 2011		BC except Vancouver	
CODE	DESCRIPTION	INCIDENTS	PERCENT	INCIDENTS	PERCENT
-	-	2	3.39	1	2.63
10	Full-time fire department	57	96.61	12	31.58
20	Volunteer/paid-on-call fire department	0	0	1	2.63
30	Combined/composite full-time and volunteer fire department	0	0	23	60.53
80	Not applicable - no fire service	0	0	1	2.63
Total		**59**	**100**	**38**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 7.8 PERCENTAGE OF FIRE INCIDENTS BY FIRE SERVICE DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

CIRCUMSTANCES CONTRIBUTING TO THE OUTBREAK OF FIRES DURING THE VANCOUVER RIOT

Igniting object

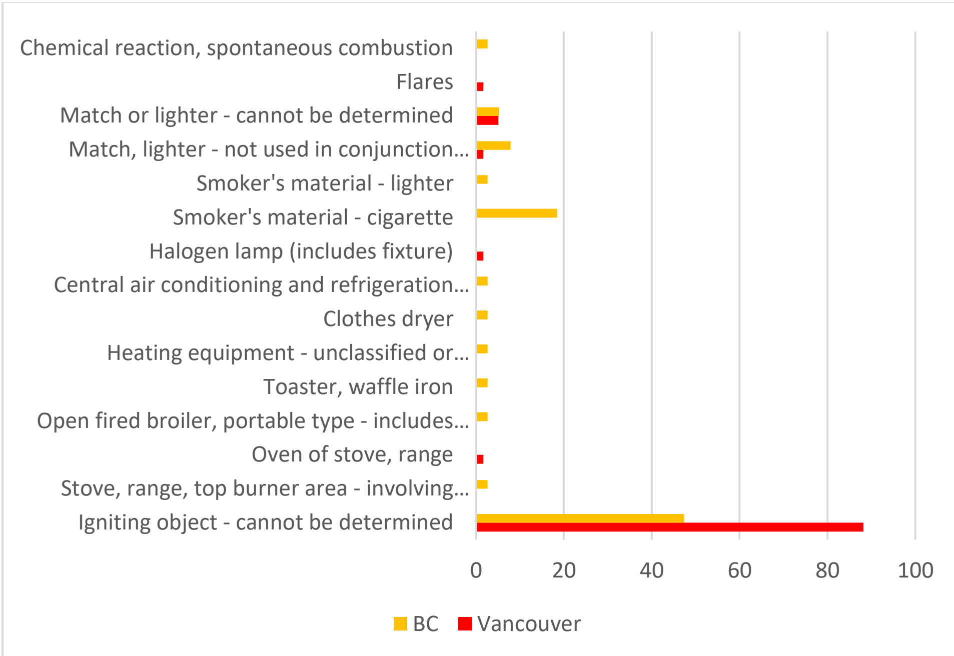
Most of the fire incidents (88%) in the riot dataset and a large portion for the non-riot dataset (47%) fall into the category "cannot be determined" (Table 7.9 and Figure 7.9). This makes it impossible to draw any meaningful comparison between these two datasets. The only noticeable difference that can be observed here is that the fire incidents from "*smoker's materials including lighter, cigarette and match*" are more frequent in the BC dataset. These items (code 700s) constitute almost 35% for non-riot dataset, while for riot dataset this number is almost 8%.

TABLE F 9 FREQUENCY AND PERCENTAGE OF FIRE INCIDENTS BY IGNITING OBJECT DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER

Igniting object		Vancouver on June 15-16, 2011		BC except Vancouver	
CODE	DESCRIPTION	INCIDENTS	PERCENT	INCIDENTS	PERCENT
000	Igniting object - cannot be determined	52	88.14	18	47.37
040	Stove, range, top burner area - involving other circumstances	0	0	1	2.63
050	Oven of stove, range	1	1.69	0	0
140	Open fired broiler, portable type - includes barbecue	0	0	1	2.63
160	Toaster, waffle iron	0	0	1	2.63
290	Heating equipment - unclassified or unknown	0	0	1	2.63
330	Clothes dryer	0	0	1	2.63
350	Central air conditioning and refrigeration equipment	0	0	1	2.63
651	Halogen lamp (includes fixture)	1	1.69	0	0
711	Smoker's material - cigarette	0	0	7	18.42
717	Smoker's material - lighter	0	0	1	2.63
720	Match, lighter - not used in conjunction with smoking	1	1.69	3	7.89
723	Match or lighter - cannot be determined	3	5.08	2	5.26
954	Flares	1	1.69	0	0
980	Chemical reaction, spontaneous combustion	0	0	1	2.63
Total		**59**	**100**	**38**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE F 9 PERCENTAGE OF FIRE INCIDENTS BY IGNITING OBJECT DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Energy Causing Ignition (form of heat)

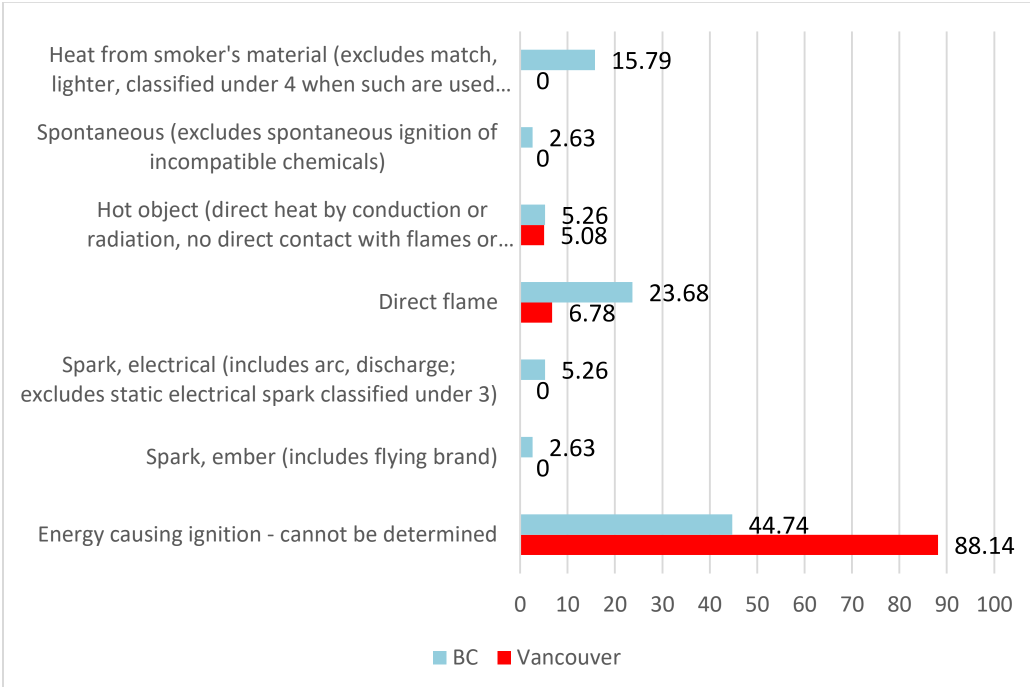
As most of the fire incidents in the riot dataset (88%) fall into the "*cannot determined*" class, making a conclusive analysis is almost impossible (refer to Table 7.10 and Figure 7.10). However, a noticeable difference is observed on the item "direct flame". While 23.7% of the fire incidents in BC (except Vancouver) were caused by direct flame, only 6.7% of fire incidents in Vancouver occurred by direct flame.

TABLE 7.10 FIRE INCIDENTS BY ENERGY CAUSING IGNITION DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER

Energy causing ignition		Vancouver on June 15-16, 2011		BC except Vancouver	
CODE	**DESCRIPTION**	**INCIDENTS**	**PERCENT**	**INCIDENTS**	**PERCENT**
00	Energy causing ignition - cannot be determined	52	88.14	17	44.74
01	Spark, ember (includes flying brand)	0	0	1	2.63
02	Spark, electrical (includes arc, discharge; excludes static electrical spark classified under 3)	0	0	2	5.26
04	Direct flame	4	6.78	9	23.68
06	Hot object (direct heat by conduction or radiation, no direct contact with flames or embers)	3	5.08	2	5.26
07	Spontaneous (excludes spontaneous ignition of incompatible chemicals)	0	0	1	2.63
08	Heat from smoker's material (excludes match, lighter, classified under 4 when such are used other than in conjunction with smoker's material)	0	0	6	15.79
Total		**59**	**100**	**38**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 7.10 PERCENTAGE OF FIRE INCIDENTS BY ENERGY CAUSING IGNITION DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Materials First Ignited

There is a profound difference between the riot and non-riot datasets in terms of "*garbage, trash, rubbish*" (Table 7.11 and Figure 7.11). In the Vancouver dataset almost 69% of the fire incidents originated from garbage and rubbish, while in the BC dataset almost 5% are related to this item. Moreover, 3% of fire incidents in the Vancouver dataset originated from cardboard while this number for BC (excluding Vancouver) is 0%. This is the most concrete evidence of the impact of riot on the fire incidents because during a disaster, such as a riot, people put fire to whatever is available to them. During such events the most accessible materials to ignite is trash cans, cardboard and boxes found in the street.

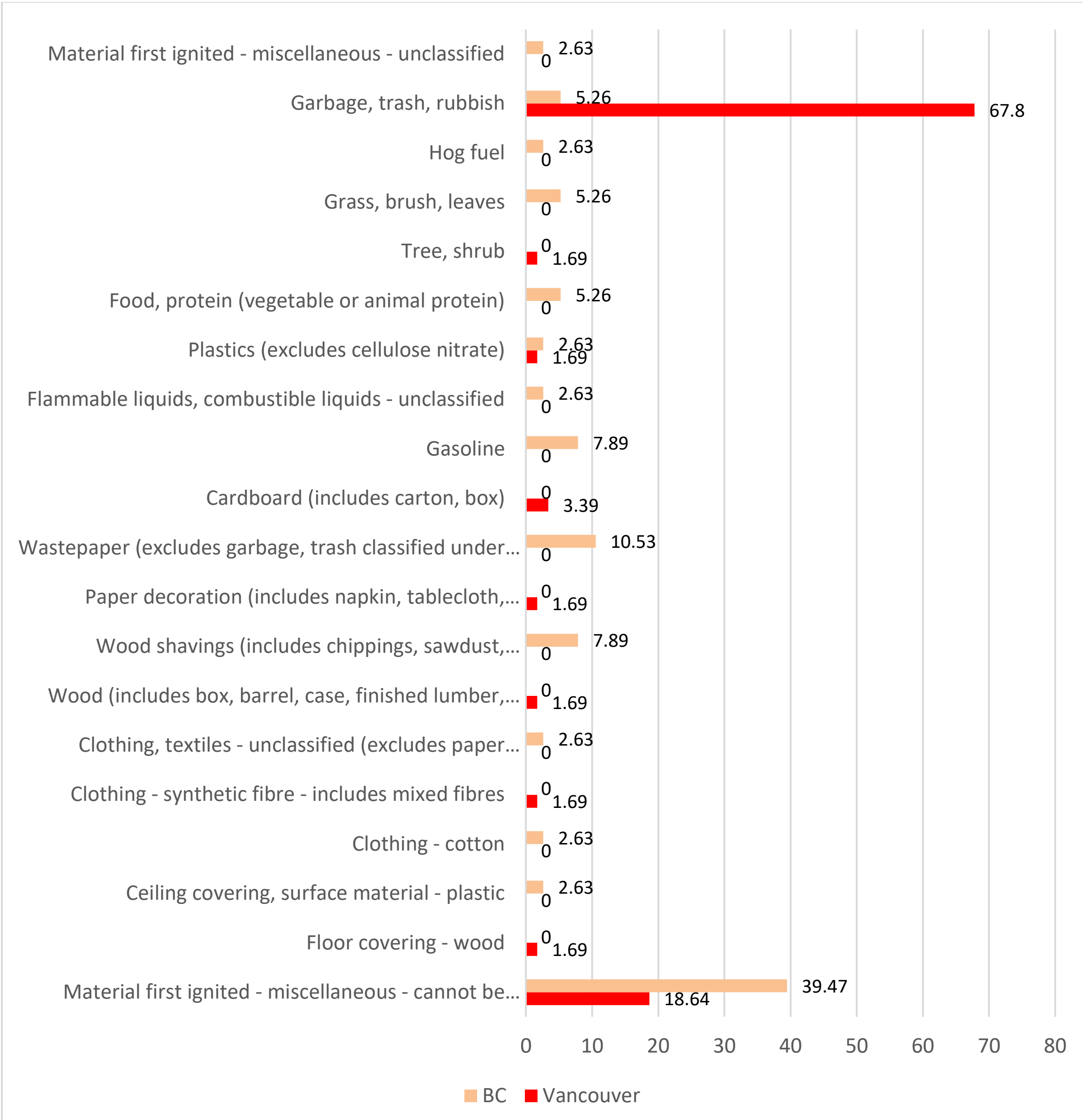
TABLE 7.11 FIRE INCIDENTS BY MATERIAL FIRST IGNITED DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER

Material first ignited		Vancouver on June 15-16, 2011		BC except Vancouver	
CODE	DESCRIPTION	INCIDENTS	PERCENT	INCIDENTS	PERCENT
000	Material first ignited - miscellaneous - cannot be determined	11	18.64	15	39.47
050	Floor covering - wood	1	1.69	0	0
150	Ceiling covering, surface material - plastic	0	0	1	2.63
310	Clothing - cotton	0	0	1	2.63
330	Clothing - synthetic fibre - includes mixed fibres	1	1.69	0	0
390	Clothing, textiles - unclassified (excludes paper clothing classified under 450)	0	0	1	2.63
410	Wood (includes box, barrel, case, finished lumber, plywood; excludes structural component)	1	1.69	0	0

Material first ignited		Vancouver on June 15-16, 2011		BC except Vancouver	
CODE	**DESCRIPTION**	**INCIDENTS**	**PERCENT**	**INCIDENTS**	**PERCENT**
420	Wood shavings (includes chippings, sawdust, excelsior, wood wool, wood flour)	0	0	3	7.89
450	Paper decoration (includes napkin, tablecloth, clothing, costume)	1	1.69	0	0
460	Wastepaper (excludes garbage, trash classified under 960)	0	0	4	10.53
470	Cardboard (includes carton, box)	2	3.39	0	0
510	Gasoline	0	0	3	7.89
590	Flammable liquids, combustible liquids - unclassified	0	0	1	2.63
730	Plastics (excludes cellulose nitrate)	1	1.69	1	2.63
822	Food, protein (vegetable or animal protein)	0	0	2	5.26
840	Tree, shrub	1	1.69	0	0
860	Grass, brush, leaves	0	0	2	5.26
916	Hog fuel	0	0	1	2.63
960	Garbage, trash, rubbish	40	67.80	2	5.26
990	Material first ignited - miscellaneous - unclassified	0	0	1	2.63
Total		59	100	38	100

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 7.11 PERCENTAGE OF FIRE INCIDENTS BY MATERIAL FIRST IGNITED DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Act or Omission

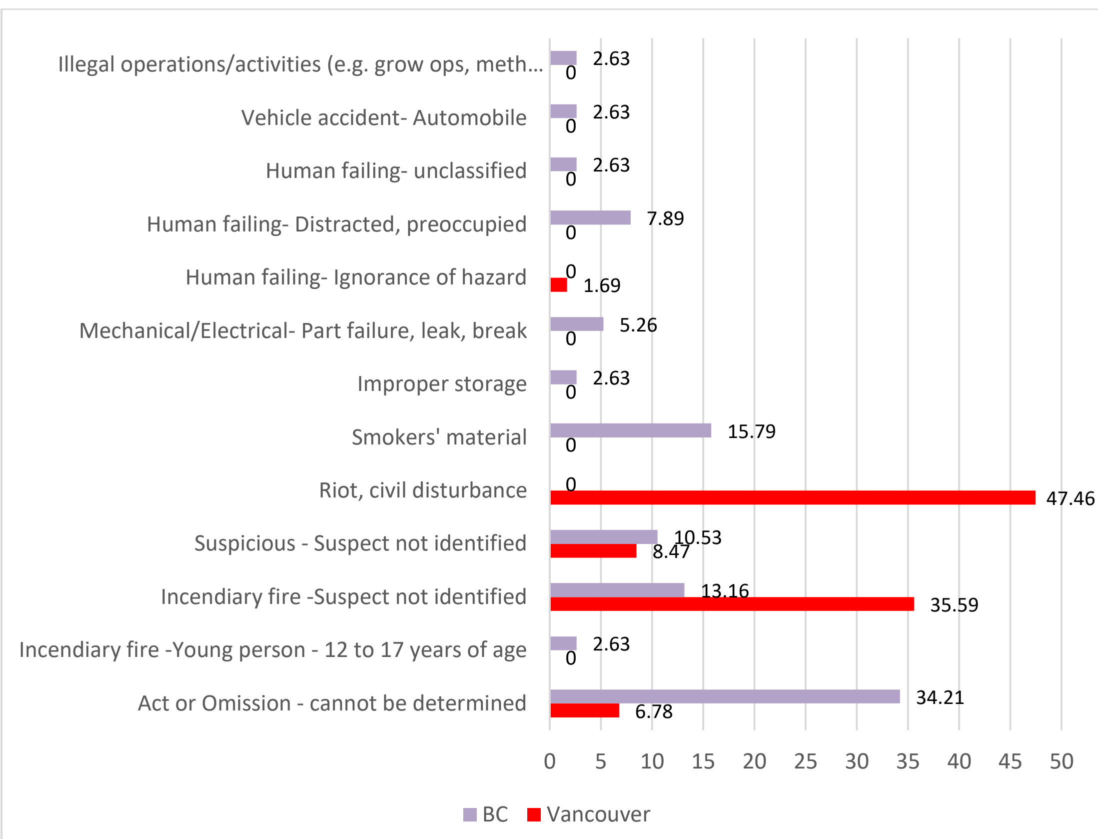
There is a significant difference between the riot and the non-riot datasets in the item "*riot, civil disturbance*" (Table 7.12 and Figure 7.12A, Figure 7.12B). In the Vancouver dataset 47% of the fire incidents originated from the riot, while in the BC dataset this number is zero. Also, there is an obvious difference in the item "*incendiary fire- suspect not identified*"; in the Vancouver dataset this item is 35% and in the BC (excluding Vancouver) dataset it is 13%. It shows that in Vancouver, most of the fire incidents at that time were caused by civil disturbance, riot and incendiary items. This demonstrates the impact of rioting on the occurrence of fire incidents.

TABLE 7.12 FIRE INCIDENTS BY ACT OR OMISSION DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER

Act or Omission		Vancouver on June 15-16, 2011		BC except Vancouver	
CODE	DESCRIPTION	INCIDENTS	PERCENT	INCIDENTS	PERCENT
000	Act or Omission - cannot be determined	4	6.78	13	34.21
112	Incendiary fire -Young person - 12 to 17 years of age	0	0	1	2.63
114	Incendiary fire -Suspect not identified	21	35.59	5	13.16
124	Suspicious - Suspect not identified	5	8.47	4	10.53
130	Riot, civil disturbance	28	47.46	0	0
210	Smokers' material	0	0	6	15.79
380	Improper storage	0	0	1	2.63
410	Mechanical/Electrical- Part failure, leak, break	0	0	2	5.26
770	Human failing- Ignorance of hazard	1	1.69	0	0
780	Human failing- Distracted, preoccupied	0	0	3	7.89
790	Human failing- unclassified	0	0	1	2.63
810	Vehicle accident- Automobile	0	0	1	2.63
995	Illegal operations/activities (e.g. grow ops, meth labs)	0	0	1	2.63
Total		**59**	**100**	**38**	**100**

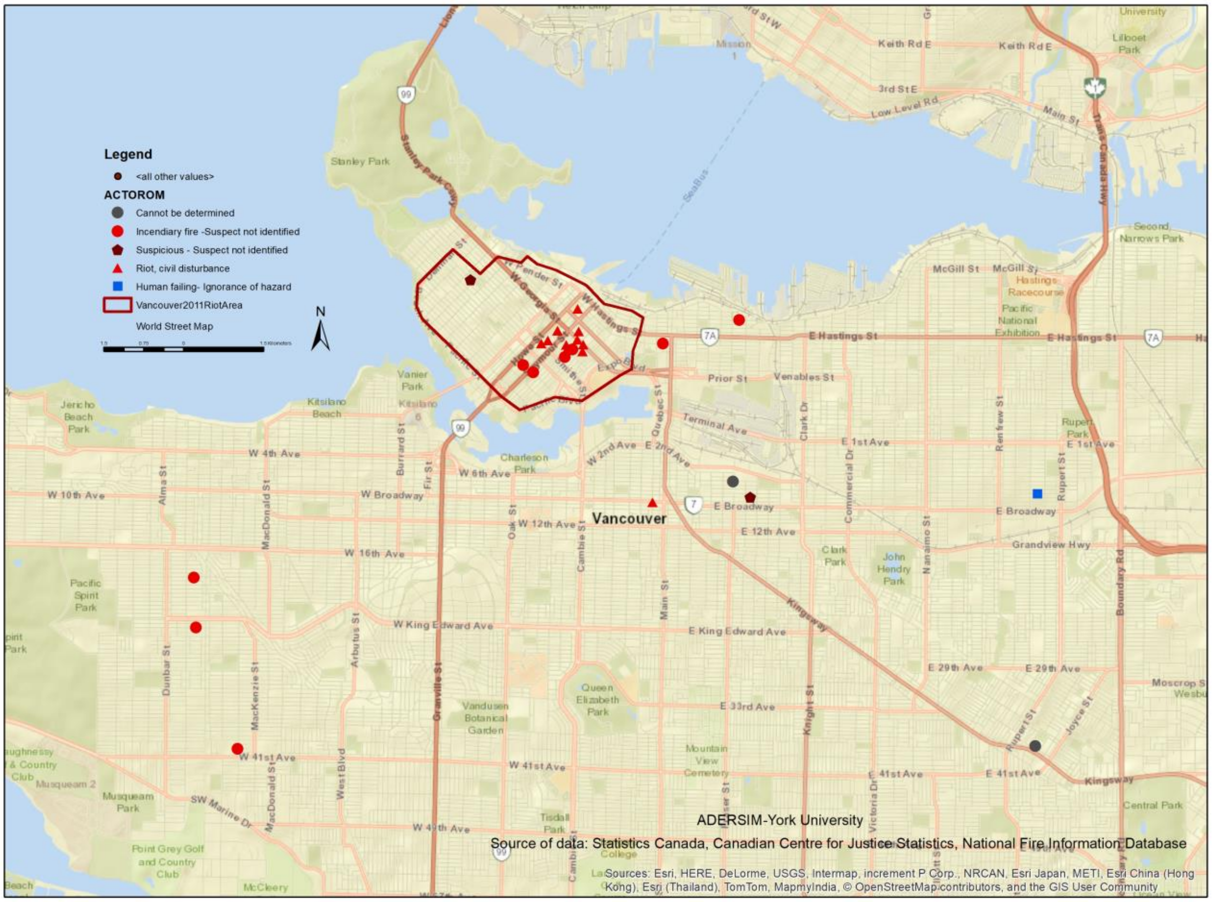
Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 7.12A PERCENTAGE OF FIRE INCIDENTS BY BY ACT OR OMISSION DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 7.12B FIRE INCIDENTS BY ACT OR OMISSION DURING THE 2011 VANCOUVER RIOT



THE ORIGIN AND SPREAD OF FIRE IN FIRE INCIDENTS DURING THE VANCOUVER RIOT

Area of Origin

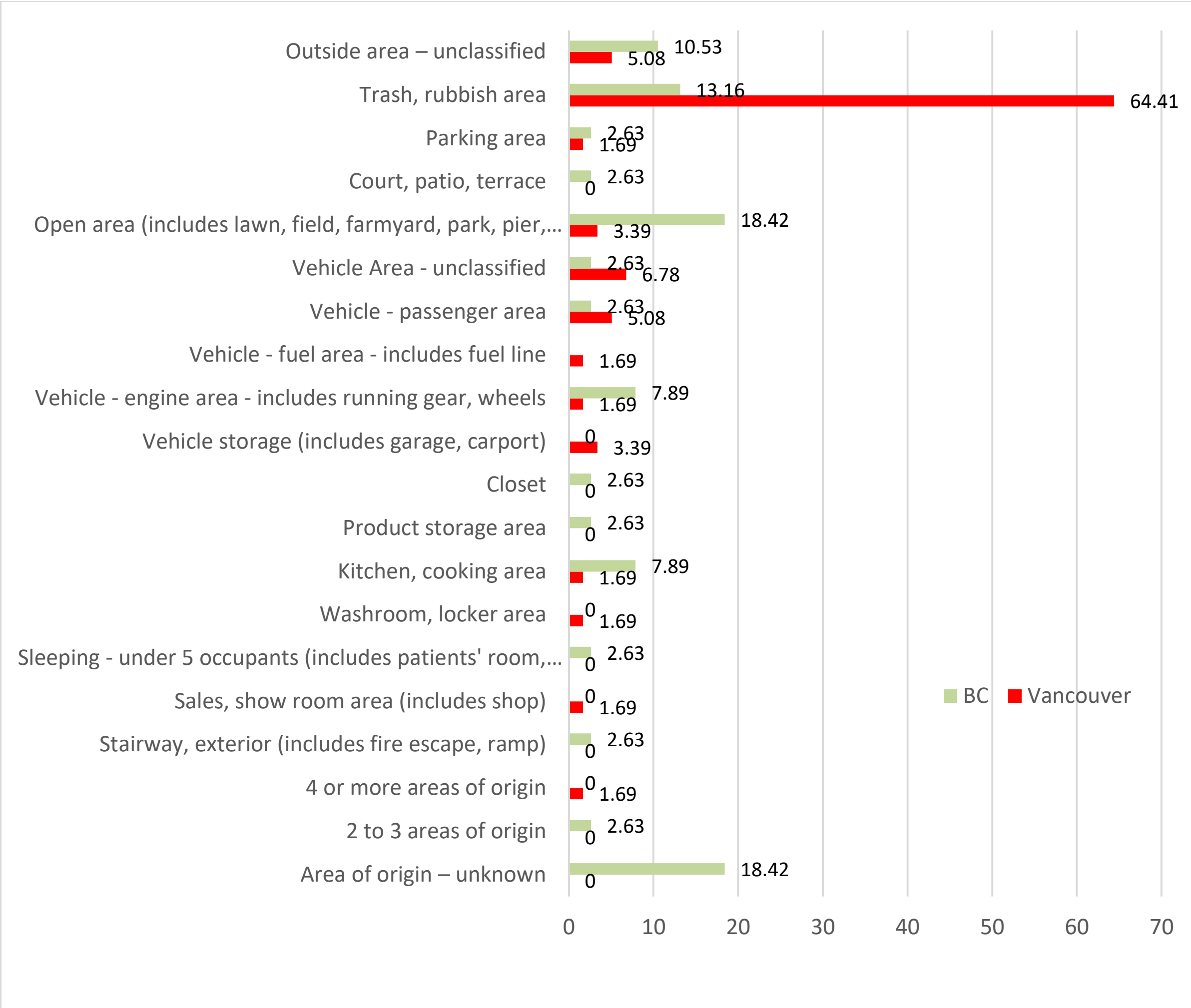
A very significant difference exists between the Vancouver and the British Columbia (excluding Vancouver) datasets when comparing "*trash, rubbish area*" (Table 7.13 and Figure 7.13A, Figure 7.13B). While in the Vancouver dataset almost 65% of the fire incidents originated from the rubbish area this, number for the BC dataset is only 13%. Also, most items related to vehicles such as "*Vehicle storage*", "*Vehicle - fuel area*", "*Vehicle - passenger area*" and "*Vehicle Area – unclassified*", is at least two times higher than the non-riot dataset (BC). These figures illustrate that during the riot in Vancouver most of the fire incidents happened outside and in the trash and rubbish areas or vehicles.

TABLE 7.13 FIRE INCIDENTS BY AREA OF ORIGIN DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER

Area of Origin		Vancouver on June 15-16, 2011		BC except Vancouver	
CODE	**DESCRIPTION**	**INCIDENTS**	**PERCENT**	**INCIDENTS**	**PERCENT**
000	Area of origin – unknown	0	0	7	18.42
001	2 to 3 areas of origin	0	0	1	2.63
002	4 or more areas of origin	1	1.69	0	0
020	Stairway, exterior (includes fire escape, ramp)	0	0	1	2.63
150	Sales, show room area (includes shop)	1	1.69	0	0
210	Sleeping - under 5 occupants (includes patients' room, bedroom, cell, lockup)	0	0	1	2.63
250	Washroom, locker area	1	1.69	0	0
310	Kitchen, cooking area	1	1.69	3	7.89
410	Product storage area	0	0	1	2.63
420	Closet	0	0	1	2.63
470	Vehicle storage (includes garage, carport)	2	3.39	0	0
820	Vehicle - engine area - includes running gear, wheels	1	1.69	3	7.89
830	Vehicle - fuel area - includes fuel line	1	1.69		
850	Vehicle - passenger area	3	5.08	1	2.63
890	Vehicle Area - unclassified	4	6.78	1	2.63
910	Open area (includes lawn, field, farmyard, park, pier, wharf)	2	3.39	7	18.42
920	Court, patio, terrace	0	0	1	2.63
930	Parking area	1	1.69	1	2.63
950	Trash, rubbish area	38	64.41	5	13.16
990	Outside area – unclassified	3	5.08	4	10.53
Total		**59**	**100**	**38**	**100**

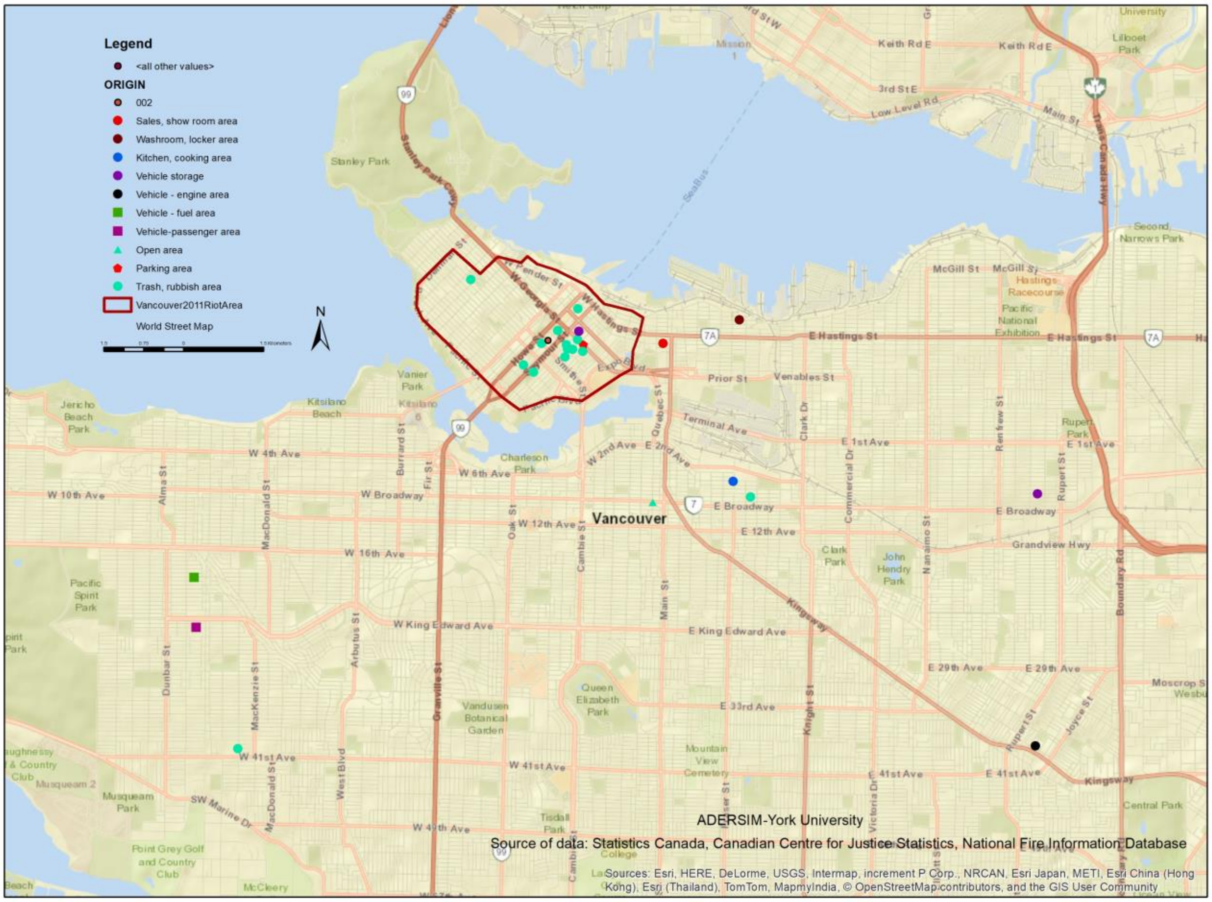
Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 7.13A PERCENTAGE OF FIRE INCIDENTS BY AREA OF ORIGIN DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 7.13B FIRE INCIDENTS BY AREA OF ORIGIN DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER



FIRE LOSS DURING THE VANCOUVER RIOT

Extent of Fire

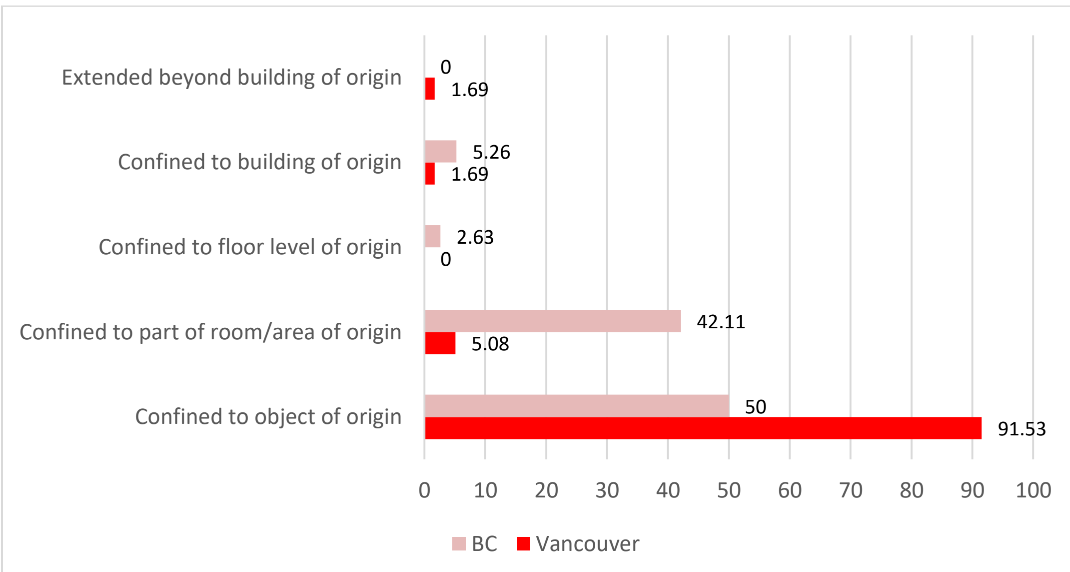
There is a considerable difference between the riot and the non-riot datasets in the item "*confined to object of origin*" (Table 7.14 and Figure 7.14A, and Figure 7.14B). While the riot (Vancouver) dataset showed that almost 92% of the fire incidents were confined to the object of origin, this number for the non-riot (BC without Vancouver) dataset is 50%. In addition, there is a considerable difference in item "*Confined to part of room/area of origin*" between the two datasets. While more than 42% of the fire incidents in the non-riot dataset relates to this item, this number for the riot dataset is only 5%. This shows again that most of the fire incidents during the riot happened in open spaces not in the building or enclosed sites.

TABLE 7.14 FIRE INCIDENTS BY EXTENT OF FIRE DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER

Extent of fire		Vancouver on June 15-16, 2011		BC except Vancouver	
CODE	**DESCRIPTION**	**INCIDENTS**	**PERCENT**	**INCIDENTS**	**PERCENT**
01	Confined to object of origin	54	91.53	19	50.00
02	Confined to part of room/area of origin	3	5.08	16	42.11
04	Confined to floor level of origin	0	0	1	2.63
05	Confined to building of origin	1	1.69	2	5.26
06	Extended beyond building of origin	1	1.69	0	0
Total		**59**	**100**	**38**	**100**

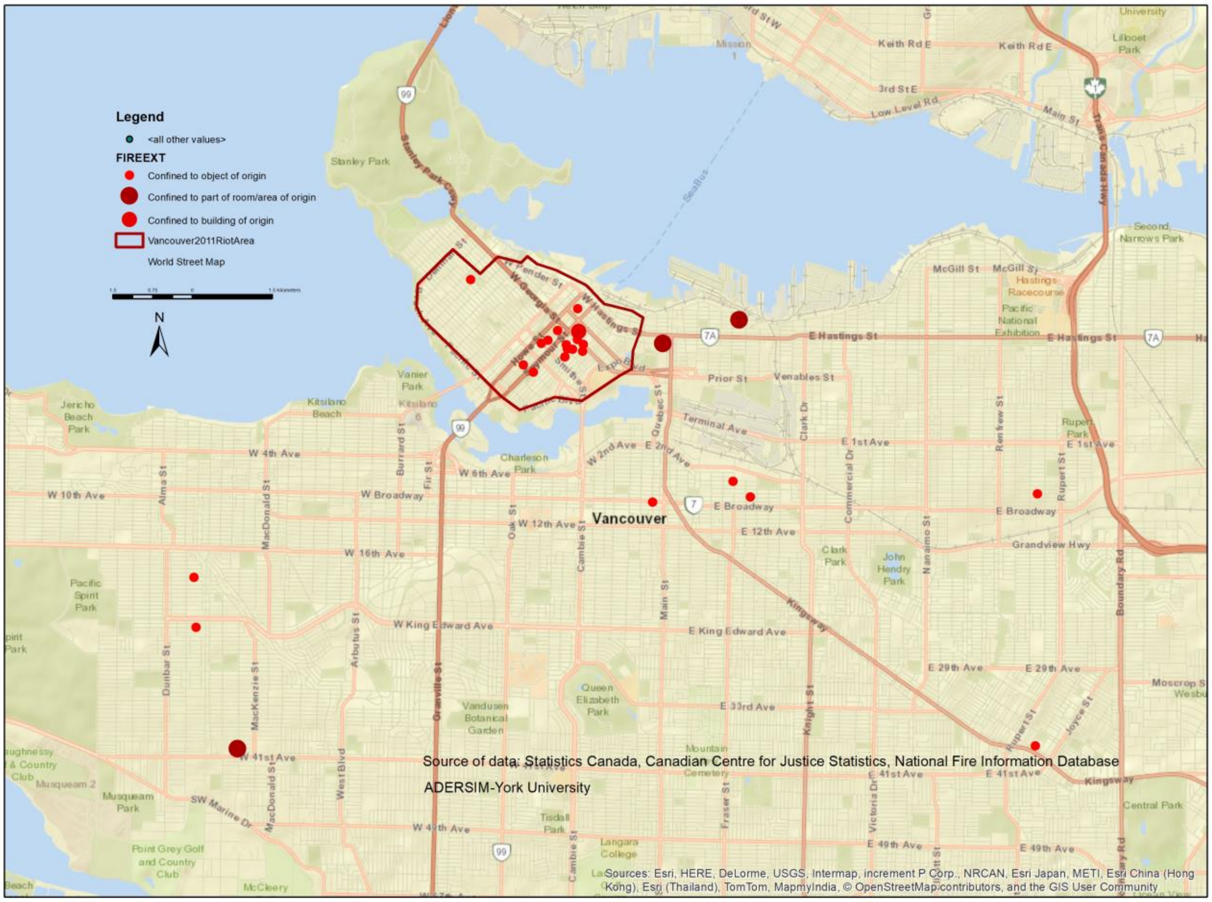
Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 7.14A PERCENTAGE OF FIRE INCIDENTS BY EXTENT OF FIRE DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 7.14B DISTRIBUTION OF FIRE INCIDENTS BY EXTENT OF FIRE DURING THE 2011 VANCOUVER RIOT



Note: Only 26 out of 59 fire incidents have been mapped. No postal code provided for other cases.

DISCOVERY OF FIRE AND ACTIONS TAKEN DURING THE VANCOUVER RIOT

Initial Detection

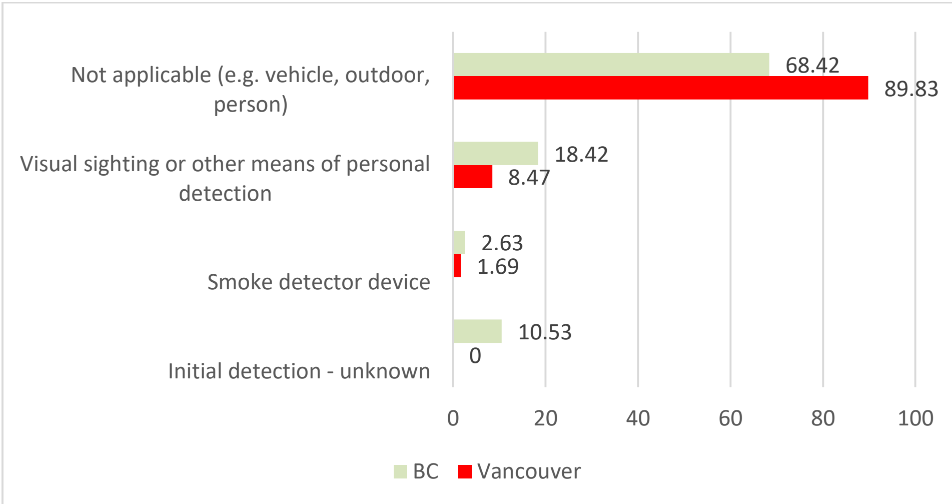
Almost 90% of the fire incidents in the riot dataset (Table 7.15 and Figure 7.15) relates to the "*Not applicable (e.g. vehicle, outdoor, person)*" and this makes it difficult to make a conclusive analysis, but this confirms the previous findings that during the riot most of the fire incidents occurred outdoor.

TABLE 7.15 FIRE INCIDENTS BY INITIAL DETECTION DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER

Initial detection		Vancouver on June 15-16, 2011		BC except Vancouver	
CODE	**DESCRIPTION**	**INCIDENTS**	**PERCENT**	**INCIDENTS**	**PERCENT**
00	Initial detection - unknown	0	0	4	10.53
02	Smoke detector device	1	1.69	1	2.63
07	Visual sighting or other means of personal detection	5	8.47	7	18.42
88	Not applicable (e.g. vehicle, outdoor, person)	53	89.83	26	68.42
Total		**59**	**100**	**38**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 7.15 PERCENTAGE OF FIRE INCIDENTS BY INITIAL DETECTION DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Action Taken

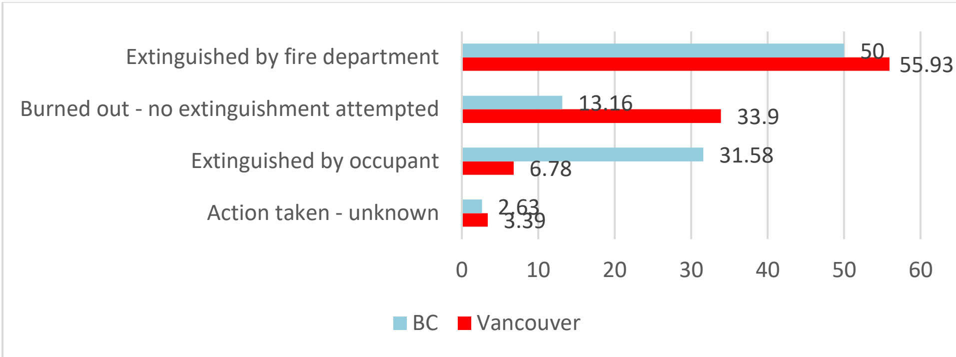
There are considerable differences in the items "*Burned out- no extinguishment attempted*" and "*Extinguished by occupant*" between riot (Vancouver) and non-riot (BC except Vancouver) datasets (Table 7.16 and Figure 7.16). While in Vancouver almost 39% of the fire incidents are burned out (no extinguishment attempted), this number for BC is 13%. Moreover, while 31% of the fire incidents are extinguished by occupants in the non-riot dataset, this number in Vancouver is almost 7%.

TABLE 7.16 FIRE INCIDENTS BY ACTION TAKEN DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER

Action taken		Vancouver on June 15-16, 2011		BC except Vancouver	
CODE	**DESCRIPTION**	**INCIDENTS**	**PERCENT**	**INCIDENTS**	**PERCENT**
0	Action taken - unknown	2	3.39	1	2.63
1	Extinguished by occupant	4	6.78	12	31.58
2	Burned out - no extinguishment attempted	20	33.90	5	13.16
3	Extinguished by fire department	33	55.93	19	50.00
Total		**59**	**100**	**38**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 7.16 PERCENTAGE OF FIRE INCIDENTS BY ACTION TAKEN DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Method of Fire Control and Extinguishment

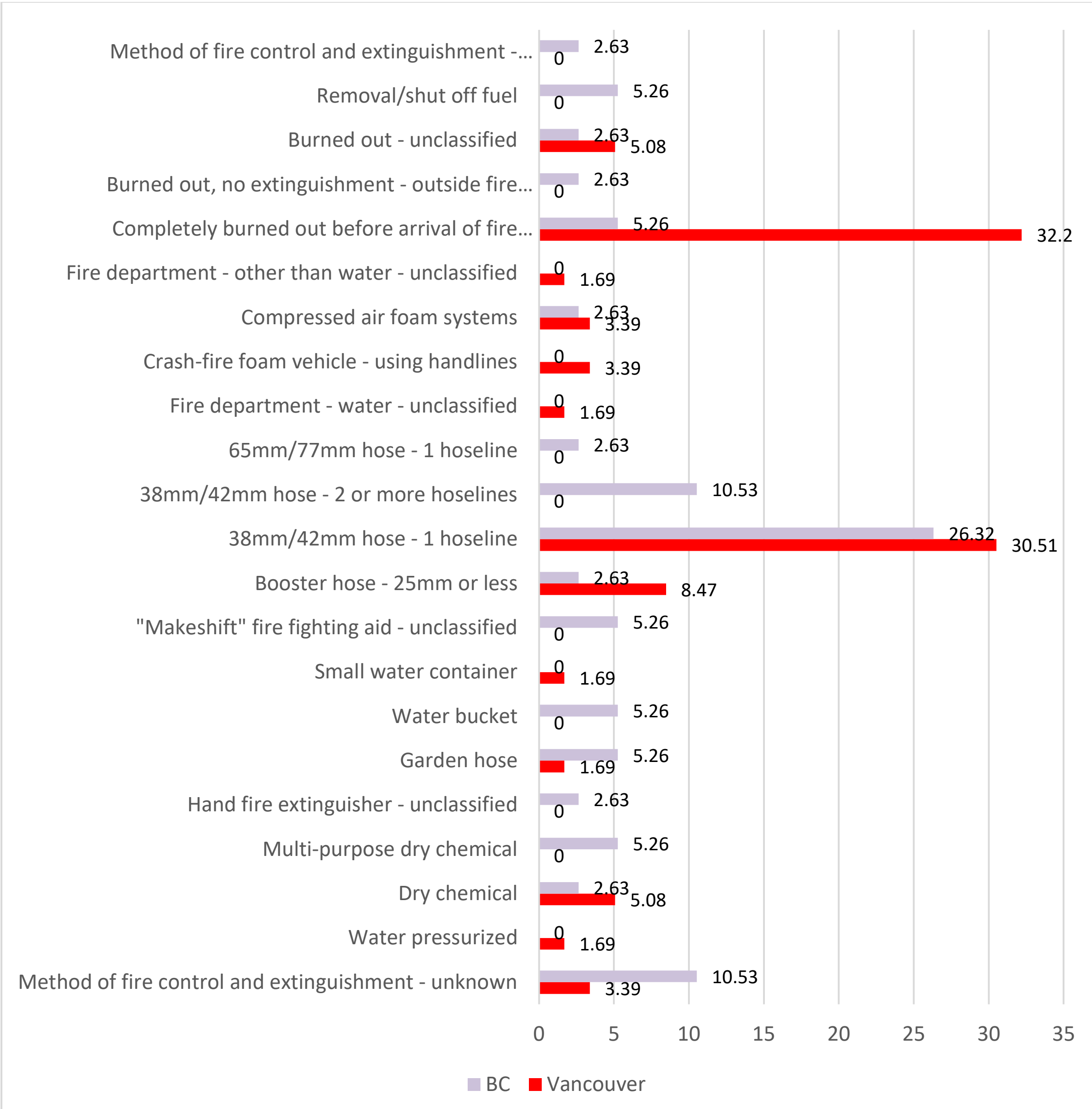
There is a considerable difference between riot (Vancouver) and non-riot (BC except Vancouver) datasets when comparing "*Completely burned out before arrival of fire department*" (Table 7.17 and Figure 7.17). While in Vancouver almost 32% of fire incidents are completely burned out before the arrival of fire department, this number for BC is only 5%.

TABLE 7.17 FIRE INCIDENTS BY METHOD OF FIRE CONTROL AND EXTINGUISHMENT DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER

Method of fire control and extinguishment		Vancouver on June 15-16, 2011		BC except Vancouver	
CODE	DESCRIPTION	INCIDENTS	PERCENT	INCIDENTS	PERCENT
00	Method of fire control and extinguishment - unknown	2	3.39	4	10.53
12	Water pressurized	1	1.69	0	0
17	Dry chemical	3	5.08	1	2.63
18	Multi-purpose dry chemical	0	0	2	5.26
19	Hand fire extinguisher - unclassified	0	0	1	2.63
31	Garden hose	1	1.69	2	5.26
32	Water bucket	0	0	2	5.26
33	Small water container	1	1.69	0	0
39	"Makeshift" fire fighting aid - unclassified	0	0	2	5.26
41	Booster hose - 25mm or less	5	8.47	1	2.63
42	38mm/42mm hose - 1 hoseline	18	30.51	10	26.32
43	38mm/42mm hose - 2 or more hoselines	0	0	4	10.53
44	65mm/77mm hose - 1 hoseline	0	0	1	2.63
49	Fire department - water - unclassified	1	1.69	0	0
52	Crash-fire foam vehicle - using handlines	2	3.39	0	0
57	Compressed air foam systems	2	3.39	1	2.63
59	Fire department - other than water - unclassified	1	1.69	0	0
81	Completely burned out before arrival of fire department	19	32.20	2	5.26
83	Burned out, no extinguishment - outside fire protection area	0	0	1	2.63
89	Burned out - unclassified	3	5.08	1	2.63
95	Removal/shut off fuel	0	0	2	5.26
99	Method of fire control and extinguishment - unclassified	0	0	1	2.63
Total		59	100	38	100

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 7.17 PERCENTAGE OF FIRE INCIDENTS BY METHOD OF FIRE CONTROL AND EXTINGUISHMENT DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Performance of Smoke Alarm Device

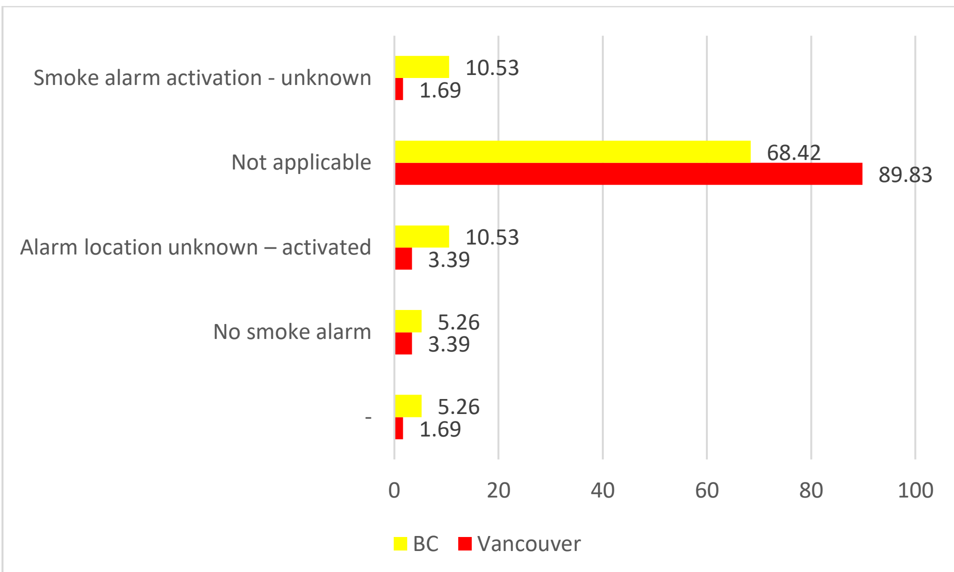
For most of the fire incidents in both datasets (riot and non-riot datasets) this variable is not applicable. So, drawing any robust conclusion is not possible here. The category "*Not applicable*" - meaning that smoke alarm devices are not relevant to fire incidents- for the Vancouver dataset is almost 90% and for the BC (except Vancouver) dataset is 68%. However, reviewing other items including "*smoke alarm activation-unknown*" and "*alarm location unknown- activated*" demonstrate that the amount for non-riot dataset (BC) is noticeably higher than the riot (Vancouver) dataset (Table 7.18 and Figure 7.18).

TABLE 7.18 FREQUENCY AND PERCENTAGE OF FIRE INCIDENTS BY PERFORMANCE OF SMOKE ALARM DEVICE DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER

Performance of smoke alarm device		Vancouver on June 15-16, 2011		BC except Vancouver	
CODE	DESCRIPTION	INCIDENTS	PERCENT	INCIDENTS	PERCENT
-	-	1	1.69	2	5.26
00	No smoke alarm	2	3.39	2	5.26
50	Alarm location unknown – activated	2	3.39	4	10.53
88	Not applicable	53	89.83	26	68.42
99	Smoke alarm activation - unknown	1	1.69	4	10.53
Total		59	100	38	100

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 7.18 PERCENTAGE OF FIRE INCIDENTS BY PERFORMANCE OF SMOKE ALARM DEVICE DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Impact of Smoke Alarm Activation on Occupant Response/Evacuation

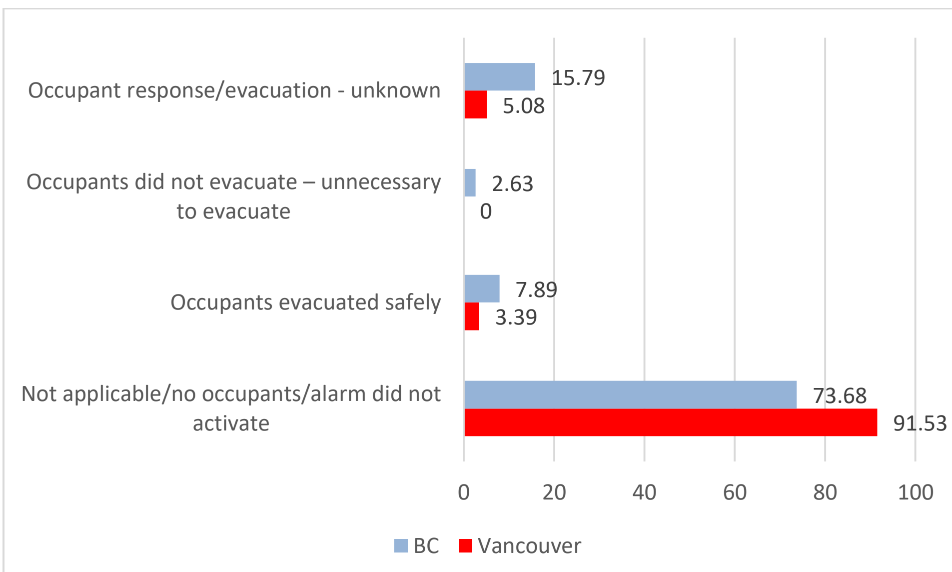
For most of the fire incidents in both datasets (riot and non-riot datasets) this variable is not applicable. So, drawing any concrete conclusion is not possible. The amount of item "*Not applicable/no occupants/alarm did not activate*" for the Vancouver dataset it is more than 91% and for the BC (except Vancouver) dataset it is 73%. However, the amount of item "*occupant response/evacuation*" for the non-riot dataset is almost three times more than the riot dataset (15% versus 5%). This confirms the previous findings that during the riot, most of the fire incidents occurred in open spaces and out of buildings (Table 7.19 and Figure 7.19).

TABLE 7.19 INCIDENTS BY IMPACT OF SMOKE ALARM ACTIVATION ON OCCUPANT RESPONSE/ EVACUATION DURING THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER

Impact of smoke alarm activation on occupant response/ evacuation		Vancouver on June 15-16, 2011		BC except Vancouver	
CODE	DESCRIPTION	INCIDENTS	PERCENT	INCIDENTS	PERCENT
00	Not applicable/no occupants/alarm did not activate	54	91.53	28	73.68
01	Occupants evacuated safely	2	3.39	3	7.89
05	Occupants did not evacuate – unnecessary to evacuate	0	0	1	2.63
99	Occupant response/evacuation - unknown	3	5.08	6	15.79
Total		59	100	38	100

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 7.19 PERCENTAGE OF FIRE INCIDENTS BY IMPACT OF SMOKE ALARM ACTIVATION ON OCCUPANT RESPONSE/ EVACUATION THE 2011 VANCOUVER RIOT AND BC WITHOUT VANCOUVER



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

CONCLUSION

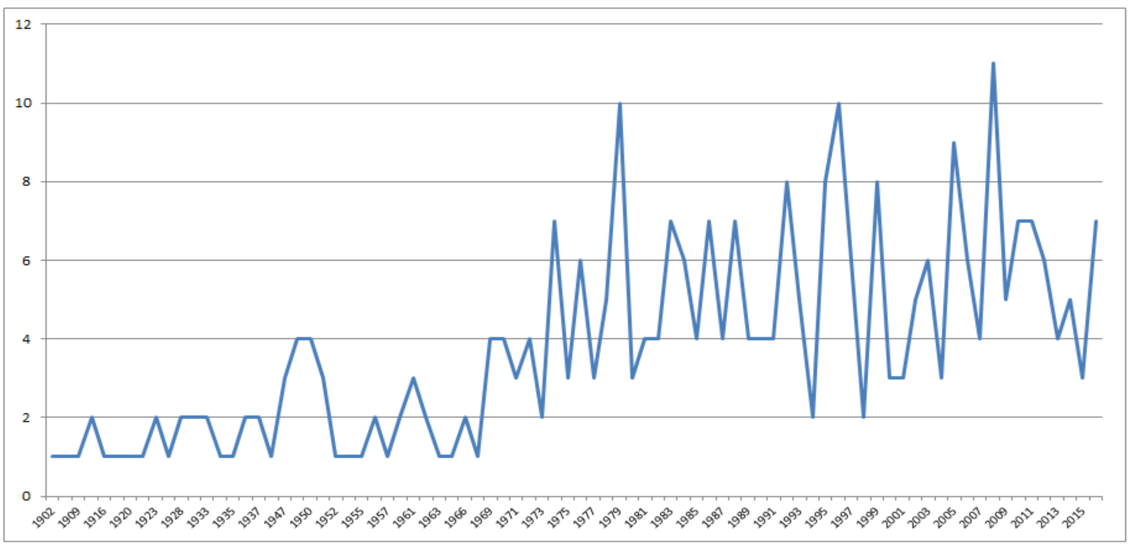
While riots are not common in Canada, historically there have been a few sport-related riots in several cities across the country. The Vancouver Riot, which occurred in June 15, 2011 was the latest major riot to occur in Canada. The statistics in this report showed that due to the riot there was an increase in outdoor fire incidents. Most of the materials used to ignite the fire incidents were garage, trash and rubbish supporting that the increase of fire incidents were because the spectators of the hockey game were setting fire to whatever was available or could be found in the streets. Also supporting this evidence, is the fact that most areas, during the riot, were fire incidents were reported involved vehicles. It was twice as likely for fire incidents to occur near vehicles during the riot days then during normal days, thus confirming again that most of the fire incidents, during the riot occurred outside, near vehicles with the use of trash and rubbish.

8 FIRE INCIDENTS DURING THE SOUTHERN ALBERTA FLOOD

INTRODUCTION AND BACKGROUND

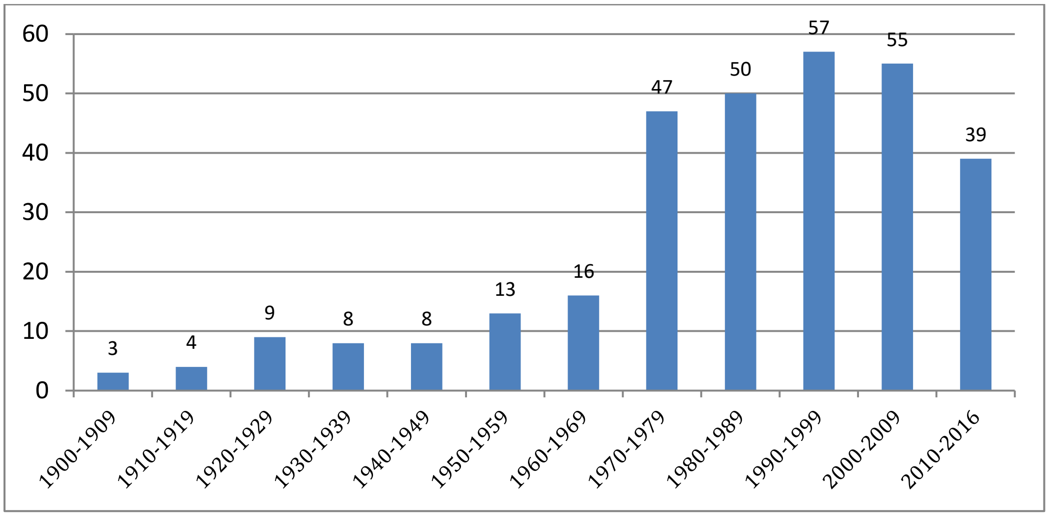
Flooding is one of the most frequent and costliest disaster events in Canada. Overall the number of flood events has increased during the past few decades (Figure 8.1A and Figure 8.1B). There are 309 case of flooding events recorded in the Canadian Disaster Database from 1900-2017. Since 1970, Canada has experienced about 5 major flooding events each year or close to 50 events per decade. Flooding can be generated by different natural processes such as snowmelt runoff, intense rainfall (flash flooding), ice jams that develop during ice formation or breakup, failure of natural dams, and coastal flooding (from storm surges), hurricanes and tsunamis (Buttle et al. 2016). Human activity, in form of development without flood management measures can also generate flooding.

FIGURE 8.1A NUMBER OF FLOODING EVENTS IN CANADA 1900 TO 2016



Source of data: Canadian Disaster Database

FIGURE 8.1B NUMBER OF FLOODING EVENTS IN CANADA PER DECADES



Source of data: Canadian Disaster Database

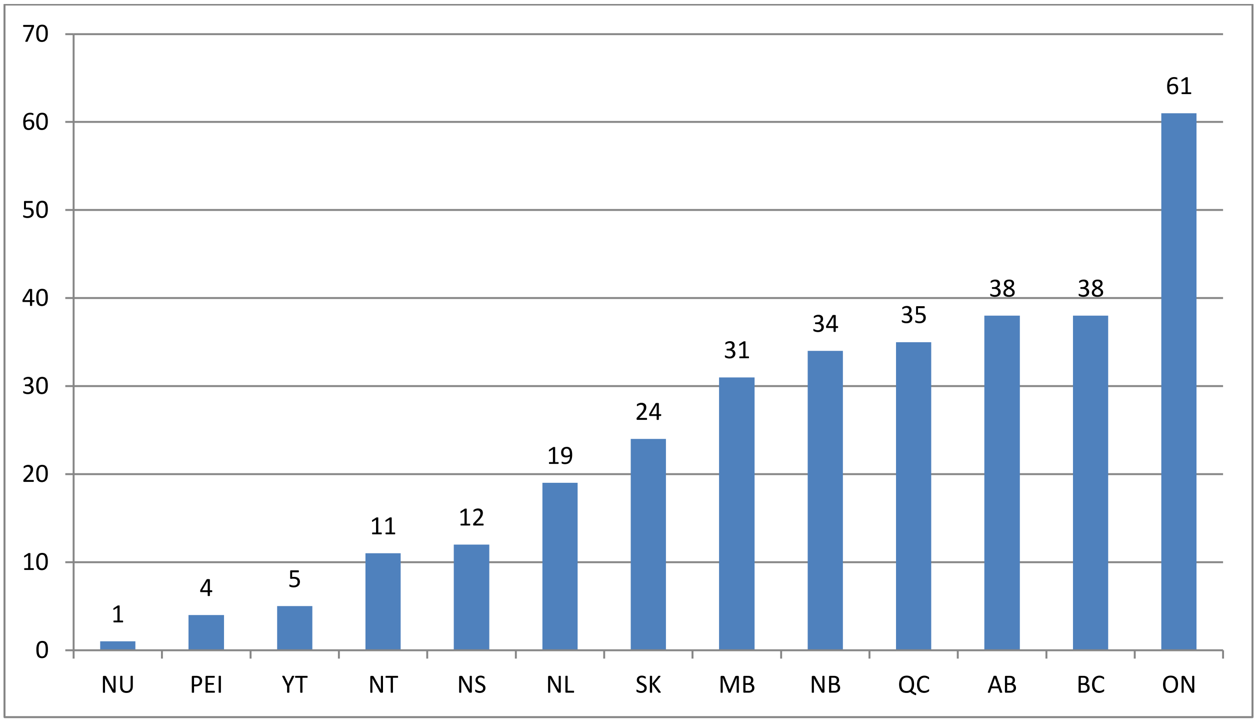
Ontario has had the highest number of flooding disasters, with 61 recorded flooding events (19.5 %) in Canada followed by British Colombia and Alberta each with 38 events (Table 8.1 and Figure 8.2).

TABLE 8.1 NUMBER OF FLOOD DISASTERS IN CANADA BY PROVINCE FROM 1900-2016

Jurisdictions	Number of Flood Disasters	Percent
AB	**38**	**12.1**
BC	**38**	**12.1**
MB	**31**	**9.9**
NB	**34**	**10.9**
NL	19	6.1
NS	12	3.8
NT	11	3.5
NU	1	0.3
ON	**61**	**19.5**
PEI	4	1.3
QC	35	11.2
SK	**24**	**7.7**
YT	5	1.6
Total	313	100

Source of data: Canadian Disaster Database

FIGURE 8.2 NUMBER OF FLOODING EVENTS IN CANADA PER DECADES



Source of data: Canadian Disaster Database

Note. The total number is 313 because flood events that have happened in more than one province have been recorded as one event for each province.

The processes that generate flooding events vary in terms of both time and space in Canada and thus the possibility of having flooding somewhere in Canada at any time of the year exist. While snowmelt-driven floods are more common in the spring and early summer, flash floods usually happen in the summer. Flood disasters have human and economic impacts for Canadians. During the twentieth century flood events killed more than 200 individuals and caused more than CAD $2 billion in damage (Buttle et al., 2016). On average more than 1333 people have been evacuated or displaced during all the flooding events in Canada for which the evacuation numbers are available.

SOUTHERN ALBERTA FLOOD

"In June 2013, excessive rainfall associated with an intense weather system triggered severe flooding in southern Alberta, which became the costliest natural disaster in Canadian history" (Liu et al., 2016). According to Milrad et al. (2015), "this flood was caused in part by unusual meteorological and hydrological precursor events, including large spring snowmelt in the foothills of the Canadian Rockies and heavy antecedent precipitation in May and early June. The tipping point was an extreme rainfall event on 19–21 June" (Milrad, et al., 2015).

It impacted many communities in Southern Alberta and forced 29 of them to declare a state of emergency and a large number of people had to be evacuated. No other flooding event in Alberta had created close to 100,000 evacuees. In Calgary alone, more than 75,000 residents were evacuated. Overall, this flood had four fatalities. Many lifeline facilities and critical infrastructures such as power, telecommunications, water, and transportation corridors (including a section of the Trans-Canada Highway) were heavily disrupted and damaged. A significant number of businesses particularly in downtown Calgary were flooded. The Southern Alberta flooding, with more than CAD $1.2 billion insured losses, is among the costliest disasters in Canada (Canadian Disaster Database, 2017). Total damage losses were estimated at 2013-adjusted CAD $5–$6 billion (Milrad, et al., 2015).

Fire incidents are not expected to happen as the direct result of flooding; however there were a large number of secondary hazards associated with flooding events such as power outages, vehicle accidents, release of hazardous materials, etc. that may have caused fire incidents. This chapter examines the fire incidents that occurred during the Southern Alberta flooding event in June and July 2013. In doing so, all fire incidents that occurred between June 19 and July 12, 2013 in Southern Alberta communities have been classified as fire incidents during this event. Comparisons between these events are made with the fire incidents that occurred during the same period in 2014.

FIRE INCIDENTS DURING THE SOUTHERN ALBERTA FLOODING

Table 8.1 shows the number and percent of fire incidents in Southern Alberta for the study period (June 19-July 12, 2013, 2014). Overall 121 fire incidents were reported during the flood year (2013) and 127 incidents in the 2014 which was not the flood year. There is a slight increase in the number of incidents in the non-flood year than the flood year.

TABLE 8.2 NUMBER OF FIRE INCIDENTS DURING THE SOUTHERN ALBERTA FLOOD DAYS AND SIMILAR DAYS IN 2014

MONTH	2013		2014	
	INCIDENTS	PERCENT	INCIDENTS	PERCENT
June	62	51.2	63	49.6
July	59	48.8	64	50.4
Total	121	100	127	100

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

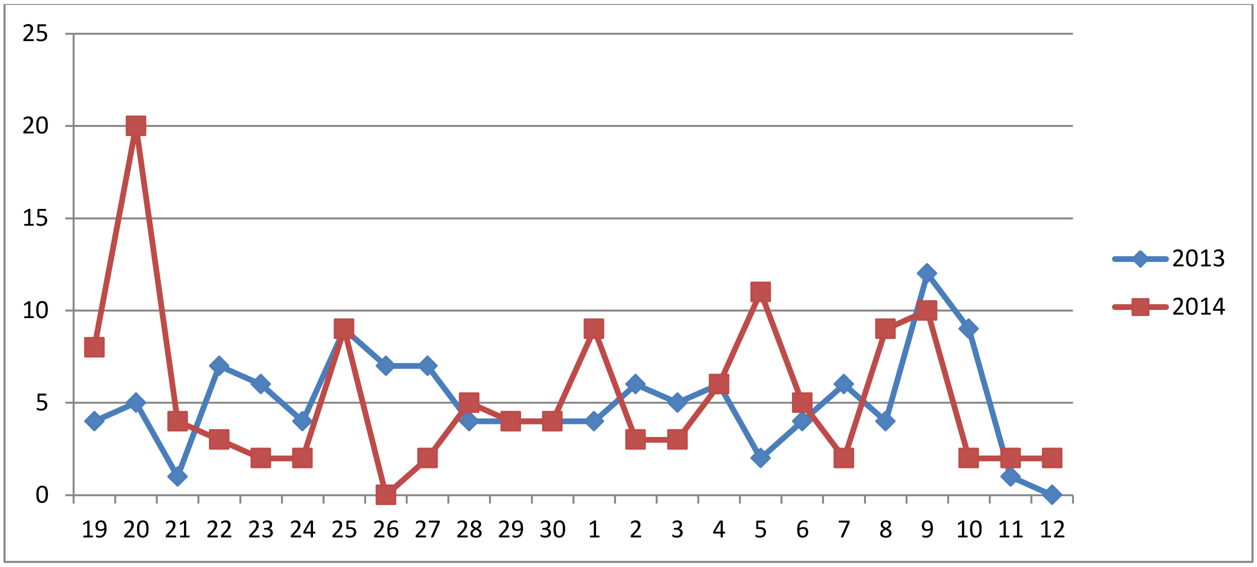
TABLE 8.3 NUMBER OF FIRE INCIDENTS DURING THE SOUTHERN ALBERTA FLOOD DAYS AND SIMILAR DAYS IN 2014

DATE	2013		2014	
	INCIDENTS	PERCENT	INCIDENTS	PERCENT
19 June	4	3.3	8	6.3
20 June	5	4.1	20	15.7
21 June	1	0.8	4	3.1
22 June	7	5.8	3	2.4
23 June	6	5	2	1.6
24 June	4	3.3	2	1.6
25 June	9	7.4	9	7.1
26 June	7	5.8	0	0
27 June	7	5.8	2	1.6
28 June	4	3.3	5	3.9
29 June	4	3.3	4	3.1
30 June	4	3.3	4	3.1
1 July	4	3.3	9	7.1
2 July	6	5	3	2.4
3 July	5	4.1	3	2.4
4 July	6	5	6	4.7
5 July	2	1.7	11	8.7
6 July	4	3.3	5	3.9
7 July	6	5	2	1.6
8 July	4	3.3	9	7.1
9 July	12	9.9	10	7.9
10 July	9	7.4	2	1.6
11 July	1	0.8	2	1.6
12 July	0	0	2	1.6
Total	121	100	127	100

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Table 8.3 and Figure 8.3 show the variations in fire incidents during different days. Other than a peek in June 20, 2014, for the most part the numbers of fire incidents are at the same range in both datasets suggesting no major impact on fire incidents from the flooding event. This will be further investigated in this chapter.

TABLE 8.3 NUMBER OF FIRE INCIDENTS DURING THE SOUTHERN ALBERTA FLOOD DAYS AND SIMILAR DAYS IN 2014



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

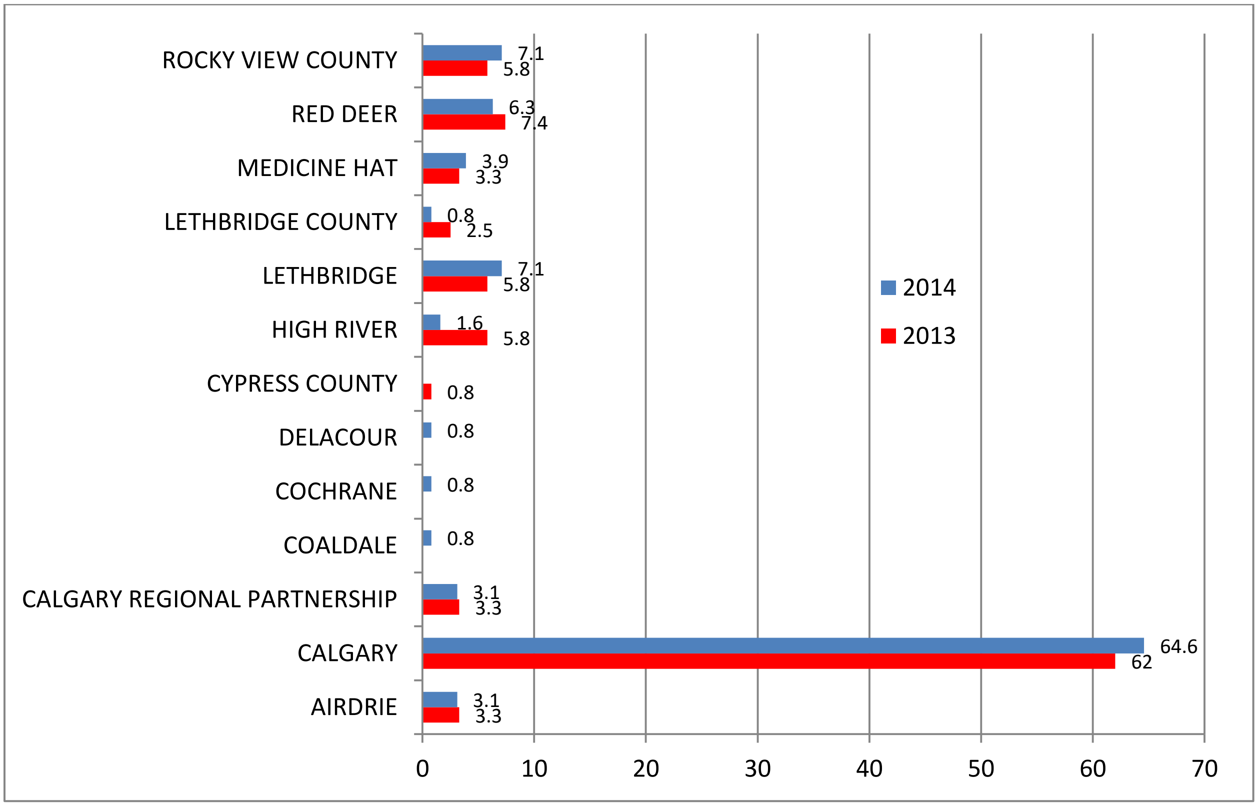
Table 8.4 and Figure 8.4A and 8.4B show the number of fire incidents in different communities in Southern Alberta for flood days in 2013 and non-flood days in 2014. About 62 % of all fire incidents in the 2013 dataset belong to the City of Calgary. While the overall number of incidents are not too high for smaller communities, majority of them show more incidents in 2013 compared to 2014.

TABLE 8.4 FIRE INCIDENTS IN SOUTHERN ALBERTA FROM JUNE 19-JULY 12 BY LOCATION

LOCATION	2013		2014	
	INCIDENTS	PERENT	INCIDENTS	PERENT
AIRDRIE	4	3.3	4	3.1
CALGARY	75	62	82	64.6
CALGARY REGIONAL PARTNERSHIP	4	3.3	4	3.1
COALDALE	0	0	1	0.8
COCHRANE	0	0	1	0.8
DELACOUR	0	0	1	0.8
CYPRESS COUNTY	1	0.8		
HIGH RIVER	7	5.8	2	1.6
LETHBRIDGE	7	5.8	9	7.1
LETHBRIDGE COUNTY	3	2.5	1	0.8
MEDICINE HAT	4	3.3	5	3.9
RED DEER	9	7.4	8	6.3
ROCKY VIEW COUNTY	7	5.8	9	7.1
Total	121	100	127	100

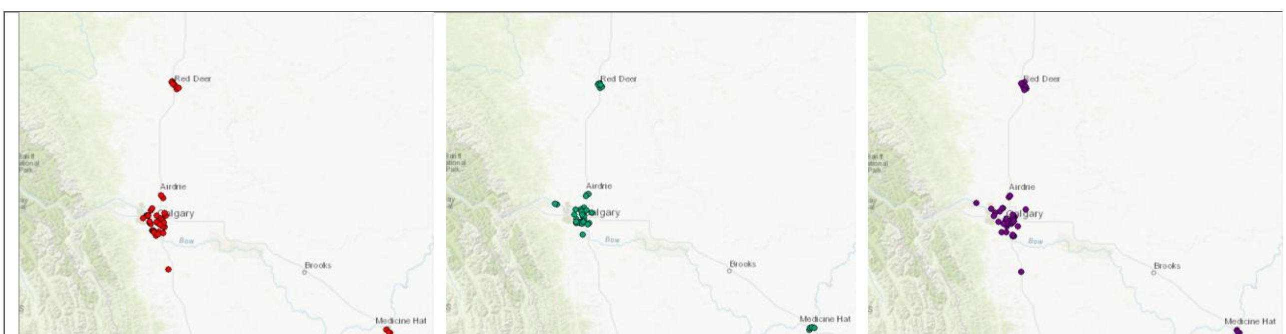
Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 8.4A FIRE INCIDENTS IN SOUTHERN ALBERTA FROM JUNE 19-JULY 12 BY LOCATION



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 8.4B FIRE INCIDENTS IN SOUTHERN ALBERTA FROM JUNE 19-JULY 12 BY LOCATION



2013	2012	2014

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Note. The above map shows the fire incidents that have had postal codes information only.

FIRE INCIDENTS DURING SOUTHERN ALBERTA FLOOD

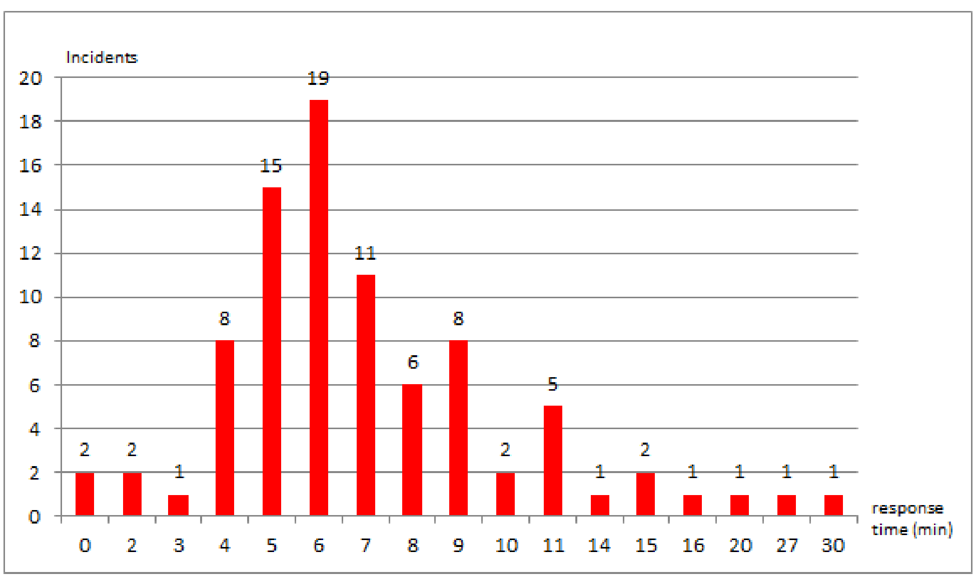
Response time information is available for most fire incidents in Alberta. In this case about 70 percent of the fire incidents included response time information. Response times for those fire incidents during flood days are shown in Figure 8.5. From these figures it appears that the response time has been longer for the fire incidents compared with the fire incidents in comparable days in 2014. While the mean response time for 2013 dataset is 7.41, the mean for 2014 dataset is 8.8. However the mode is 6 for the flood day's fire incidents, but 5 for non-flood days in 2014. Considering that during the flooding events the total number of calls to fire departments increased and the roads were disrupted or become less accessible, the increase in response time is expected. However, our findings do not suggest this. Further analysis is needed to confirm these findings.

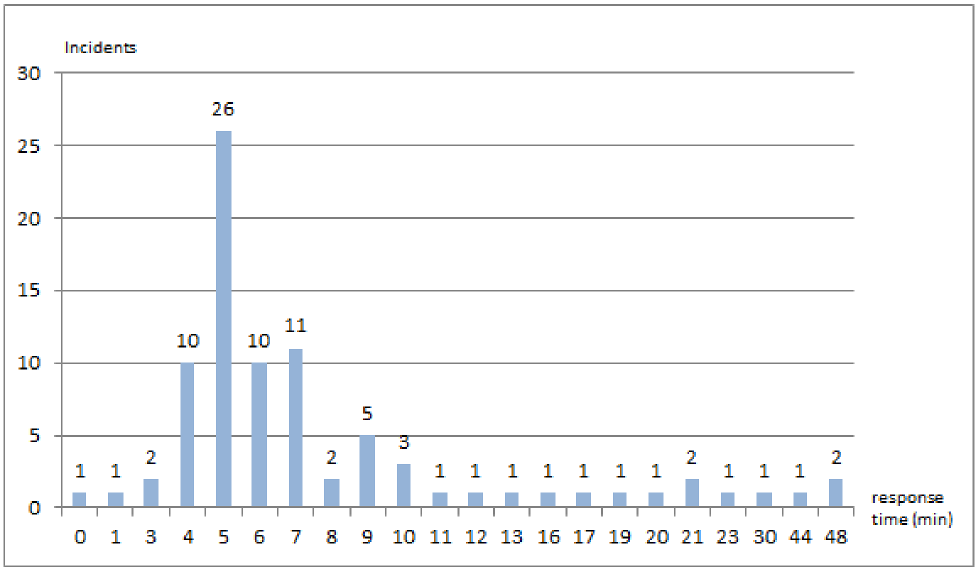
TABLE 8.5 BASIC STATISTICS FOR RESPONSE TIME (MINUTE) FOR FIRE INCIDENTS DURING THE SOUTHERN ALBERTA FLOOD (JUNE 19-JULY 12 2013) AND NORMAL DAYS IN 2014

Statistics	June 19-July 12, 2013	June 19-July 12, 2014
N	86	85
Mean	7.41	8.8
Std. Error of Mean	0.495	0.96
Median	6	6
Mode	6	5
Std. Deviation	4.593	8.846
Variance	21.091	78.257
Range	30	48
Minimum	0	0
Maximum	30	48

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 8.5 RESPONSE TIME (MINUTE) FOR FIRE INCIDENTS DURING THE SOUTHERN ALBERTA FLOOD (JUNE 19-JULY 12 2013) AND NORMAL DAYS IN 2014





Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Mutual Aid

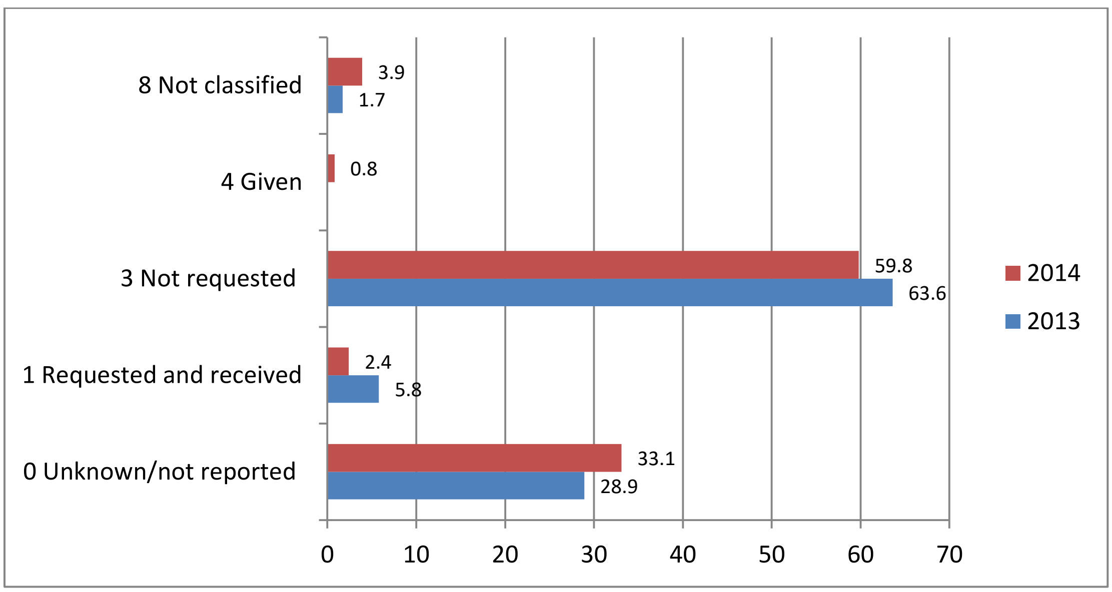
Table 8.6 and Figure 8.6 provide information about the fire incidents in terms of mutual aid usage. Overall not much mutual aid was used, but based on this information 7 fire incidents in 2013 requested and received mutual aid. This number is less than half (3) for fire incidents in similar days for 2014.

TABLE 8.6 USE OF MUTUAL AID IN FIRE INCIDENTS DURING THE SOUTHERN ALBERTA FLOOD 2013

MUTUAL AID		2013		2014	
CODE	DESCRIPTION	INCIDENTS	PERCENT	INCIDENTS	PERCENT
0	Unknown/not reported	35	28.9	42	33.1
1	Requested and received	7	5.8	3	2.4
3	Not requested	77	63.6	76	59.8
4	Given	0	0	1	0.8
8	Not classified	2	1.7	5	3.9
Total		121	100	127	100

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 8.6 USE OF MUTUAL AID IN FIRE INCIDENTS DURING THE SOUTHERN ALBERTA FLOOD 2013



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Death and Injuries of Fire Incidents

Overall one person was killed in the fire incidents during the southern Alberta flood days. This figure is 5 for the 2014 dataset. The number of Injured persons was one for each group of data.

PROPERTY AND FIRE INCIDENTS DURING THE SOUTHERN ALBERTA FLOOD

Major Occupancy Group

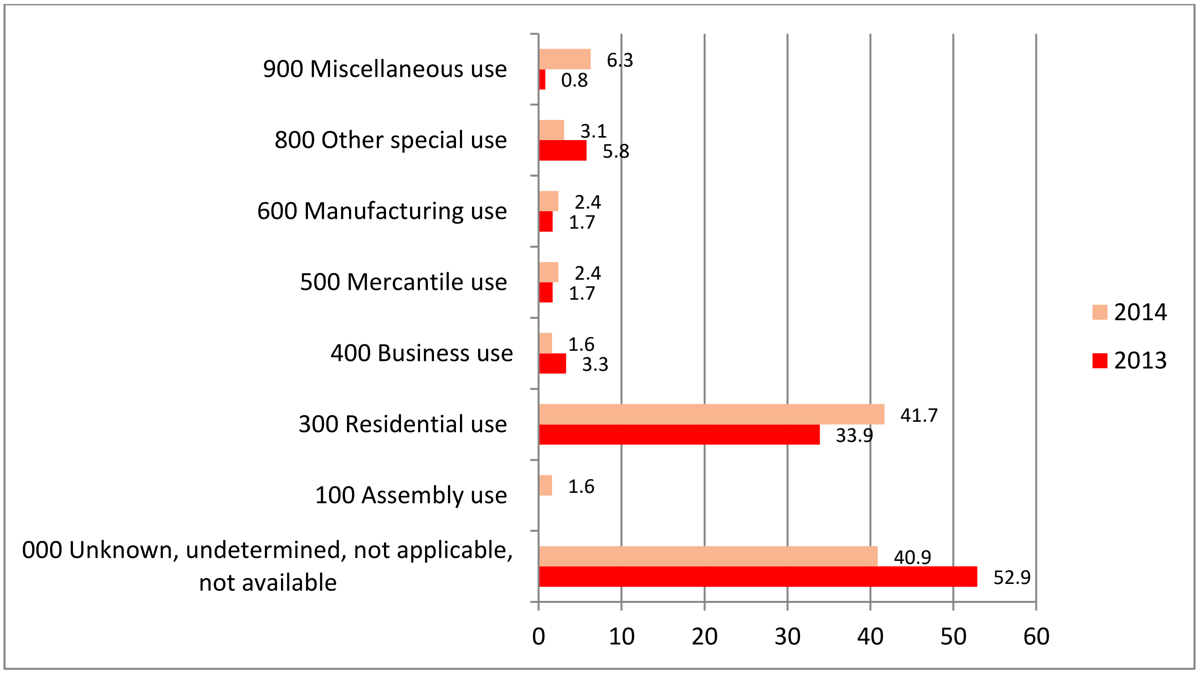
No major difference is observed in terms of the occupancy of properties for fire incidents during the flood days and non-flood days (Table 8.7 and Figure 8.7). However, it appears that during the flood days, the percent of residential fires have been less than during the flood days (33.9 %) compared to the non-flood days (41.7 %).

TABLE 8.7 FIRE INCIDENTS BY MAJOR OCCUPANCY GROUP DURING THE SOUTHERN ALBERTA FLOOD

MAJOR OCCUPANCY GROUP		2013		2014	
CODE	DESCRIPTION	INCIDENTS	PERCENT	INCIDENTS	PERCENT
0000	Unknown, undetermined, not applicable, not available	64	52.9	52	40.9
100	Assembly use			2	1.6
300	Residential use	41	33.9	53	41.7
400	Business use	4	3.3	2	1.6
500	Mercantile use	2	1.7	3	2.4
600	Manufacturing use	2	1.7	3	2.4
800	Other special use	7	5.8	4	3.1
900	Miscellaneous use	1	0.8	8	6.3
Total		**121**	**100**	**127**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 8.7 FIRE INCIDENTS BY MAJOR OCCUPANCY GROUP DURING THE SOUTHERN ALBERTA FLOOD



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Property Class Group

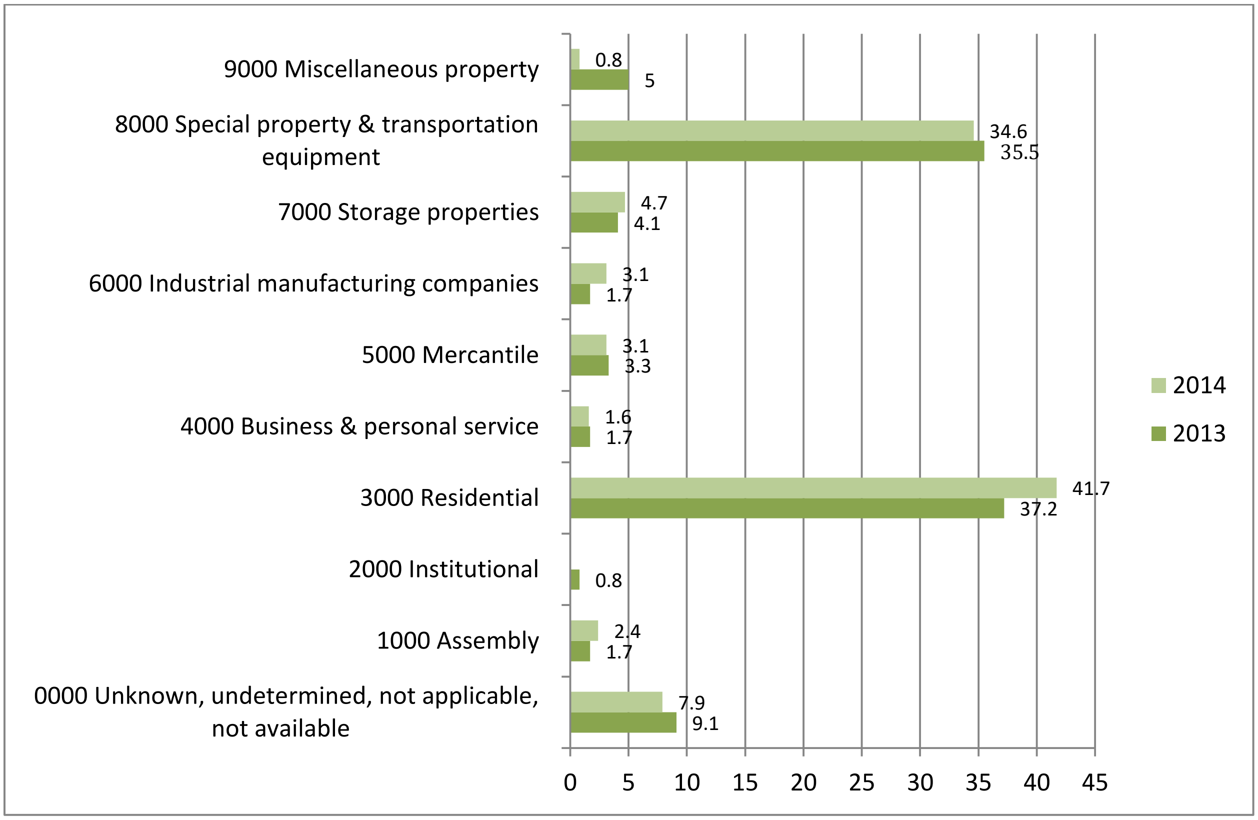
No major difference is observed in terms of property class group for fire incidents during the flood days and non-flood days (Table 8.8 and Figure 8.8). However, it appears that during the flood days the percent of residential fires was less during the flood days (37.2 %) compared with the non-flood days (41.7 %).

FIGURE 8.8 FIRE INCIDENTS BY PROPERTY CLASS GROUP DURING THE SOUTHERN ALBERTA FLOOD

	PROPERTY CLASSIFICATION GROUP	2013		2014	
CODE	**DESCRIPTION**	**INCIDENTS**	**PERCENT**	**INCIDENTS**	**PERCENT**
0000	Unknown, undetermined, not applicable, not available	11	9.1	10	7.9
1000	Assembly	2	1.7	3	2.4
2000	Institutional	1	0.8		
3000	Residential	45	37.2	53	41.7
4000	Business & personal service	2	1.7	2	1.6
5000	Mercantile	4	3.3	4	3.1
6000	Industrial manufacturing companies	2	1.7	4	3.1
7000	Storage properties	5	4.1	6	4.7
8000	Special property & transportation equipment	43	35.5	44	34.6
9000	Miscellaneous property	6	5	1	0.8
Total		**121**	**100**	**127**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 8.8 FIRE INCIDENTS BY PROPERTY CLASS GROUP DURING THE SOUTHERN ALBERTA FLOOD



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Building Height

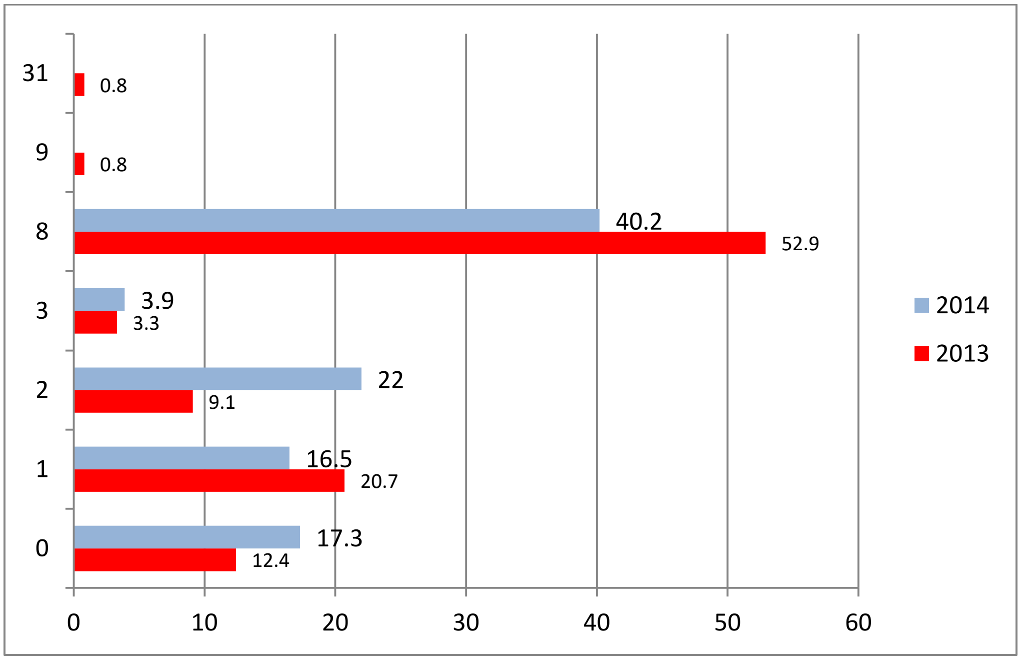
It appears that more fire incidents have been reported for higher buildings during the flood event (Table 8.9 and Figure 8.9). While it is hard to draw a conclusion from these numbers, the fact that downtown Calgary has a higher proportion of multi-story buildings may explain some of these differences.

TABLE 8.9 FIRE INCIDENTS BY PROPERTY HEIGHT DURING THE SOUTHERN ALBERTA FLOOD

BUILDING HEIGH (Actual number of stories)	2013		2014	
	INCIDENTS	PERCENT	INCIDENTS	PERCENT
0	15	12.4	22	17.3
1	25	20.7	21	16.5
2	11	9.1	28	22
3	4	3.3	5	3.9
8	64	52.9	51	40.2
9	1	0.8		
31	1	0.8		
Total	121	100	127	100

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 8.9 FIRE INCIDENTS BY PROPERTY HEIGHT DURING THE SOUTHERN ALBERTA FLOOD



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIRE PROTECTION FEATURES

Fire Detection Devices

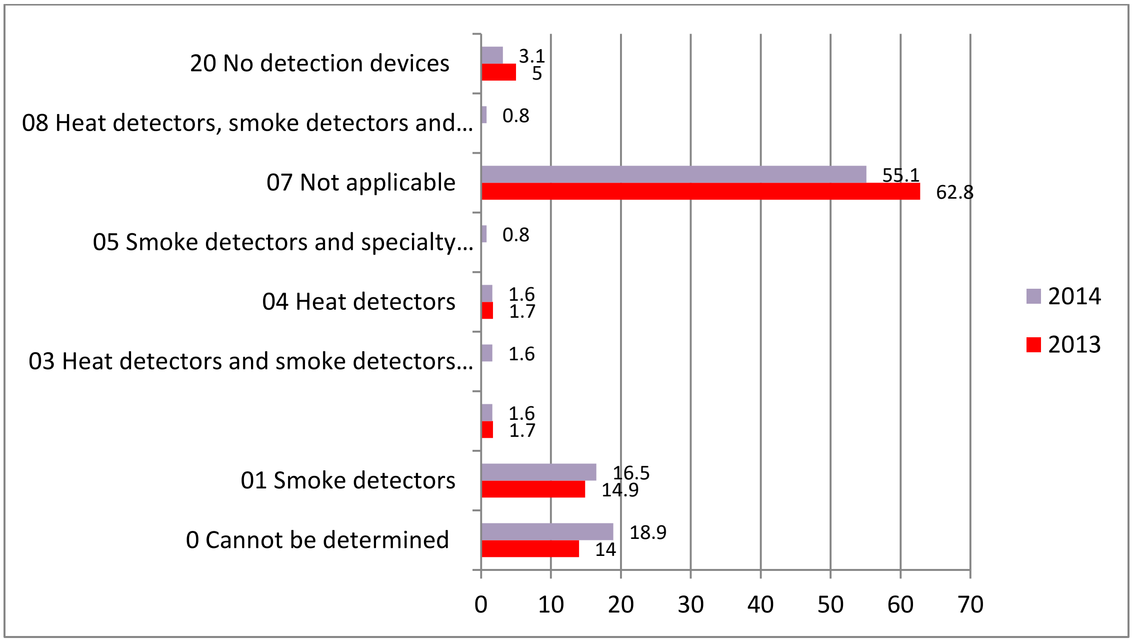
No major difference is observed in terms of fire detection device for fire incidents during the flood days and non-flood days (Table 8.10 and Figure 8.10).

TABLE 8.10 FIRE INCIDENTS BY FIRE DETECTION DEVICE DURING THE SOUTHERN ALBERTA FLOOD

	FIRE DETECTION DEVICES	2013		2014	
CODE	DESCRIPTION	INCIDENTS	PERCENT	INCIDENTS	PERCENT
0	Cannot be determined	17	14	24	18.9
01	Smoke detectors	18	14.9	21	16.5
02	Smoke detectors, heat detectors and smoke detectors in return air ducts	2	1.7	2	1.6
03	Heat detectors and smoke detectors in return air ducts	0	0	2	1.6
04	Heat detectors	2	1.7	2	1.6
05	Smoke detectors and specialty detectors	0	0	1	0.8
07	Not applicable	76	62.8	70	55.1
08	Heat detectors, smoke detectors and specialty detectors	0	0	1	0.8
20	No detection devices	6	5	4	3.1
Total		121	100	127	100

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 8.10 FIRE INCIDENTS BY FIRE DETECTION DEVICE DURING THE SOUTHERN ALBERTA FLOOD



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

CIRCUMSTANCES CONTRIBUTING TO THE OUTBREAK OF FIRE DURING SOUTHERN ALBERTA FLOOD

Igniting Object Group

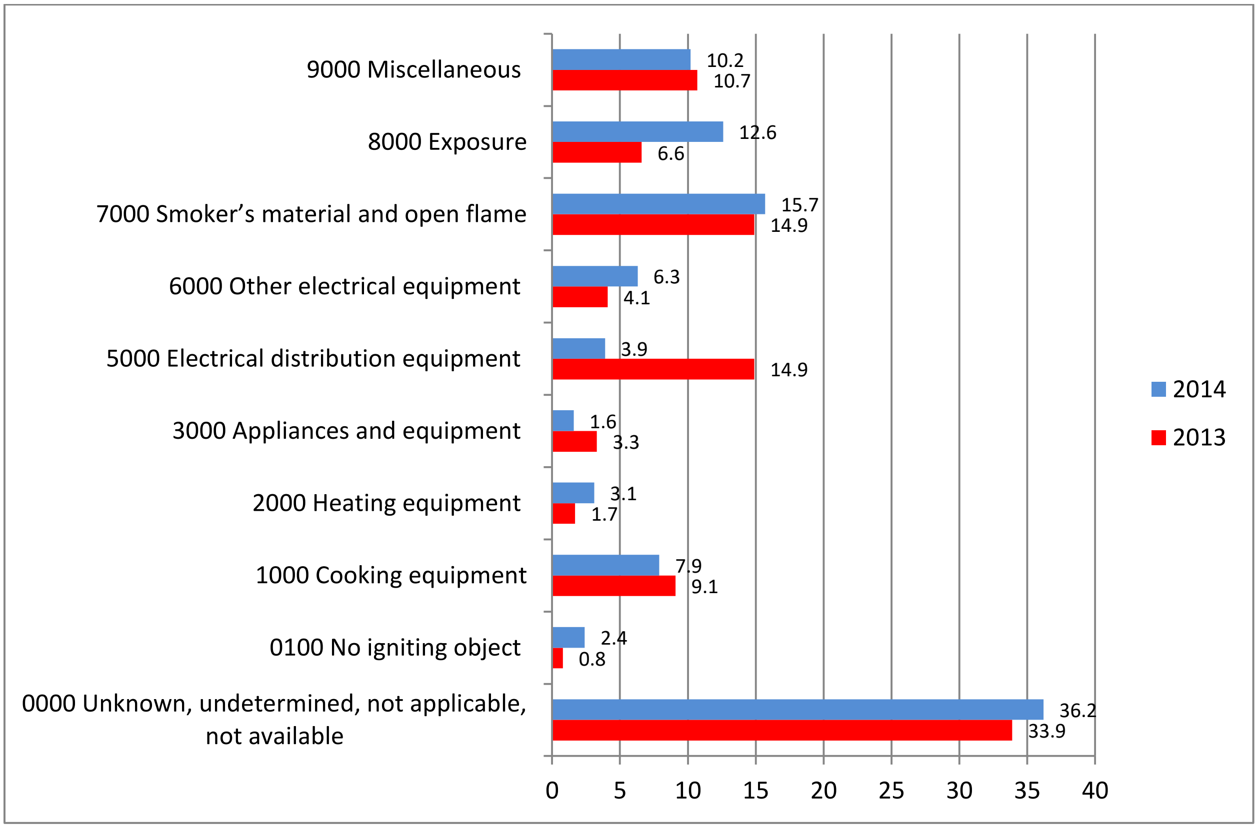
For the most part it seems that the fire incidents in both datasets are similar in terms of igniting object group (Table 8.11 and Figure 8.11). The only significant difference is with electrical distribution equipment. Considering the power outage issues during the flood events the difference can be attribute to flood.

TABLE 8.11 FIRE INCIDENTS BY FIRE DETECTION DEVICE DURING THE SOUTHERN ALBERTA FLOOD

IGNITING OBJECT GROUP		2013		2014	
CODE	**DESCRIPTION**	**INCIDENTS**	**PERCENT**	**INCIDENTS**	**PERCENT**
0000	Unknown, undetermined, not applicable, not available	41	33.9	46	36.2
0100	No igniting object	1	0.8	3	2.4
1000	Cooking equipment	11	9.1	10	7.9
2000	Heating equipment	2	1.7	4	3.1
3000	Appliances and equipment	4	3.3	2	1.6
5000	Electrical distribution equipment	18	14.9	5	3.9
6000	Other electrical equipment	5	4.1	8	6.3
7000	Smoker's material and open flame	18	14.9	20	15.7
8000	Exposure	8	6.6	16	12.6
9000	Miscellaneous	13	10.7	13	10.2
Total		**121**	**100**	**127**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 8.11 FIRE INCIDENTS BY FIRE DETECTION DEVICE DURING THE SOUTHERN ALBERTA FLOOD



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Fuel or Energy Associated with Igniting Object

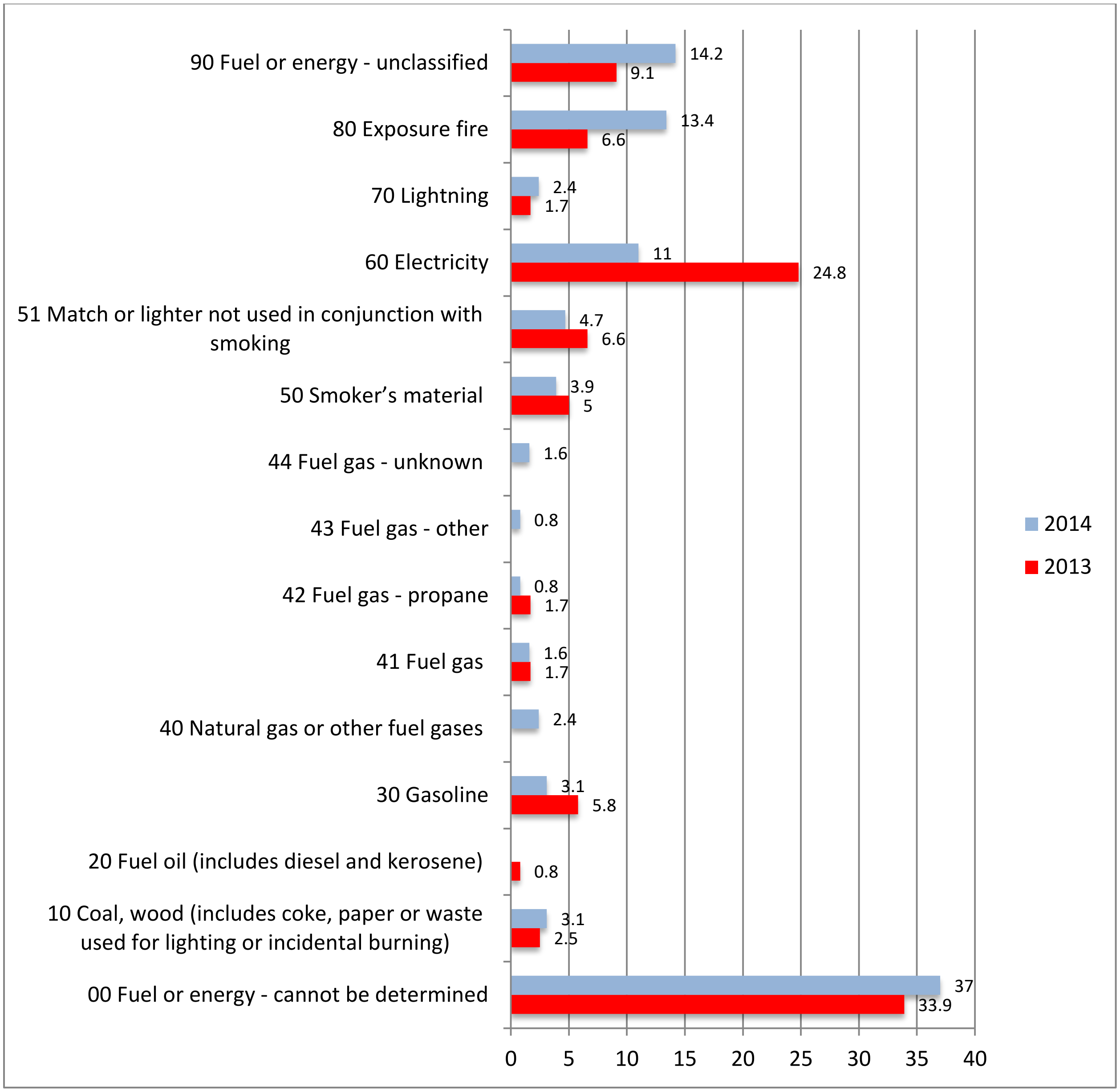
Some differences among the datasets are observed with regard to the fuel or energy associated with igniting an object (Table 8.12 and Figure 8.12). In particular, it is found that "*electricity", "gasoline"*, and "*match and lighter*" have contributed more as fuel or energy for fire incidents during the flood days compared to non-flood days in 2014. For example, while about 24 percent of fire incidents during the flood days have been fueled by "*electricity*", only 11 percent of fire incidents have listed electricity as the fuel or energy associated with the igniting object. On the other hand exposure has had higher impact on fire incidents during the non-flood days.

TABLE 8.12 FIRE INCIDENTS BY FUEL OR ENERGY ASSOCIATED WITH IGNITING OBJECT DURING THE SOUTHERN ALBERTA FLOOD

FUEL OR ENERGY ASSOCIATED WITH IGNITING OBJECT		2013		2014	
CODE	**DESCRIPTION**	**INCIDENTS**	**PERCENT**	**INCIDENTS**	**PERCENT**
00	Fuel or energy - cannot be determined	41	33.9	47	37
10	Coal, wood (includes coke, paper or waste used for lighting or incidental burning)	3	2.5	4	3.1
20	Fuel oil (includes diesel and kerosene)	1	0.8		
30	Gasoline	7	5.8	4	3.1
40	Natural gas or other fuel gases			3	2.4
41	Fuel gas	2	1.7	2	1.6
42	Fuel gas - propane	2	1.7	1	0.8
43	Fuel gas - other			1	0.8
44	Fuel gas - unknown			2	1.6
50	Smoker's material	6	5	5	3.9
51	Match or lighter not used in conjunction with smoking	8	6.6	6	4.7
60	Electricity	30	24.8	14	11
70	Lightning	2	1.7	3	2.4
80	Exposure fire	8	6.6	17	13.4
90	Fuel or energy - unclassified	11	9.1	18	14.2
Total		**121**	**100**	**127**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 8.12 FIRE INCIDENTS BY FUEL OR ENERGY ASSOCIATED WITH IGNITING OBJECT DURING THE SOUTHERN ALBERTA FLOOD



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Material First Ignited

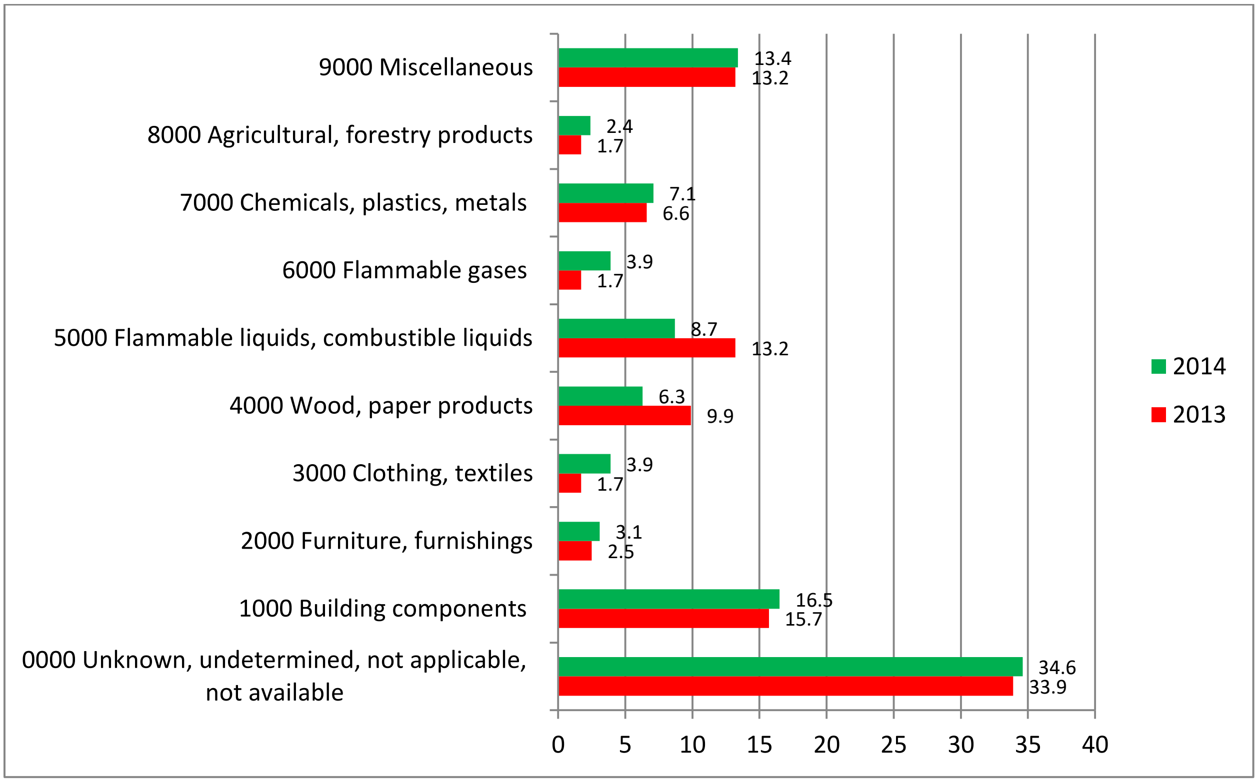
Some differences were observed in the fire incidents in terms of the materials first ignited between the flood and no-flood days (Table 8.13 and Figure 8.13). In particular this data shows that more fire incidents during the flood event were ignited using "*Flammable liquids, combustible liquid*", and "*Wood, paper products*". Further investigations are needed to confirm if the flood event has played a major role in these differences.

TABLE 8.13 FIRE INCIDENTS BY MATERIALS FIRST IGNITED DURING THE SOUTHERN ALBERTA FLOOD

MATERIAL FIRST IGNITED GROUP		2013		2014	
CODE	**DESCRIPTION**	**INCIDENTS**	**PERCENT**	**INCIDENTS**	**PERCENT**
0000	Unknown, undetermined, not applicable, not available	41	33.9	44	34.6
1000	Building components	19	15.7	21	16.5
2000	Furniture, furnishings	3	2.5	4	3.1
3000	Clothing, textiles	2	1.7	5	3.9
4000	Wood, paper products	12	9.9	8	6.3
5000	Flammable liquids, combustible liquids	16	13.2	11	8.7
6000	Flammable gases	2	1.7	5	3.9
7000	Chemicals, plastics, metals	8	6.6	9	7.1
8000	Agricultural, forestry products	2	1.7	3	2.4
9000	Miscellaneous	16	13.2	17	13.4
Total		**121**	**100**	**127**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 8.13 FIRE INCIDENTS BY MATERIALS FIRST IGNITED DURING THE SOUTHERN ALBERTA FLOOD



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Act or Omission

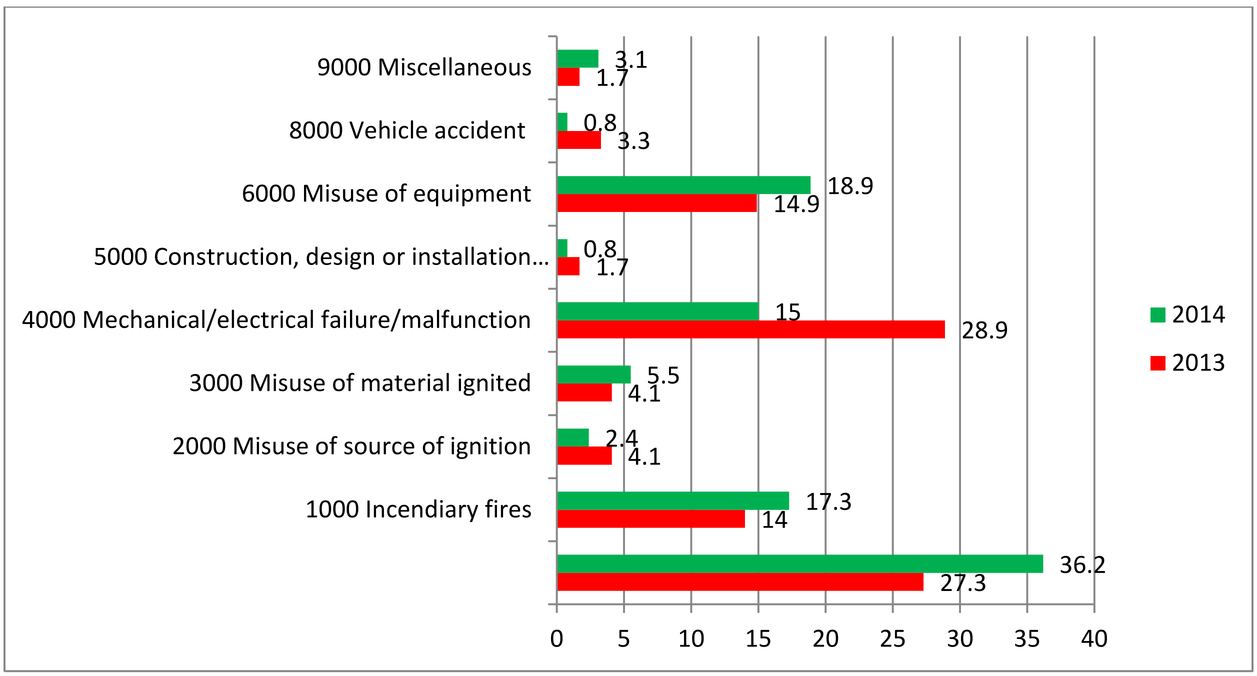
There are some minor and major differences between the fire incidents during the flood days in 2013 with non-flood days in 2014 with regard to act or omission (Table 8.14 and Figure 8.14). In particular, results show that more fire incident have been caused by "*mechanical/electrical failure/malfunction*" during the flood days compared to non-flood days which are consistence with flood conditions in general. Some differences are also observed around "*Vehicle accident*". Data shows that more fire incidents have been caused by vehicle accidents during the flood days. However, since this information is unknown or undetermined for a large portion of the fire incidents, it is not possible to confirm that these differences are necessarily attributed to the flood situations.

TABLE 8.14 FIRE INCIDENTS BY ACT OR OMMISSION GROUP DURING THE SOUTHERN ALBERTA FLOOD

ACT OR OMISSION		2013		2014	
CODE	DESCRIPTION	INCIDENTS	PERCENT	INCIDENTS	PERCENT
0000	Unknown, undetermined, not applicable, not available	33	27.3	46	36.2
1000	Incendiary fires	17	14	22	17.3
2000	Misuse of source of ignition	5	4.1	3	2.4
000	3Misuse of material ignited	5	4.1	7	5.5
4000	Mechanical/electrical failure/malfunction	35	28.9	19	15
5000	Construction, design or installation deficiency	2	1.7	1	0.8
6000	Misuse of equipment	18	14.9	24	18.9
8000	Vehicle accident	4	3.3	1	0.8
9000	Miscellaneous	2	1.7	4	3.1
Total		121	100	127	100

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

TABLE 8.14 FIRE INCIDENTS BY ACT OR OMMISSION DURING THE SOUTHERN ALBERTA FLOOD



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

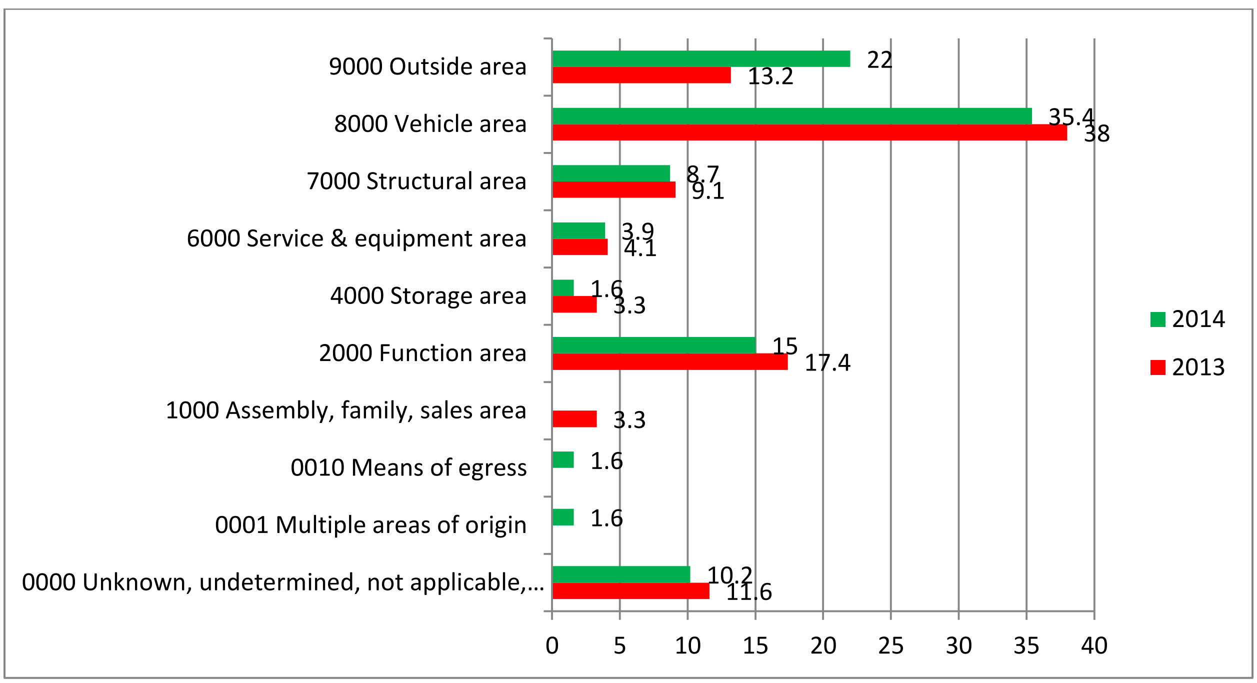
ORIGIN AND SPREAD OF FIRE DURING THE SOUTHERN ALBERTA FLOOD

TABLE 8.15 FIRE INCIDENTS BY ACT OR OMISSION DURING THE SOUTHERN ALBERTA FLOOD

Area of Origin Group		2013		2014	
CODE	**DESCRIPTION**	**INCIDENTS**	**PERCENT**	**INCIDENTS**	**PERCENT**
0000	Unknown, undetermined, not applicable, not available	14	11.6	13	10.2
0001	Multiple areas of origin	0	0	2	1.6
0010	Means of egress	0	0	2	1.6
1000	Assembly, family, sales area	4	3.3		
2000	Function area	21	17.4	19	15
4000	Storage area	4	3.3	2	1.6
6000	Service & equipment area	5	4.1	5	3.9
7000	Structural area	11	9.1	11	8.7
8000	Vehicle area	46	38	45	35.4
9000	Outside area	16	13.2	28	22
Total		**121**	**100**	**127**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 8.15 FIRE INCIDENTS BY ACT OR OMISSION DURING THE SOUTHERN ALBERTA FLOOD



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIRE LOSS DURING THE SOUTHERN ALBERTA FLOOD

Extent of Fire

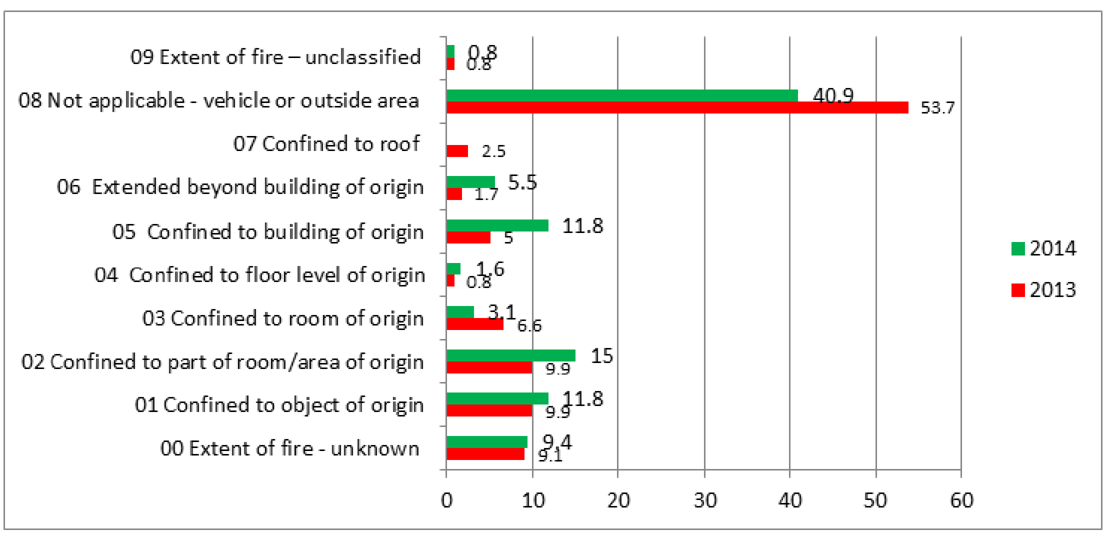
Extent of fire attributes varies in both datasets (Table 8.16 ad Figure 8.16). One major difference is the higher percentage of fire incidents with "*Not applicable - vehicle or outside area*" for the fire incidents during the flood days. This in part explains the lower values for other sections whereby lower values are observed for the fire incidents during the flood days.

TABLE 8.16 FIRE INCIDENTS BY ACT OR OMMISSION DURING THE SOUTHERN ALBERTA FLOOD

EXTENT OF FIRE		2013		2014	
CODE	**DESCRIPTION**	**INCIDENTS**	**PERCENT**	**INCIDENTS**	**PERCENT**
00	Extent of fire - unknown	11	9.1	12	9.4
01	Confined to object of origin	12	9.9	15	11.8
02	Confined to part of room/area of origin	12	9.9	19	15
03	Confined to room of origin	8	6.6	4	3.1
04	Confined to floor level of origin	1	0.8	2	1.6
05	Confined to building of origin	6	5	15	11.8
06	Extended beyond building of origin	2	1.7	7	5.5
07	Confined to roof	3	2.5		
08	Not applicable - vehicle or outside area	65	53.7	52	40.9
09	Extent of fire – unclassified	1	0.8	1	0.8
Total		**121**	**100**	**127**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

TABLE 8.15 FIRE INCIDENTS BY EXTENT OF FIRE DURING THE SOUTHERN ALBERTA FLOOD



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Extent of Damage

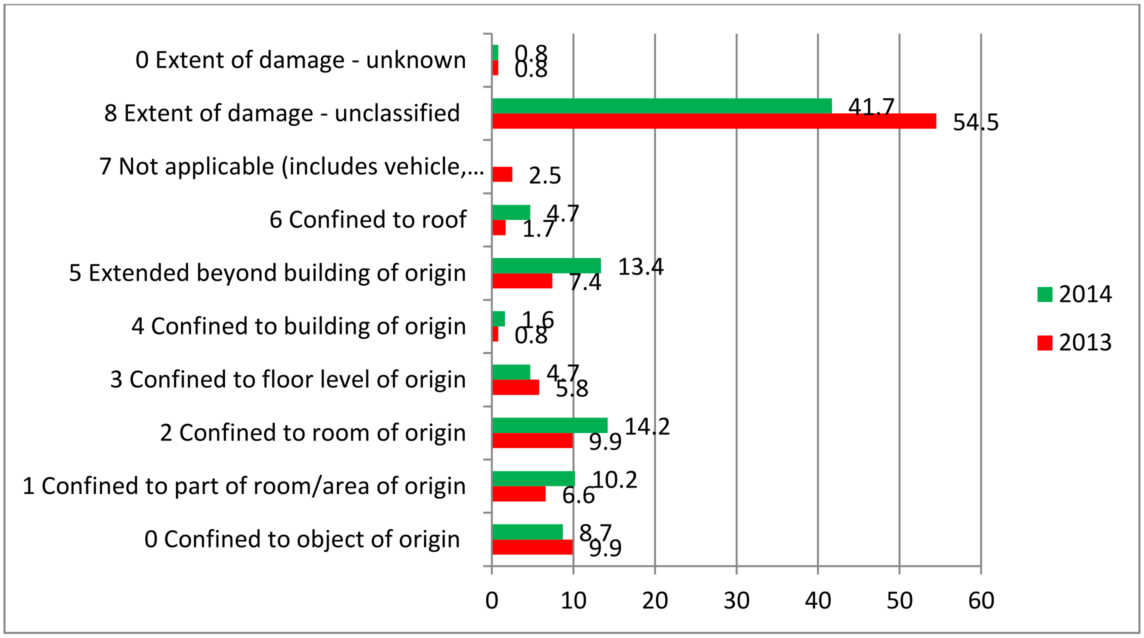
For a large portion of fire incidents the extent of damage has not been classified (Table 8.16 and Figure 8.16).

TABLE 8.16 FIRE INCIDENTS BY EXTENT OF DAMAGE DURING THE SOUTHERN ALBERTA FLOOD

Extent of Damage		2013		2014	
CODE	DESCRIPTION	INCIDENTS	PERCENT	INCIDENTS	PERCENT
0	Confined to object of origin	12	9.9	11	8.7
1	Confined to part of room/area of origin	8	6.6	13	10.2
2	Confined to room of origin	12	9.9	18	14.2
3	Confined to floor level of origin	7	5.8	6	4.7
4	Confined to building of origin	1	0.8	2	1.6
5	Extended beyond building of origin	9	7.4	17	13.4
6	Confined to roof	2	1.7	6	4.7
7	Not applicable (includes vehicle, outside area)	3	2.5		
8	Extent of damage - unclassified	66	54.5	53	41.7
9	Extent of damage - unknown	1	0.8	1	0.8
Total		**121**	**100**	**127**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 8.16 FIRE INCIDENTS BY EXTENT OF DAMAGE DURING THE SOUTHERN ALBERTA FLOOD



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Initial detection

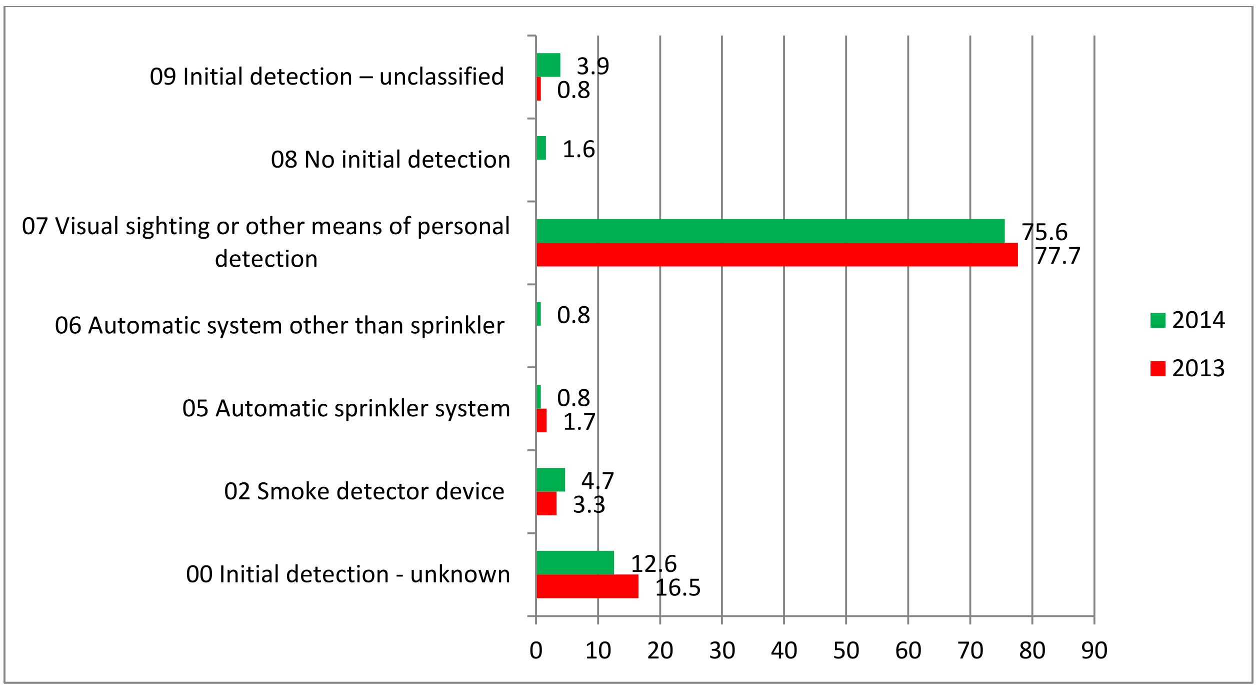
Majority of fire incidents in both flood days and normal days have been detected through "*visual sighting or other means of personal detection*" (Table 8.17 and Figure 8.17). Also for a large portion of fire incidents the initial detection has not been classified.

TABLE 8.17 FIRE INCIDENTS BY INITIAL DETECTION DURING THE SOUTHERN ALBERTA FLOOD

Initial Detection		2013		2014	
CODE	**DESCRIPTION**	**INCIDENTS**	**PERCENT**	**INCIDENTS**	**PERCENT**
00	Initial detection - unknown	20	16.5	16	12.6
02	Smoke detector device	4	3.3	6	4.7
05	Automatic sprinkler system	2	1.7	1	0.8
06	Automatic system other than sprinkler			1	0.8
07	Visual sighting or other means of personal detection	94	77.7	96	75.6
08	No initial detection			2	1.6
09	Initial detection – unclassified	1	0.8	5	3.9
Total		**121**	**100**	**127**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

TABLE 8.17 FIRE INCIDENTS BY INITIAL DETECTION DURING THE SOUTHERN ALBERTA FLOOD



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Action Taken

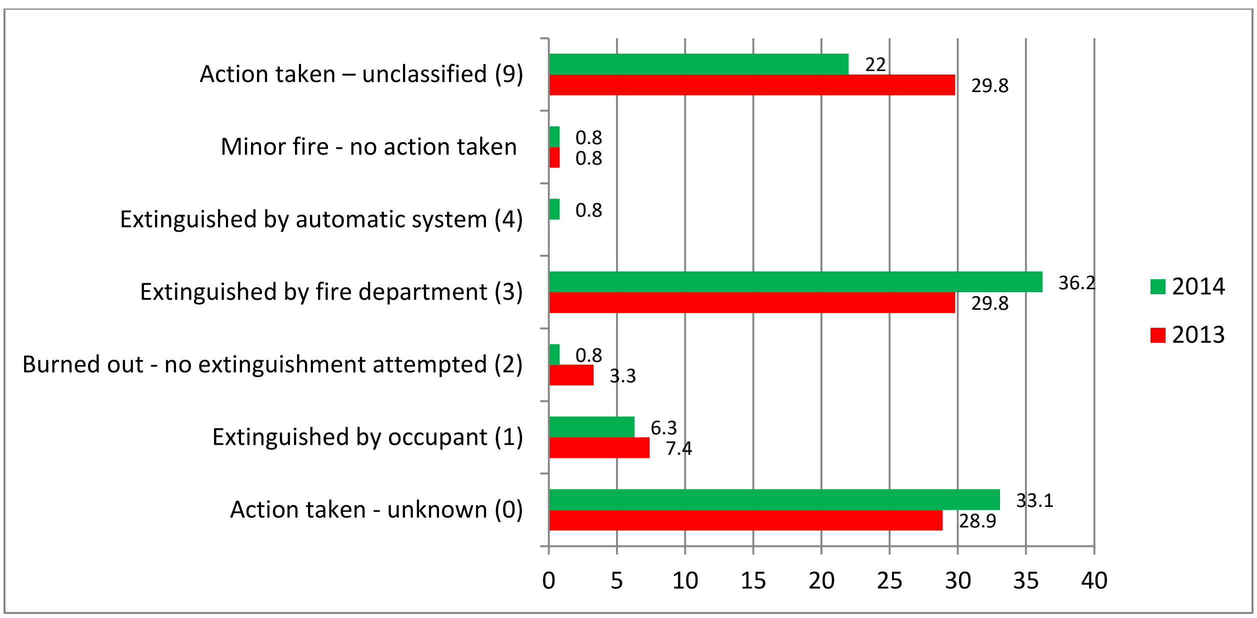
No significant differences have been identified between the two data sets (table 8.18 and figure 8.18). However, it appears that more fire incidents were "*extinguished by fire department*" in normal days in 2014 compared with flood days of 2013. Since the action taken for a higher portion of the fire incidents during the flood event is not specified, further analysis is needed to confirm if the difference is due to the flood.

TABLE 8.18 FIRE INCIDENTS BY ACTION TAKEN DURING THE SOUTHERN ALBERTA FLOOD

Action Taken		2013		2014	
CODE	**DESCRIPTION**	**INCIDENTS**	**PERCENT**	**INCIDENTS**	**PERCENT**
0	Action taken - unknown	35	28.9	42	33.1
1	Extinguished by occupant	9	7.4	8	6.3
2	Burned out - no extinguishment attempted	4	3.3	1	0.8
3	Extinguished by fire department	36	29.8	46	36.2
4	Extinguished by automatic system			1	0.8
5	Minor fire - no action taken	1	0.8	1	0.8
9	Action taken – unclassified	36	29.8	28	22
Total		**121**	**100**	**127**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 8.18 FIRE INCIDENTS BY ACTION TAKEN DURING THE SOUTHERN ALBERTA FLOOD



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

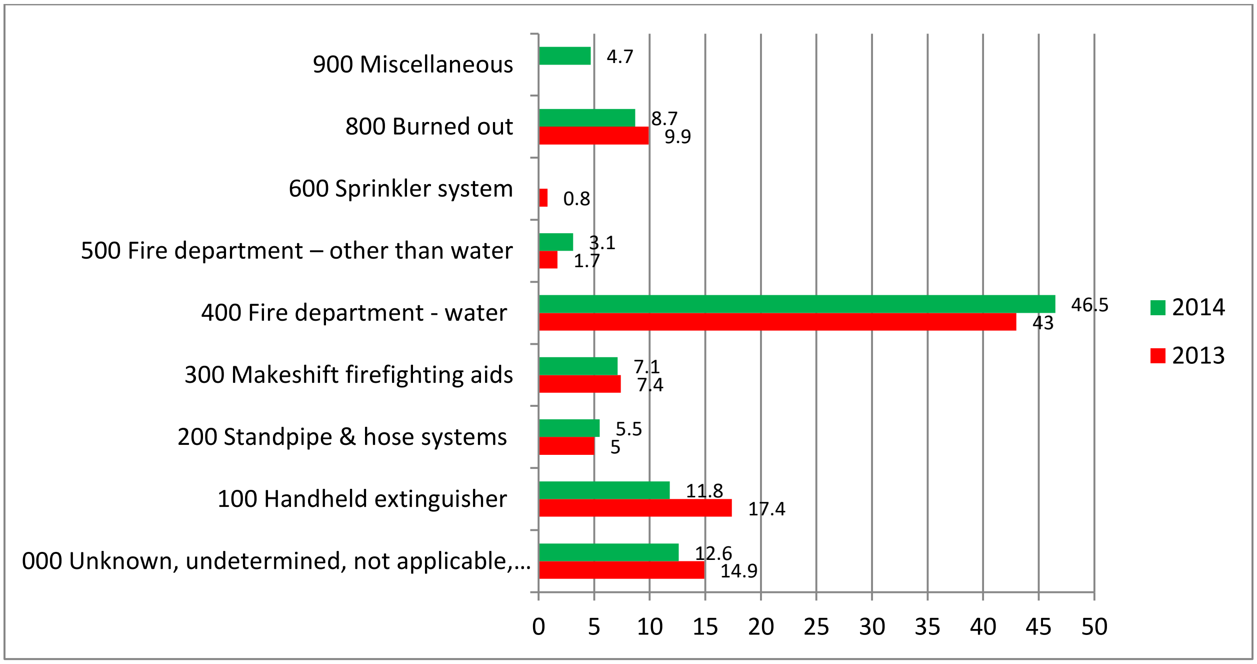
Method of Fire Control and Extinguishment

TABLE 8.19 FIRE INCIDENTS BY METHOD OF FIRE CONTROL AND EXTINGUISHMENT DURING THE SOUTHERN ALBERTA FLOOD

METHOD OF FIRE CONTROL AND EXTINGUISHMENT GROUP		2013		2014	
CODE	**DESCRIPTION**	**INCIDENTS**	**PERCENT**	**INCIDENTS**	**PERCENT**
000	Unknown, undetermined, not applicable, not available	18	14.9	16	12.6
100	Handheld extinguisher	21	17.4	15	11.8
200	Standpipe & hose systems	6	5	7	5.5
300	Makeshift firefighting aids	9	7.4	9	7.1
400	Fire department - water	52	43	59	46.5
500	Fire department – other than water	2	1.7	4	3.1
600	Sprinkler system	1	0.8		
800	Burned out	12	9.9	11	8.7
900	Miscellaneous			6	4.7
Total		121	100	127	100

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

TABLE 8.14 FIRE INCIDENTS BY METHOD OF FIRE CONTROL AND EXTINGUISHMENT DURING THE SOUTHERN ALBERTA FLOOD



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

CONCLUSION

Over the last few decades, flood events have increased drastically because of the multiple natural processes that can cause floods, like snowmelt, intense rainfall, ice, and failure of natural dams. Due to the large possibilities of flood risks, flooding can occur during any time of year across Canada. In June 2013 the intense weather triggered severe flooding in Alberta causing the costliest natural disaster in Canadian history. While flooding events do not necessarily lead to fire incidents, this chapter revealed that of the fires that did occur during the flood event, majority (14.9%) were due to "*electrical distribution equipment*". This was probably due to the power outage issues that were caused by the flood. "*Electricity*" was also the leading contributor (24.8%) to fuel and ignite an object, followed by "*match or lighter*" (6.6%) and "*gasoline*" (5.8%) because evacuees were probably trying to keep warm while being forced out of their homes.

9 FIRE INCIDENTS DURING THE FLASH FLOOD IN TORONTO AND THE GREATER TORONTO AREA

INTRODUCTION AND BACKGROUND

On July 8, 2013, a series of thunderstorms developed across portions of Southern Ontario, Canada (Boodoo et al., 2015; 2028). Thunderstorms produced up to 126 mm in precipitation causing flash-flooding in the City of Toronto and the Greater Toronto Area (Figure 9.1). The flooding closed multiple transportation corridors, caused wide-spread property damage, and disrupted power to approximately 300,000 residents. The Insurance Bureau of Canada estimated that the flooding caused CAD $940 million in insured property damage (Canadian Disaster Database, 2017). While these storms did not have any damaging winds or hail, substantial amounts of rain fell, causing major localized flash flooding (Boodoo et al., 2015; 2028). Toronto experienced flash flood in the afternoon (16:20 to 18:30), of July 8, 2013. Some parts of Toronto received over 90 mm of rain, and in some cases, the total exceeded 120 mm (Nirupama et al. 2014). For example, more than 126mm of rain was recorded at Pearson International Airport in less than two hours. The significance of these figures emerged when it was compared with the monthly average for the City of Toronto that is 74.4 mm. The closest rainfall record to this event goes back to 1954 and during Hurricane Hazel when close to 121.4mm of rain fell in one day (Boodoo et al., 2015; 2029).

Figure 9.0 Distribution of rainfall in the Greater Toronto Area during the June 2013 Flash Flood

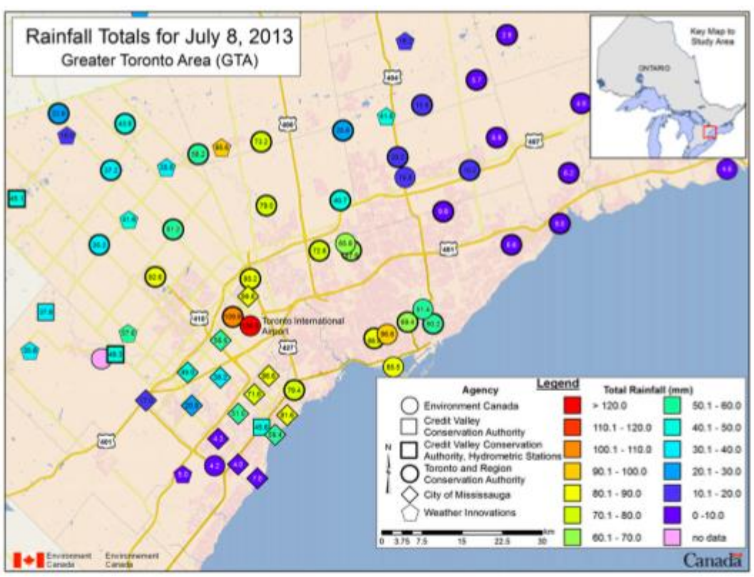


FIG. 3. Storm total rainfall accumulations at gauges from different organizations distributed around the greater Toronto area. Various symbols indicate the operating authority responsible for the gauges. The EC gauges (thin circles) reported only total storm accumulation. The others were TBRGs measuring in 5-min intervals.

Soure: Boodoo et al., 2015; 2029).

The flash flood caused major disruptions in the city and the surrounding areas. More than 300,000 residents experienced power outages, a large number of flights were cancelled, and local and regional public transit services were heavily interrupted. With more than CAD $944 million insured and infrastructure losses, it was recorded as the most expensive disaster for the province of Ontario

(Nirupama et al. 2014; 1262) and among the top 10 costliest disasters in Canada. The insured losses exceeded the 2005 and 2009 storms. At the time of the event, the cost of water related disasters surpassed insured losses caused by wildfires.

“The most notable recent severe weather system hit Toronto and the Greater Toronto Area (GTA) on Monday, July 8, 2013, and produced a series of severe thunder storms that released large amounts of rain. Much of the media reporting on the storm suggested that this event was “bigger than Hazel” and that it was the largest volume of rainfall the city had ever seen from one weather system” (Martin-Downs, 2013). However, the Hurricane Hazel event as a whole produced much more rain than the July 8th event and the period of rain was much longer (Martin-Downs, 2013). “This storm event primarily produced issues associated with urban flooding by overwhelming the region’s stormwater sewer systems and flooding low lying areas on roadways and in underpasses. Riverine flooding and extremely high water levels occurred on several watercourses within the Toronto and Region Conservation Authority’s (TRCA) jurisdiction, causing portions of roadways to be flooded (Martin-Downs, 2013).

FIRE INCIDENTS DURING THE FLASH FLOOD

In this section we review fire incidents that have been reported in the City of Toronto between the July 8 and July 10, 2013. A preliminary analysis showed higher than normal occurrences of fire incidents during these three days that could be associated with the flash flood event and its subsequent power outages and wider impacts. We compare fire incidents during the flash flood event days in July 2013 with the same days in July 2014. We decided to compare the fire incidents with similar days in July 2014 instead of similar days in 2012 mainly because July 8 in 2013 was a weekday (Monday) and July 8 in 2014 was a weekday (Tuesday), therefore we are comparing fire incidents during weekdays in both 2013 and 2014. Moreover, the total number of fire incidents in the City of Toronto was exactly similar in these days in both years. Overall, 30 fire incidents have been reported for July 8-10, 2013 and 30 fire incidents for July 8-10 2014 (Table 9.1).

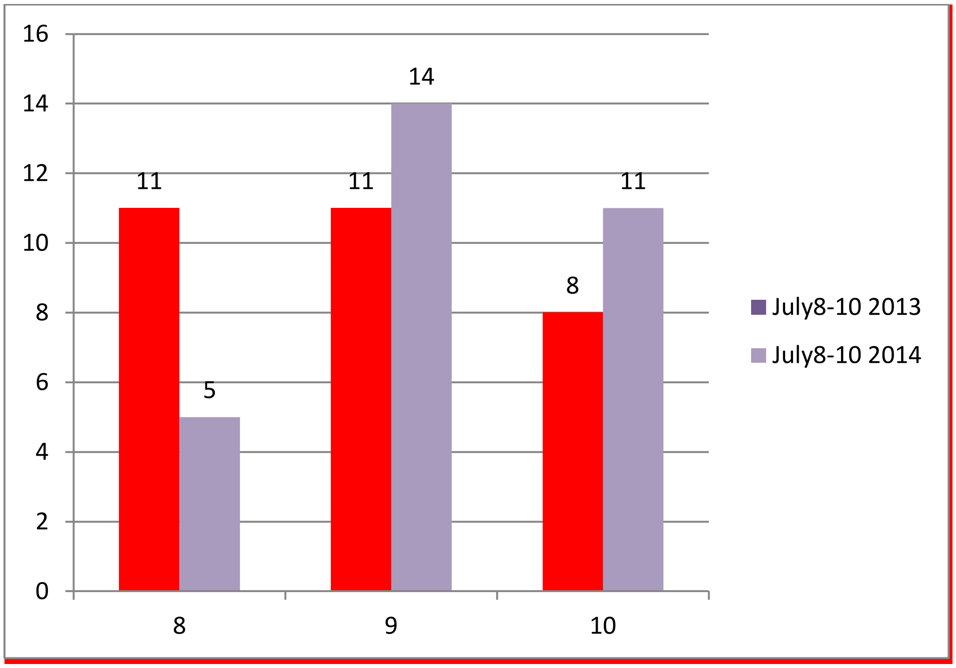
TABLE 9.1 NUMBER OF FIRE INCIDENTS JULY 2013

Dates	2013 (Flash Flood)		2014	
	INCIDENTS	PERCENT	INCIDENTS	PERCENT
8 July	11	36.7	5	16.7
9 July	11	36.7	14	46.7
10 July	8	26.7	11	36.7
Total	30	100.0	30	100

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

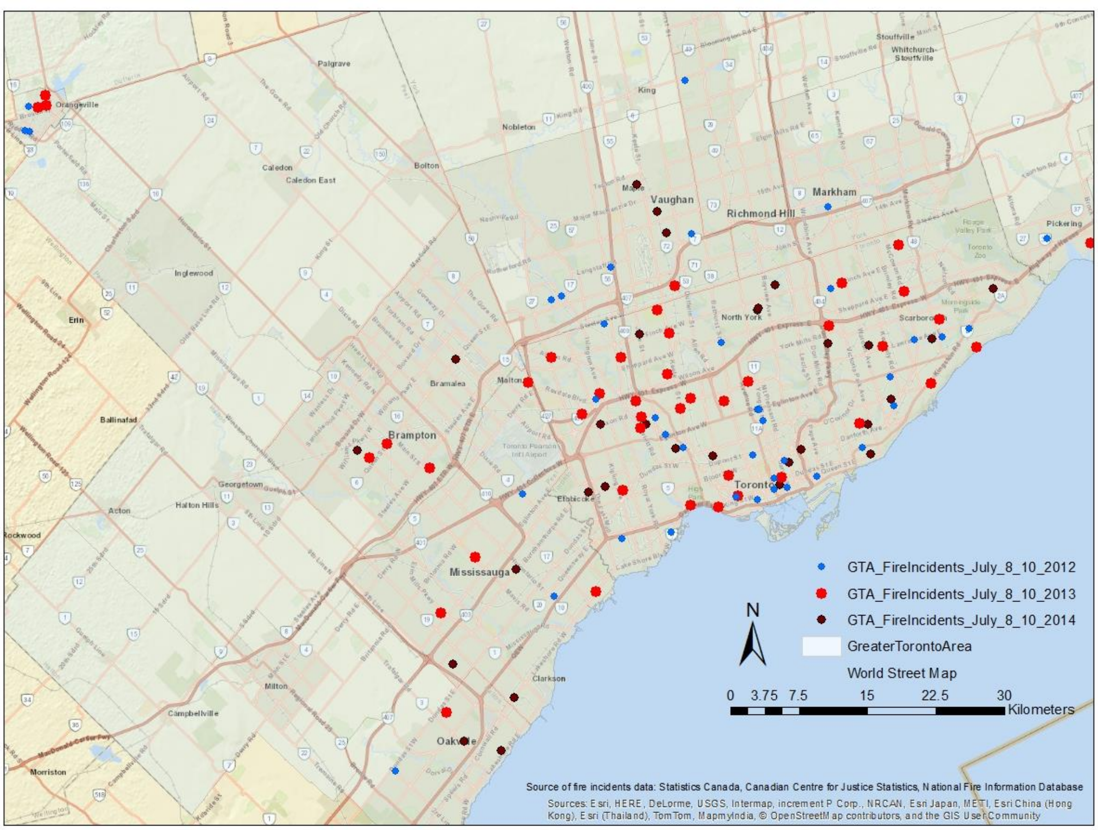
There are some differences between the number of fire incidents in these days in July 2013 and July 2014 (Figure 9.2 A and Figure 9.2B). The number of fire incidents are closer to each other in July 9 and 10 in these years. However, number of fire incidents are much higher in July8 in 2013 (11) compared to 2014 (5).

FIGURE 9.1A NUMBER OF FIRE INCIDENTS JULY 8, 9, AND 10 2013



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 9.2B FIRE INCIDENTS JULY 8, 9, AND 10 2013



Crew Size

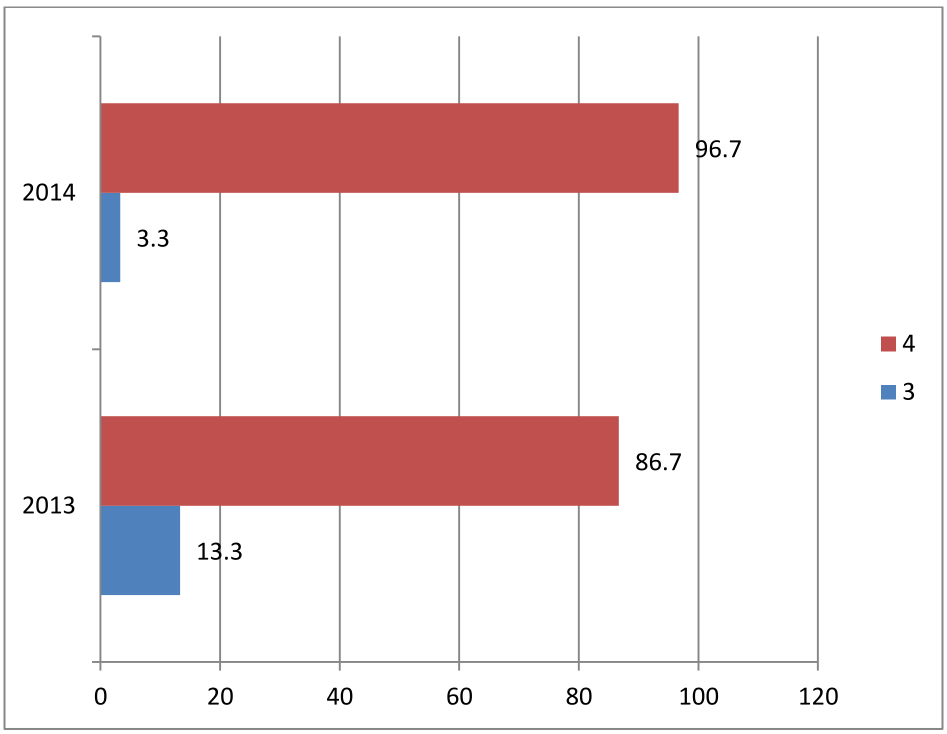
While to overall pattern of crew size appears to be similar in both years, only minor difference exists between the two years (Table 9.2 and Figure 9.2).

TABLE 9.2 CREW SIZE IN FIRE INIDENTS DURING THE JULY 2013 FLASH FLOOD IN TORONTO

CREWSIZE	July 8-10 2013		2014	
	INCIDENTS	PERCENT	INCIDENTS	PERCENT
3	4	13.3	1	3.3
4	26	86.7	29	96.7
Total	30	100	30	100

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 9.2 CREW SIZE IN FIRE INIDENTS DURING THE JULY 2013 FLASH FLOOD IN TORONTO



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Distance to Fire Incidents

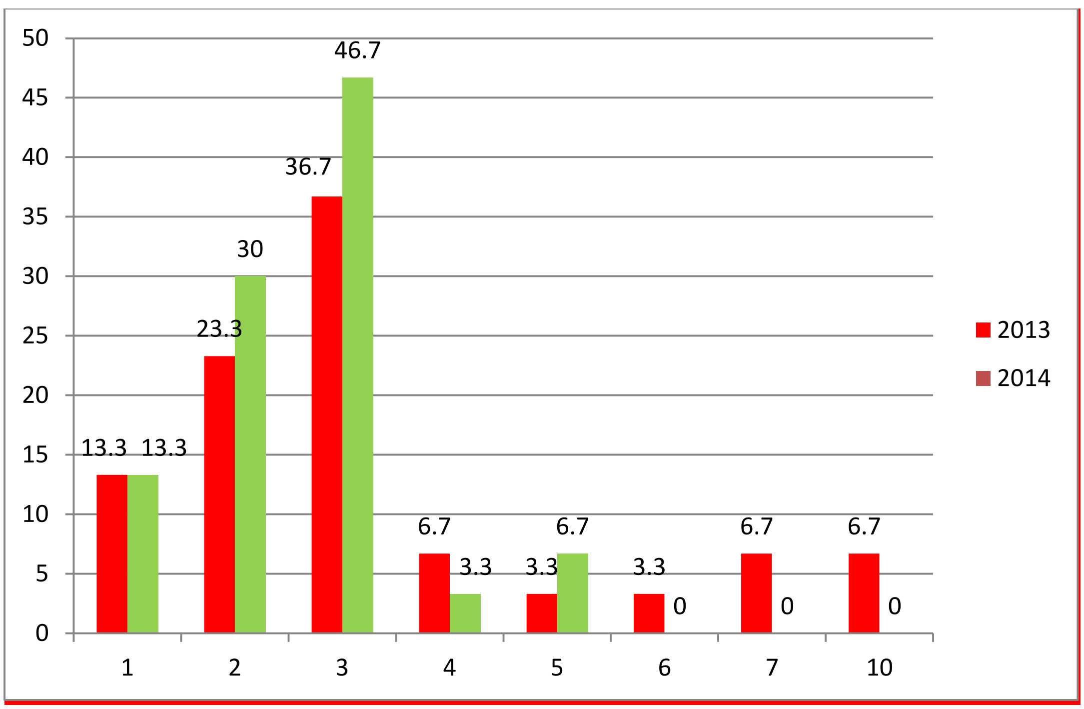
Comparison between the number of fire incidents during the flash flood days of 2013 and normal days of 2014 reveals that distance to emergencies has increased during the flash flood days. Most fire incidents in 2013 have higher values for longer distances compared to fire incidents in 2014 (Table 9.3 and Figure 9.3). This could have been due to engagement of all fire stations in the response operations and special circumstances caused by the flash flood. Under emergency situations it is more likely that fire stations that are further from the fire incidents will be the ones responding to the incident.

TABLE 9.3 DISTANCE TO FIRE INCIDENTS DURING THE JULY 2013 FLASH FLOOD IN TORONTO

DISTANCE FROM FIRE DEPARTMENT TO EMERGENCY (KM)	2013		2014	
	INCIDENTS	PERCENT	INCIDENTS	PERCENT
1 KM	4	13.3	4	13.3
2 KM	7	23.3	9	30
3 KM	11	36.7	14	46.7
4 KM	2	6.7	1	3.3
5 KM	1	3.3	2	6.7
6 KM	1	3.3	0	0
7 KM	2	6.7	0	0
10 KM	2	6.7	0	0
Total	30	100	30	100

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 9.3 DISTANCE TO FIRE INCIDENTS DURING THE JULY 2013 FLASH FLOOD IN TORONTO



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Status on Arrival

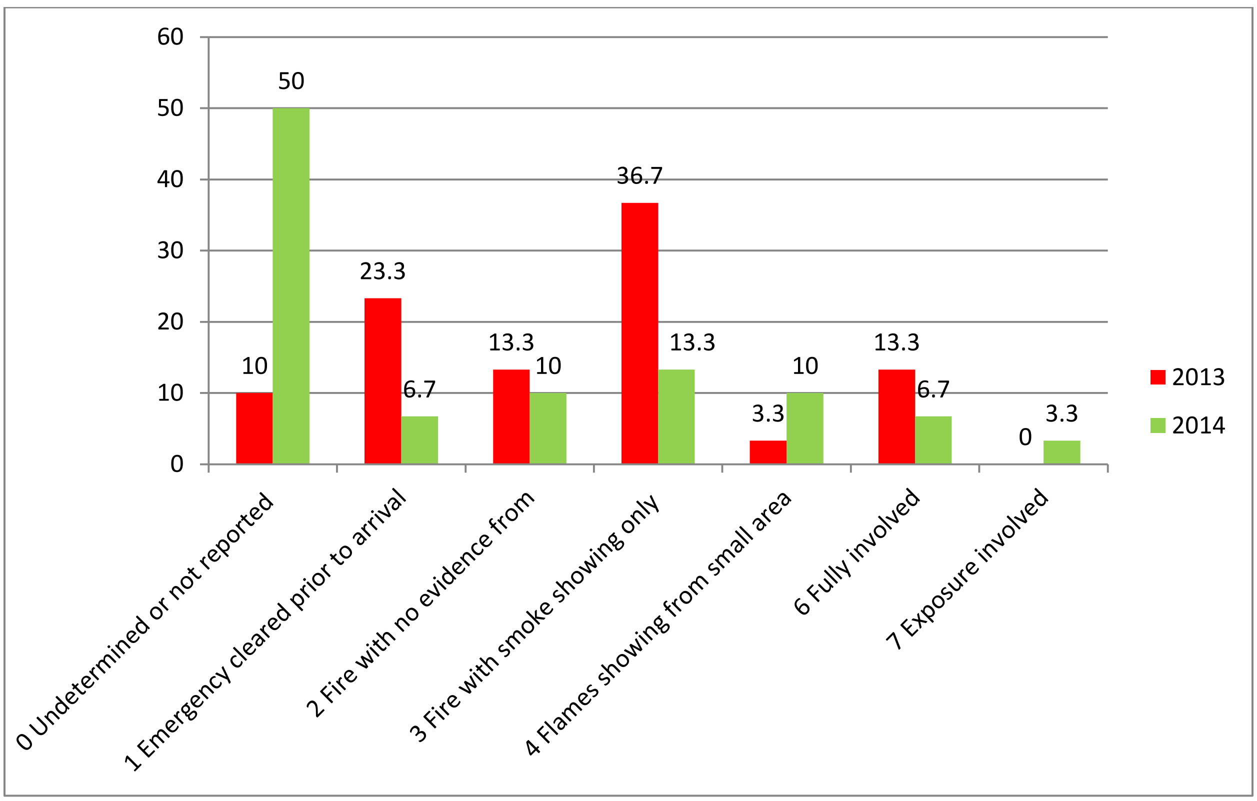
A significant number of fire incidents were recorded as having an "*undetermined or not reported*" status on arrival in 2014 which may impact our conclusions. It appears that some differences exist in the reported cases between the two years (Table 9.4 and Figure 9.4). Particularly these figures show that the number of fire incidents that have been cleared before the arrival of fire crews were higher during the 2013 flash flood days compared to similar days in 2014. In addition, more fire incidents with "*smoke showing only*" have occurred during the flash flood days in 2013.

TABLE 9.4 FIRE INCIDENTS AND STATUS ON ARRIVAL DURING THE JULY 2013 FLASH FLOOD IN TORONTO

STATUS ON ARRIVAL		2013		2014	
CODE	DESCRIPTION	INCIDENTS	PERCENT	INCIDENTS	PERCENT
0	Undetermined or not reported	3	10	15	50
1	Emergency cleared prior to arrival	7	23.3	2	6.7
2	Fire with no evidence from	4	13.3	3	10
3	Fire with smoke showing only	11	36.7	4	13.3
4	Flames showing from small area	1	3.3	3	10
6	Fully involved	4	13.3	2	6.7
7	Exposure involved			1	3.3
Total		**30**	**100**	**30**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 9.4 FIRE INCIDENTS AND STATUS ON ARRIVAL DURING THE JULY 2013 FLASH FLOOD IN TORONTO



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIRE INCIDENTS AND PROPERTY ATTRIBUTES DURING THE JULY 2013 FLASH FLOOD IN TORONTO

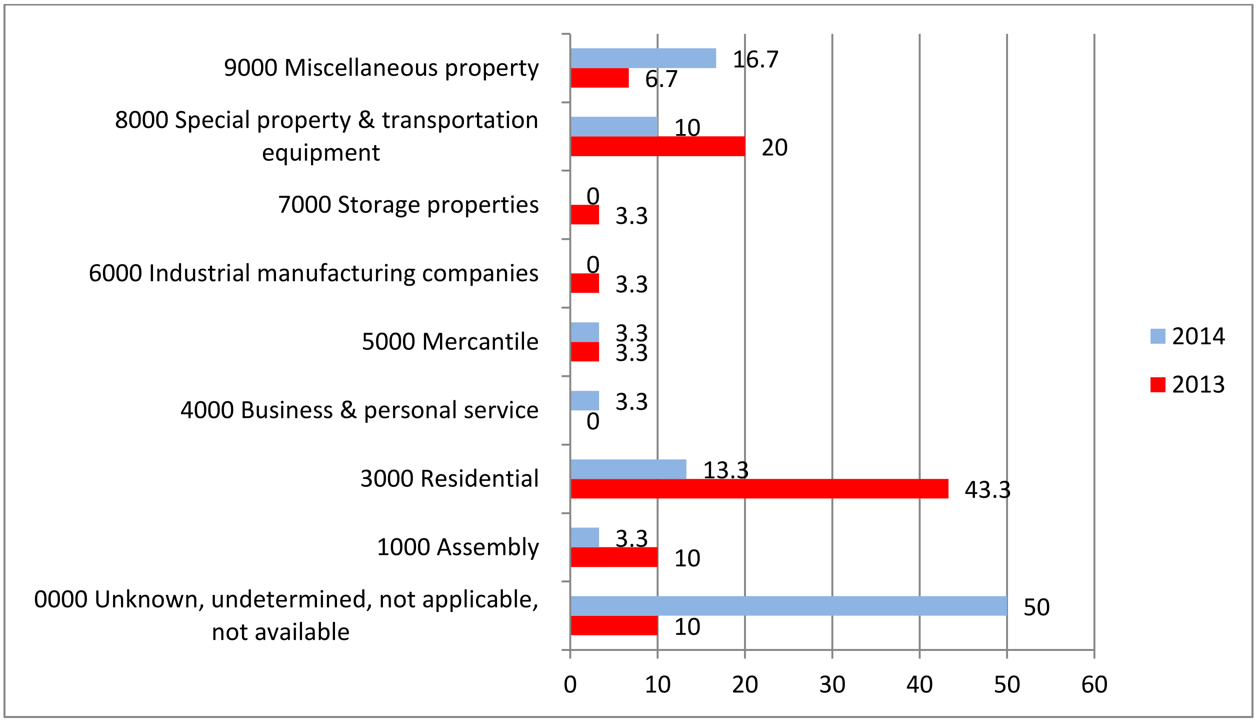
There is significant difference between the unknown or undetermined property classifications in the two sets; therefore it will be difficult to infer reliable conclusions from the data (Table 9.5 and Figure 9.5). However, from the current figures, it appears that more residential fires have been reported during the flash flood days in 2013. Special property and transportation equipment also show higher numbers. Considering that the flash flood caused road and basement flooding in most parts of the city, these differences may not be accidental. Past studies provide evidences of rising car accidents with bad weather including flash floods (Rahman et al., 2016; Ferris and Newburn, 2017; Thistlethwaite et al., 2017).

TABLE 9.5 FIRE INCIDENTS AND PROPERTY CLASSES, JULY 2013 FLASH FLOOD IN TORONTO

PROPERTY CLASSIFICATION GROUP		2013		2014	
CODE	DESCRIPTION	INCIDENTS	PERCENT	INCIDENTS	PERCENT
0000	Unknown, undetermined, not applicable, not available	3	10	15	50
1000	Assembly	3	10	1	3.3
3000	Residential	13	43.3	4	13.3
4000	Business & personal service	0	0	1	3.3
5000	Mercantile	1	3.3	1	3.3
6000	Industrial manufacturing companies	1	3.3	0	0
7000	Storage properties	1	3.3	0	0
8000	Special property & transportation equipment	6	20	3	10
9000	Miscellaneous property	2	6.7	5	16.7
Total		**30**	**100**	**30**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 9.5 FIRE INCIDENTS AND PROPERTY CLASSES, JULY 2013 FLASH FLOOD IN TORONTO



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Property Height

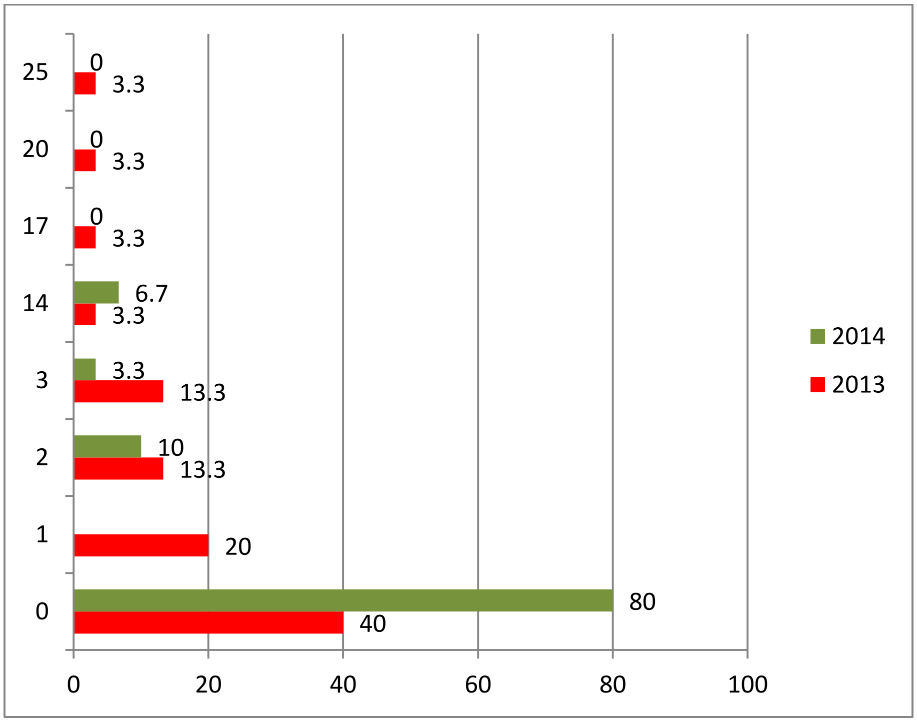
While the number of fire incidents is generally lower in high rise buildings, certain emergencies may increase the number of incidents in high rise buildings. For example power outage caused by flooding, ice storm, etc. may increase incidents in high rise buildings. Based on what we have, it appears that more fire incidents have been reported in high rise buildings during the July 2013 flash flood (Table 9.6 and Figure 9.6).

TABLE 9.6 FIRE INCIDENTS AND PROPERTY HEIGHT, JULY 2013 FLASH FLOOD IN TORONTO

Building Height (number of storeys)	2013		2014	
	INCIDENTS	PERCENT	INCIDENTS	PERCENT
0	12	40	24	80
1	6	20		
2	4	13.3	3	10
3	4	13.3	1	3.3
14	1	3.3	2	6.7
17	1	3.3	0	0
20	1	3.3	0	0
25	1	3.3	0	0
Total	**30**	**100**	**30**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 9.6 FIRE INCIDENTS AND PROPERTY HEIGHT, JULY 2013 FLASH FLOOD IN TORONTO



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

CIRCUMSTANCES CONTRIBUTING TO THE OUTBREAK OF FIRE DURING THE JULY 2013 FLASH FLOOD IN TORONTO

Igniting Object

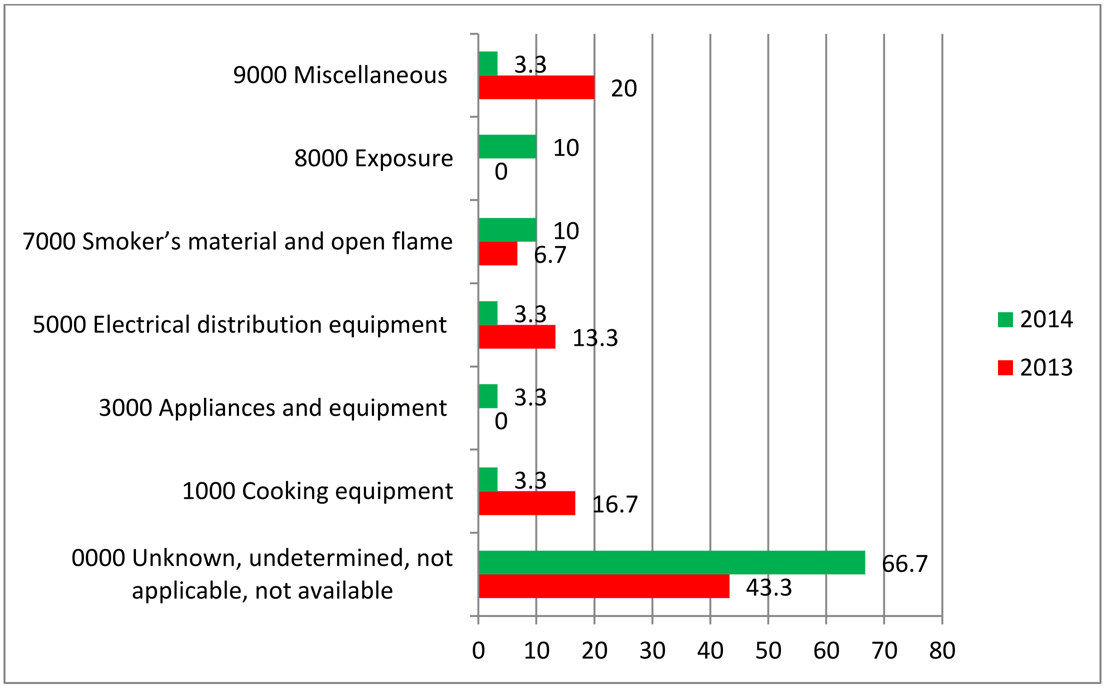
Based on the recorded fire incidents for July 8-10, 2013 and 2014, a number of differences were observed between the two sets. Fire incidents related to "*cooking equipment, electrical distribution equipment*" and "*miscellaneous*" show higher percentages for the July 2013 flash flood dates. Massive power outages in the City of Toronto that were caused by the flash flood in the very hot summer days can partially explain these differences.

TABLE 9.7 FIRE INCIDENTS AND IGNITING OBJECT JULY 2013 FLASH FLOOD IN TORONTO

	IGNITING OBJECT GROUP	2013		2014	
CODE	DESCRIPTION	INCIDENTS	PERCENT	INCIDENTS	PERCENT
0000	Unknown, undetermined, not applicable, not available	13	43.3	20	66.7
1000	Cooking equipment	5	16.7	1	3.3
3000	Appliances and equipment	0	0	1	3.3
5000	Electrical distribution equipment	4	13.3	1	3.3
7000	Smoker's material and open flame	2	6.7	3	10
8000	Exposure	0	0	3	10
9000	Miscellaneous	6	20	1	3.3
Total		**30**	**100**	**30**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 9.7 FIRE INCIDENTS AND IGNITING OBJECT DURING JULY 2013 FLASH FLOOD IN TORONTO



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Fuel or Energy Associated with Igniting Objet

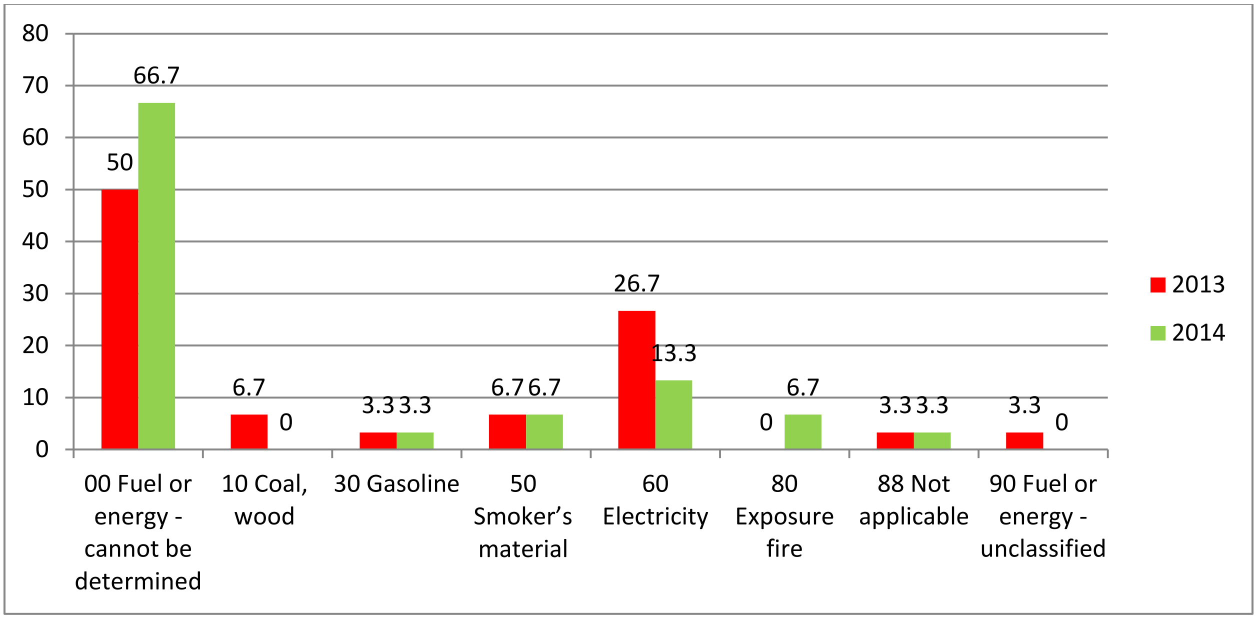
It is not accidental that the number of fire incidents with "*electricity*" as the fuel or "*energy*" is higher for 2013 flash flood days compared to normal days in 2014 (Table 9.8 and Figure 9.8). While 26.7 percent of fire incidents during the flash flood days are associated with electricity as the fuel or energy associated with igniting objects, only 13.3 percent of fire incidents on the non-flash flood days are associated with electricity as the fuel or energy with igniting objects.

TABLE 9.8 FIRE INCIDENTS AND FUEL OR ENERGY ASSOCIATED WITH IGNITING OBJECT DURING JULY 2013 FLASH FLOOD IN TORONTO

FUEL OR ENERGY ASSOCIATED WITH IGNITING OBJECT		2013		2014	
CODE	**DESCRIPTION**	**INCIDENTS**	**PERCENT**	**INCIDENTS**	**PERCENT**
00	Fuel or energy - cannot be determined	15	50	20	66.7
10	Coal, wood (includes coke, paper or waste used for lighting or incidental burning)	2	6.7		
30	Gasoline	1	3.3	1	3.3
50	Smoker's material	2	6.7	2	6.7
60	Electricity	8	26.7	4	13.3
80	Exposure fire			2	6.7
88	Not applicable	1	3.3	1	3.3
90	Fuel or energy - unclassified	1	3.3		
Total		**30**	**100**	**30**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 9.8 FIRE INCIDENTS AND FUEL OR ENERGY ASSOCIATED WITH IGNITING OBJECT DURING JULY 2013 FLASH FLOOD IN TORONTO



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Act or Omission

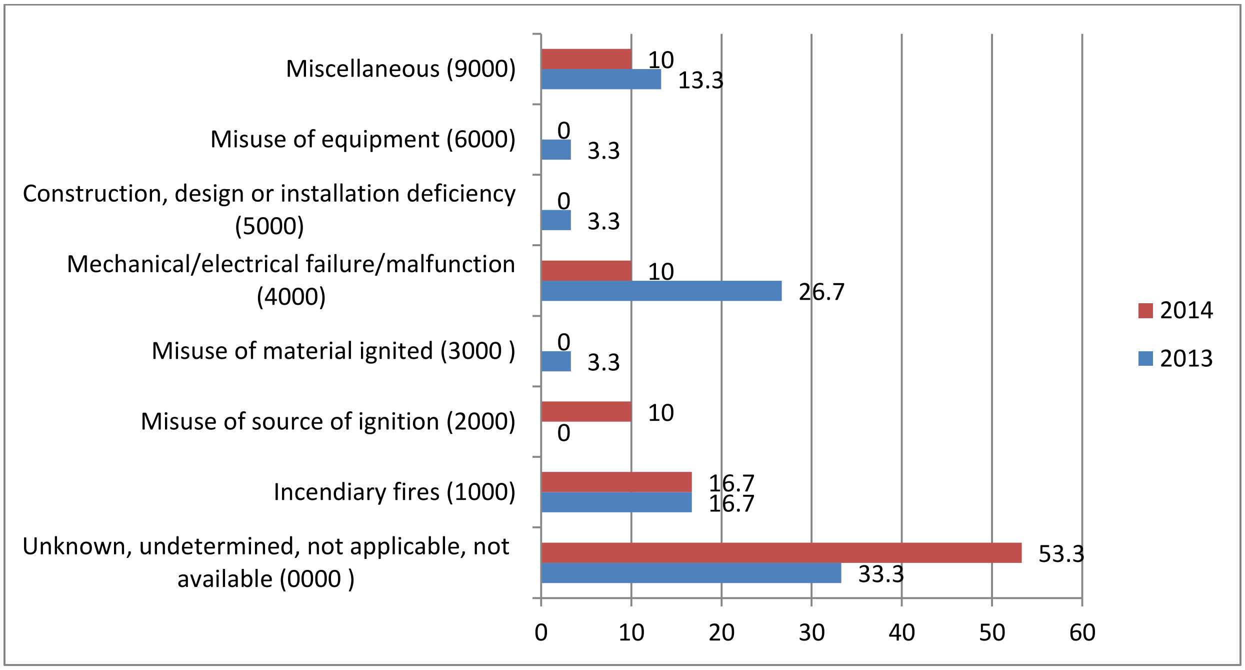
Table 9.9 and Figure 9.9 results show that more fire incidents have been caused by "*mechanical/electrical failure/malfunction"* during the flash flood days compared to non-flash flood days.

TABLE 9.9 FIRE INCIDENTS AND ACT OR OMISSION DURING JULY 2013 FLASH FLOOD IN TORONTO

ACT OR OMISSION GROUP		2013		2014	
CODE	DESCRIPTION	INCIDENTS	PERCENT	INCIDENTS	PERCENT
0000	Unknown, undetermined, not applicable, not available	10	33.3	16	53.3
1000	Incendiary fires	5	16.7	5	16.7
2000	Misuse of source of ignition	0	0	3	10
3000	Misuse of material ignited	1	3.3	0	0
4000	Mechanical/electrical failure/malfunction	8	26.7	3	10
5000	Construction, design or installation deficiency	1	3.3	0	0
6000	Misuse of equipment	1	3.3	0	0
9000	Miscellaneous	4	13.3	3	10
	Total	30	100	30	100

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 9.9 FIRE INCIDENTS AND ACT OR OMISSION DURING JULY 2013 FLASH FLOOD IN TORONTO



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

ORIGIN AND SPREAD OF FIRE DURING JULY 2013 FLASH FLOOD IN TORONTO

Area of Origin

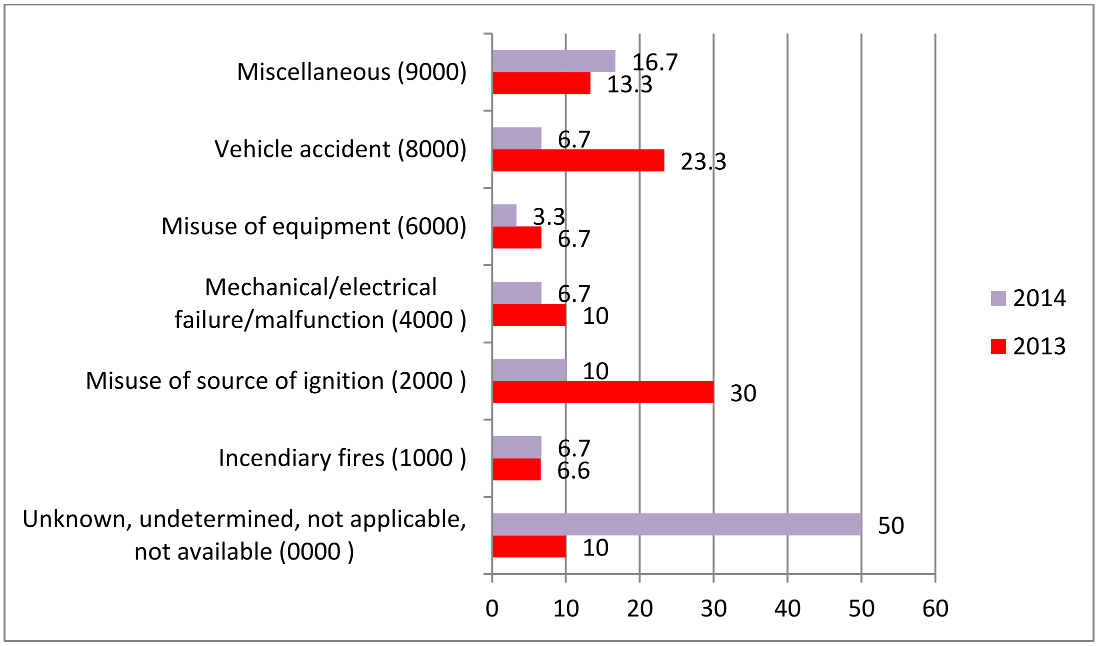
50 percent of the fire incidents during 2014 were recorded as having an "*unknown, undetermined*" area of origin (Table 9.10 and Figure 9.10). However, there is a large amount of "*misuse of source ignition"* identified in 2013 fire incidents compared to non-flash flood event in 2014. Also there is a higher amount of vehicle accidents during the flash flood event in 2013 when compared to 2014.

TABLE 9.10 AREA OF ORIGIN IN FIRE INCIDENTS DURING JULY 2013 FLASH FLOOD IN TORONTO

AREA OF ORIGIN GROUP		2013		2014	
CODE	DESCRIPTION	INCIDENTS	PERCENT	INCIDENTS	PERCENT
0000	Unknown, undetermined, not applicable, not available	3	10	15	50
1000	Incendiary fires	2	6.6	2	6.7
2000	Misuse of source of ignition	9	30	3	10
4000	Mechanical/electrical failure/malfunction	3	10	2	6.7
6000	Misuse of equipment	2	6.7	1	3.3
8000	Vehicle accident	7	23.3	2	6.7
9000	Miscellaneous	4	13.3	5	16.7
	Total	30	100	30	100

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 9.10 AREA OF ORIGIN IN FIRE INCIDENTS DURING JULY 2013 FLASH FLOOD IN TORONTO



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

CONCLUSION

The 2013 Flash Flood that affected Toronto and the Greater Toronto Area (GTA) disrupted over 300,000 residents and caused wide spread damage to private property and public critical infrastructure. Even though the disaster filled Toronto with water, the 2013 flash flood caused higher than normal occurrences of fire, when compared to similar dates in 2014. This could have been due to the subsequent power outages experiences across Toronto and the GTA. In addition, higher fire incidents were seen during flood events due to the ignition of "*electoral distribution equipment*". Many fires also originated because of vehicle accidents, probably because thousands of residents were left without power for 3 days.

10 FIRE INCIDENTS DURING THE GREATER TORONTO ICE STORM

INTRODUCTION AND BACKGROUND

The 2013 Ice Storm (20-23 of December) was one of the worst ice storms to hit Southern Ontario (Canada), particularly the Greater Toronto Area. This ice storm caused massive power outages in the impacted areas and produced snow and freezing rain, causing substantial damage to local power distribution lines and trees. More than 600,000 households were without power when the storm began in Southern Ontario (Government of Ontario, 2013). Moreover, the ice storm generated large amounts of debris in the form of broken power poles, power cables, trees, homes, buildings, and vehicles. The lack of power, icy roads, and debris kept most people at home if they had alternate heating systems.

Studies show that the storm caused an increase in emergency department's visits for acute traumatic injuries (such as falls, motor vehicle collisions, injuries from clean-up of debris, and overall rates of fractures and other musculoskeletal injuries) and other severe weather related illnesses (such as gastrointestinal illness, cold-related injuries, acute cardiovascular events, respiratory illness and acute psychiatric illnesses) (Rajaram et al., 2016). The economic impacts (i.e. loss of job and revenue) were significant due to the interruption of business activities and operations in pre-Christmas season. The storm directly impacted the lives of about one million people across the GTA. A significant number of people were forced to abandon their homes and many businesses had to close their businesses for at-least a week (Applebaum, 2014).

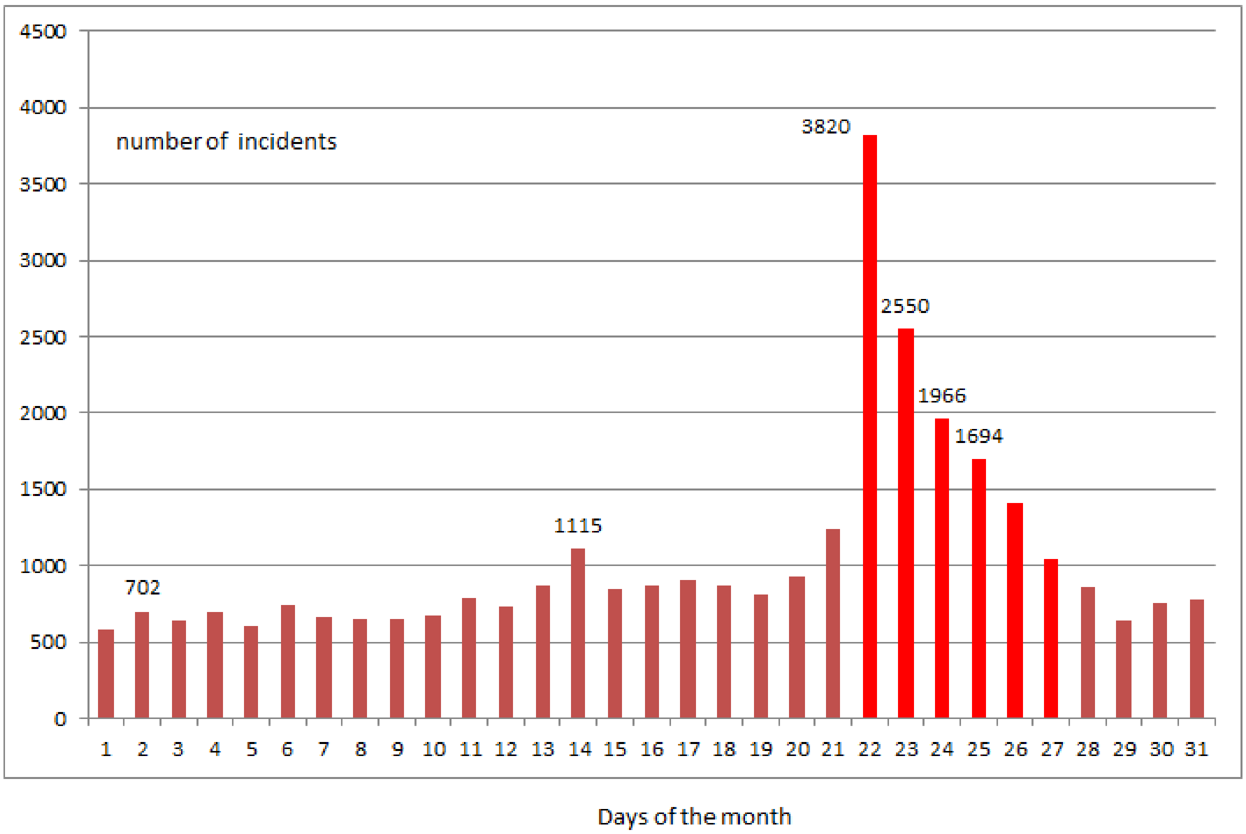
The City of Toronto experienced its single largest emergency social services response in its history by opening 13 emergency reception centres. Some highways and streets were closed due to debris and unavailability of traffic control systems and traffic lights (Coutts, 2014). Local airports including Toronto's Pearson International Airport experienced substantial flight delays and cancelations and Canada Post could not deliver mails during the most important business week in the entire year (Applebaum, 2014). Many people were travelling for Christmas at this time of the year and the storm left rail and air travelers stranded. Toronto Fire Services received 316 calls for carbon monoxide (CO) exposures and calls for emergency medical services (general medical issues, slips and falls and CO exposures) increased by more than 60%. Lack of heating in homes, use of inappropriate alternative heating sources, running power generators in enclosed spaces, food contamination due to lack of refrigeration, slippery sidewalks due to ice accumulation, falling ice from buildings and tree debris, downed live power lines, were among the main associated secondary hazards that generated these increases in emergency calls (Rajaram et al., 2016).

The ice storm increased the need for emergency services across the GTA. For example, "Toronto Fire Services responded to 316 carbon monoxide calls, 813 medical calls, 128 rescues, 102 vehicle incidents and 538 check calls during and after the ice storm" (Higgins, 2014). The ice storm impacts started from "07:00 on Dec. 21 and the calls ended at 07:00 on Dec. 25, Toronto Fire Services (TFS) responded to 5,534 incidents, with 9,655 vehicle responses" (Higgins, 2014). "In the same period in 2012, there were just over 1,200 incidents. Forty-two per cent of the calls during the storm – or 2,351 – were for downed wires. Of the 668 fire calls in this period, nine were multiple-alarm fires, and an additional 15 were working-fire responses, all made more difficult because of extreme weather conditions. There were 316 carbon monoxide calls, 813 medical calls, 128 rescues, 102 vehicle incidents and 538 check calls "(Higgins, 2014).

FIRE INCIDENTS DURING THE ICE STORM

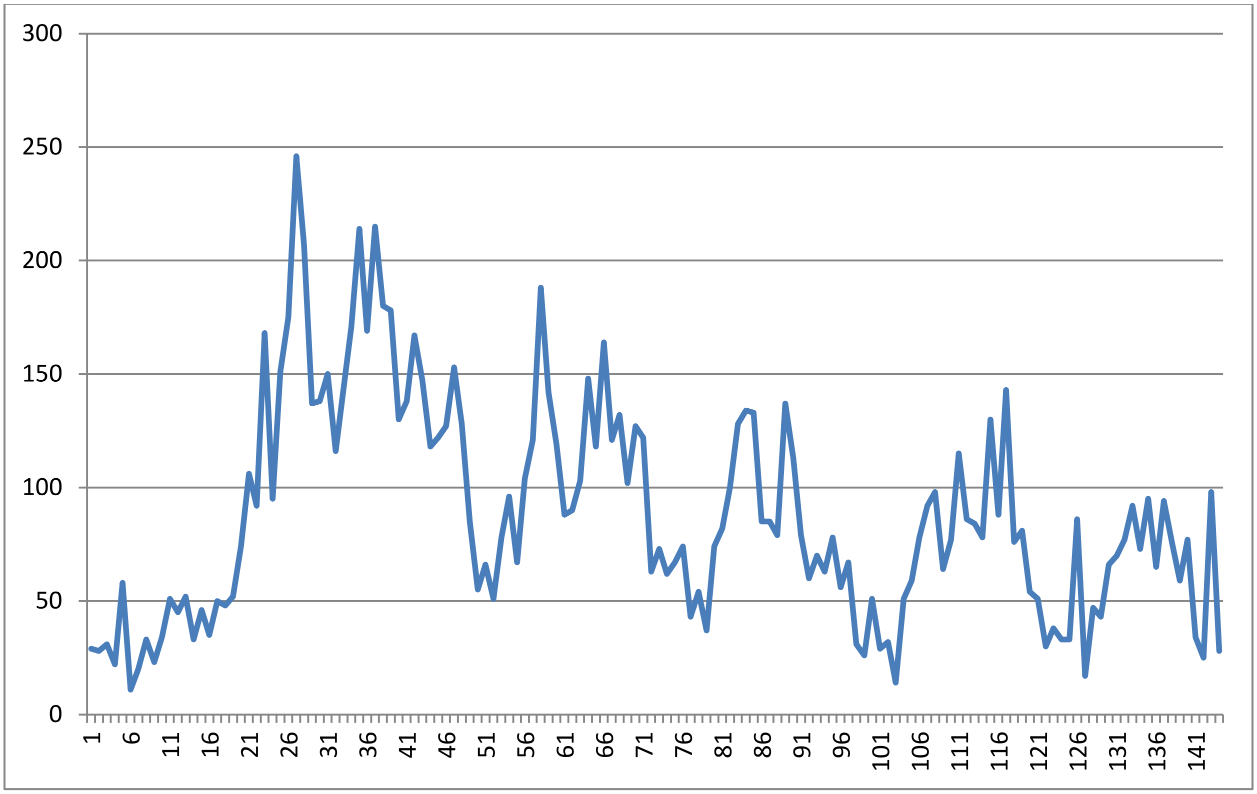
According to the Toronto Fire Services database on December 22, there were 3820 service requests received. The number declined after the December 22, but was still high till December 26 compared to normal days in December.

FIGURE 10.0A NUMBER OF FIRE INCIDENENT RESPONDED BY THE TORONTO FIRE SERVICES IN DEEMBER 2013



Source of data: City of Toronto Open Data.

FIGURE 10.0B NUMBER OF FIRE INCIDENENT RESPONDED BY THE TORONTO FIRE SERVICES IN DEEMBER 2013 BY HOUR



Source of data: City of Toronto Open Data.

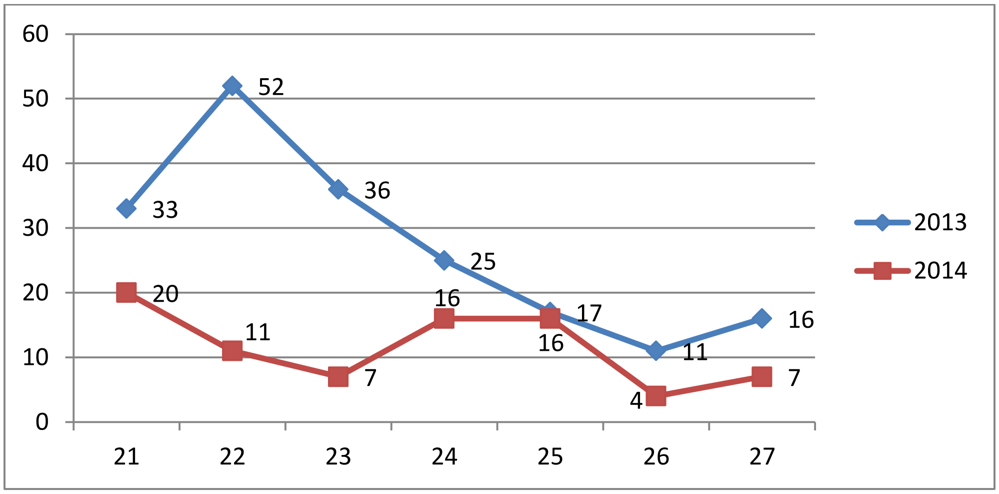
Looking at the number of fire incidents during December 2013, we found that fire incidents in the GTA were above the normal level from December 21 to 27. Therefore these days were selected as the disaster and emergency days. Overall 190 fire incidents existed in the NFID for Toronto Metropolitan (GTA) in these days for 2013. There were only 81 records for the same days in 2014 (Table 10.1 and Figure 10.1).

FIGURE 10.1 FIRE INCIDENTS DECEMBER 2013 AND DECEMBER 2014

Dates in December	2013		2014	
	INCIDENTS	PERCENT	INCIDENTS	PERCENT
21	33	17.4	20	24.7
22	52	27.4	11	13.6
23	36	18.9	7	8.6
24	25	13.2	16	19.8
25	17	8.9	16	19.8
26	11	5.8	4	4.9
27	16	8.4	7	8.6
Total	190	100	81	100

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 10.1 FIRE INCIDENTS DECEMBER 2013 AND DECEMBER 2014



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

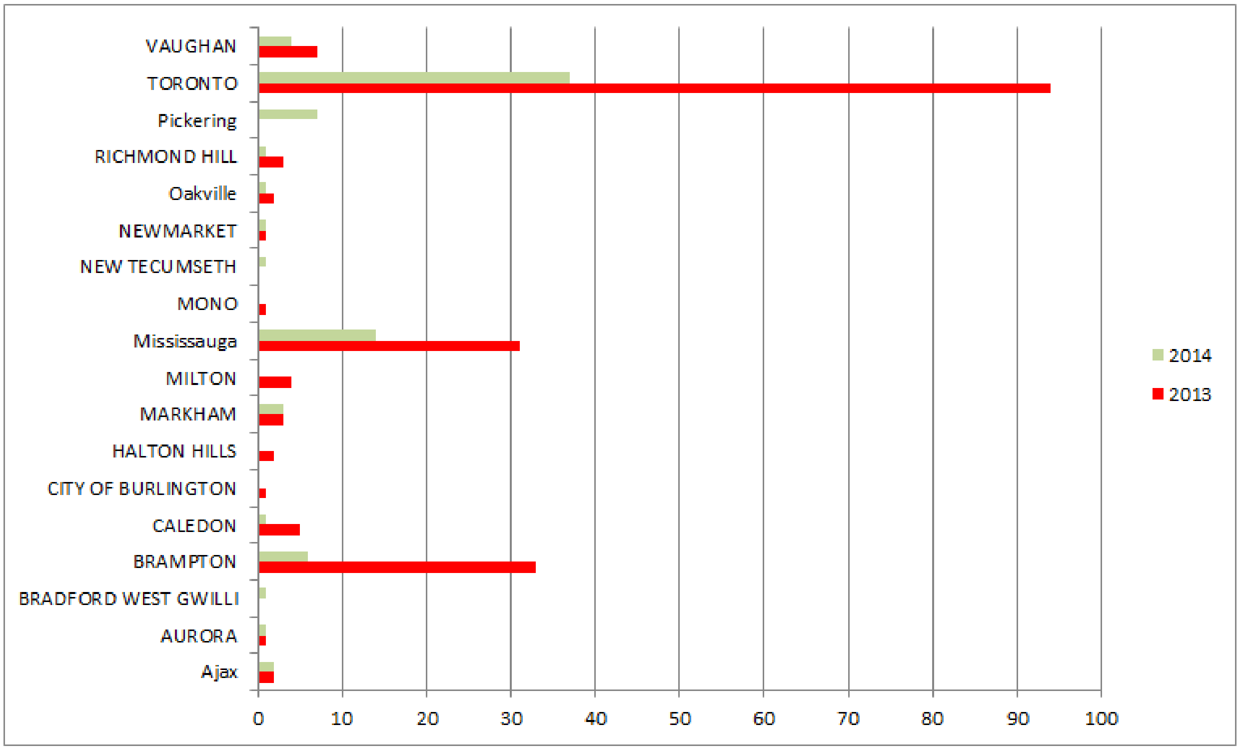
While the GTA covers a large number of cities, towns, and communities, majority of the reported incidents during these days belong to the City of Toronto (94), Mississauga (31), and Brampton (33) (Table 10.2, Figure 10.2A, Figure 10.2B). Majority of the GTA communities, particularly these major cities experienced higher than normal fire incidents during these days.

TABLE 2.10 FIRE INCIDENTS DECEMBER 2013 AND DECEMBER 2014

LOCATIONS	2013		2014	
	INCIDENTS	PERCENT	INCIDENTS	PERCENT
Ajax	2	1.1	2	2.5
AURORA	1	0.5	1	1.2
BRADFORD WEST GWILLI			1	1.2
BRAMPTON	33	17.3	6	7.4
CALEDON	5	2.6	1	1.2
CITY OF BURLINGTON	1	0.5		
HALTON HILLS	2	1.1		
MARKHAM	3	1.6	3	3.7
MILTON	4	2.1		
Mississauga	31	16.3	14	17.3
MONO	1	1.2		
NEW TECUMSETH			1	1.2
NEWMARKET	1	0.5	1	1.2
OAKVILLE	2	1.1	1	1.2
RICHMOND HILL	3	1.6	1	1.2
Pickering			7	8.7
TORONTO	94	49.4	37	41.7
VAUGHAN	7	3.7	4	4.9
Total	190	100	81	100

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

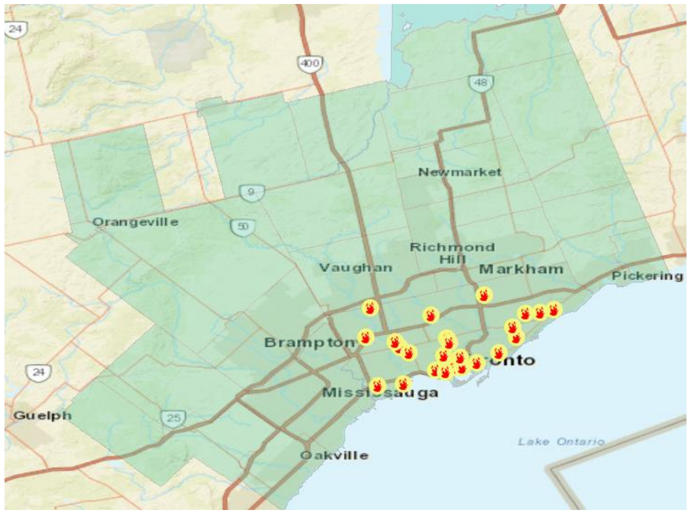
FIGURE 10.2A FIRE INCIDENTS DECEMBER 21-27, 2013 AND 2014



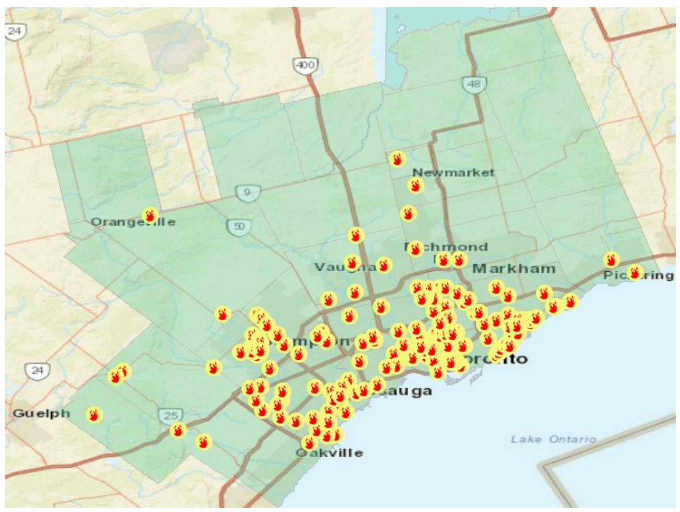
Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

According to the data, mutual aid was not used in during the ice storm for the reported fire incidents. Records show 5 cases of mutual aid during similar days in 2014.

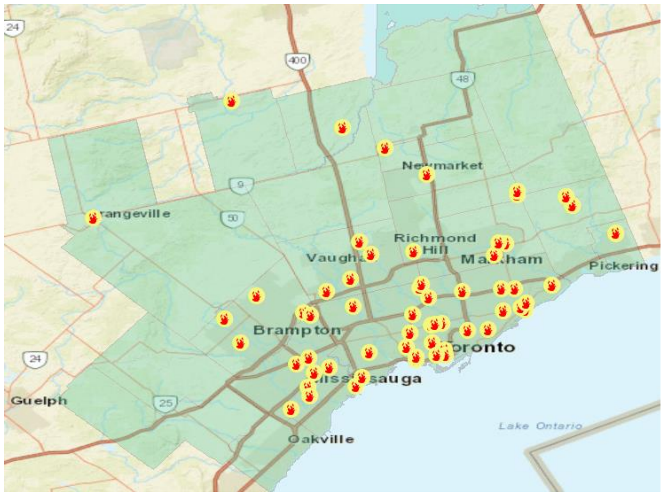
FIGURE 10.2A FIRE INCIDENTS DECEMBER 21-27, 2012, 2013 AND 2014



2012: 26 Fire Incidents



2013, 179 Fire Incidents



2014, 65 Fire Incidents

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Crew Size (initial)

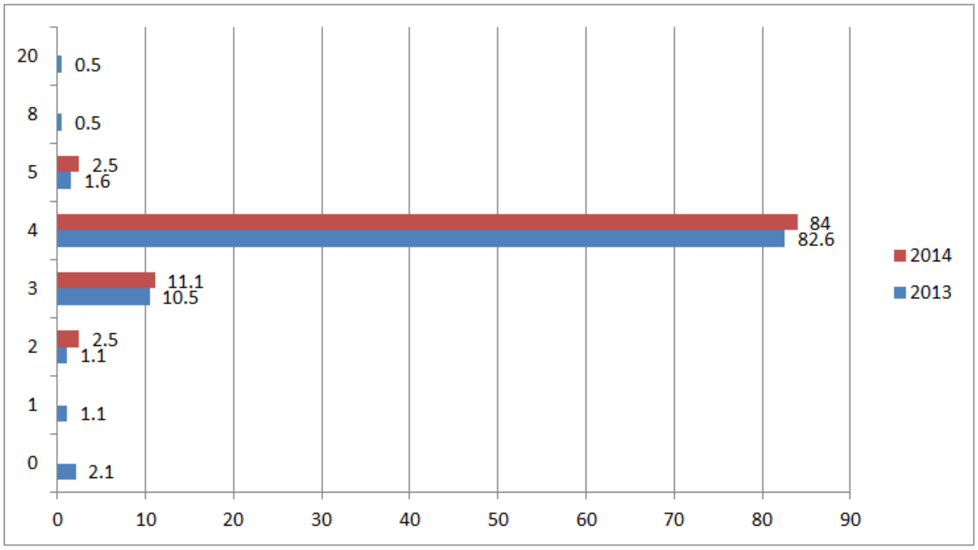
We observed no difference in crew size between the two sets of data. About 82 percent of all fire incidents during the ice storm days in 2013 were responded to by 4 crews. This figure was 84 percent for 2014 incidents (Table 10.3 and Figure 10.3).

TABLE 10.3 INITIAL CREW SIZE IN FIRE INCIDENTS DECEMBER 21-27, 2013 AND 2014

CREW SIZE (INITIAL)	2013		2014	
	INCIDENTS	PERCENT	INCIDENTS	PERCENT
0	4	2.1		
1	2	1.1		
2	2	1.1	2	2.5
3	20	10.5	9	11.1
4	157	82.6	68	84
5	3	1.6	2	2.5
8	1	0.5		
20	1	0.5		
Total	190	100	81	100

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 10.3 INITIAL CREW SIZE IN FIRE INCIDENTS DECEMBER 21-27, 2013 AND 2014



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Distance from Fire Department to Emergency

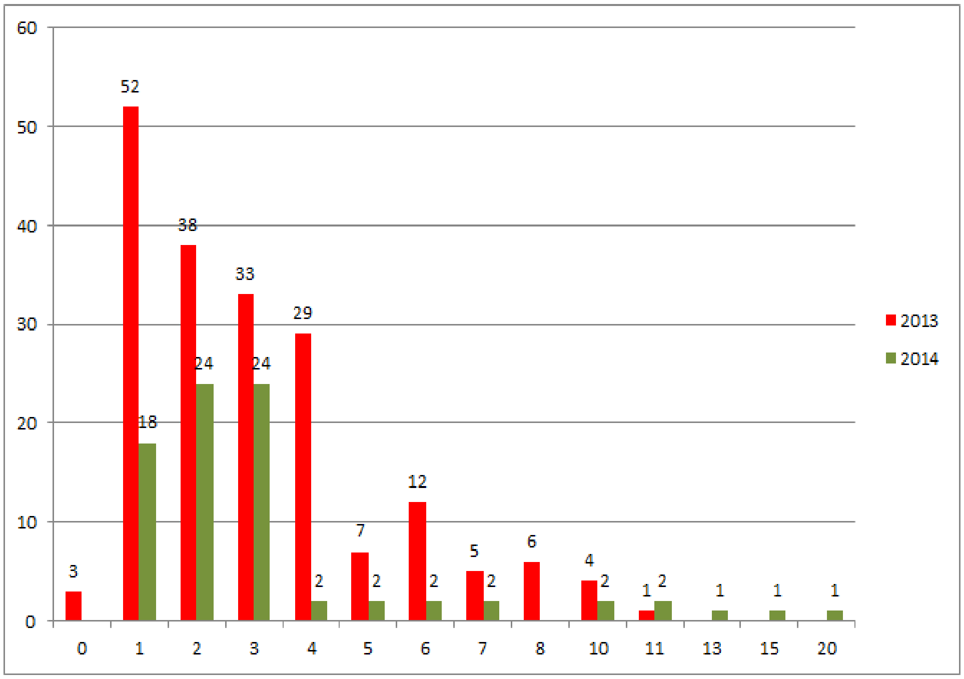
Table 10.4 and Figure 10.4 show that the majority (27.4%) of the fire incidents that occurred during the ice storm were within 1km of the fire department. Similar results were found for fire incidents during 2014, but the majority of fire incidents occurred between 2km (29.6%) and 3km (29.6%) away from the fire department.

TABLE 10.4 DISTANCE FROM FIRE DEPARTMENT TO EMERGENCY IN FIRE INCIDENTS DECEMBER 21-27, 2013 AND 2014

DISTANCE FROM FIRE DEPARTMENT TO EMERGENCY (KM)	2013		2014	
	INCIDENTS	PERCENT	INCIDENTS	PERCENT
0	3	1.6		
1	52	27.4	18	22.2
2	38	20	24	29.6
3	33	17.4	24	29.6
4	29	15.3	2	2.5
5	7	3.7	2	2.5
6	12	6.3	2	2.5
7	5	2.6	2	2.5
8	6	3.2		
10	4	2.1	2	2.5
11	1	0.5	2	2.5
13			1	1.2
15			1	1.2
20			1	1.2
Total	190	100	81	100

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 10.4 DISTANCE FROM FIRE DEPARTMENT TO EMERGENCY IN FIRE INCIDENTS DECEMBER 21-27, 2013 AND 2014



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Status on Arrival

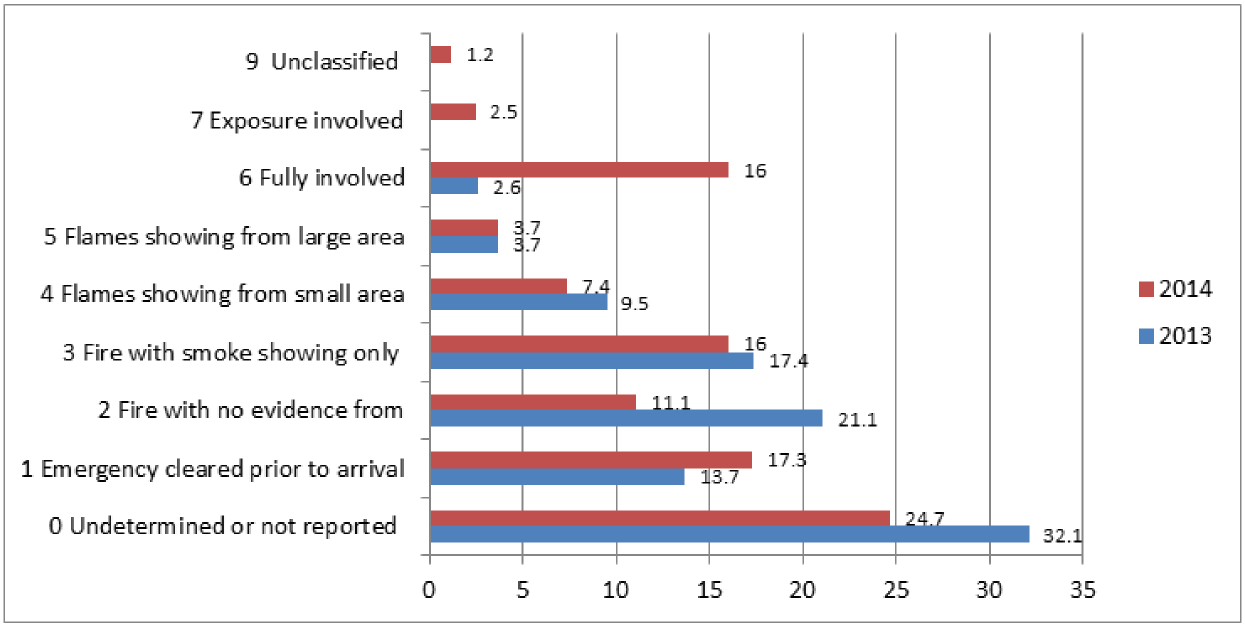
In both 2013 (32.1%) and 2014 (24.7%) majority if fire incidents were "*undetermined or not reported*" upon arrival (Refer to Table 10.5 and Figure 10.5). There is a higher amount of incidents undetermined during the 2013 Ice Storm compared to 2014.

TABLE 10.5 FIRE INCIDENTS AND STATUS ON ARRIVAL DURING DECEMBER 21-27, 2013 AND 2014

STATUS ON ARRIVAL		2013		2014	
CODE	DESCRIPTION	INCIDENTS	PERCENT	INCIDENTS	PERCENT
0	Undetermined or not reported	61	32.1	20	24.7
1	Emergency cleared prior to arrival	26	13.7	14	17.3
2	Fire with no evidence from	40	21.1	9	11.1
3	Fire with smoke showing only	33	17.4	13	16
4	Flames showing from small area	18	9.5	6	7.4
5	Flames showing from large area	7	3.7	3	3.7
6	Fully involved	5	2.6	13	16
7	Exposure involved			2	2.5
9	Unclassified			1	1.2
Total		190	100	81	100

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 10.5 FIRE INCIDENTS AND STATUS ON ARRIVAL DURING DECEMBER 21-27, 2013 AND 2014



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Number of People Rescued, Killed and Injured

Very few of the fire incidents during the 2013 ice storm days needed rescue operations. Out of 190 cases of fire incidents during the ice storm days, only 4 involved rescue operations. Two cases rescued one person each and two other cases rescued two persons each. There was no rescue operation in the 81 fire incidents during the same days in 2014. During the ice storm period there were 3 fire incidents each with one fatality. Two of these fatalities have been explained by Higgins (2014). "Two of the fire calls resulted in fatalities, both through the night on Dec. 24-25. The first was a male victim who died in a car fire; the vehicle was fully involved when crews arrived. The man was a resident of the building at which the car was located, which was without power at the time of the incident. The second incident was at a four-storey residential building that had full power, so there was no indication that the fatality was storm related" (Higgins, 2014). Again there was no fatality for 81 fire incidents that occurred for the December 2014 cases. Finally according to the data a total of 9 people were injured during the fire incidents in the Ice Storm period in 2013. Five fire incidents involved one injury each and there was one fire with 4 injures. On the same days in 2014 fires, there were 8 injuries in 6 different fire incidents.

FIRES AND PROPERTY ATTRIBUTES DURING THE 2013 ICE STORM IN THE GREATER TORONTO AREA

Property Class

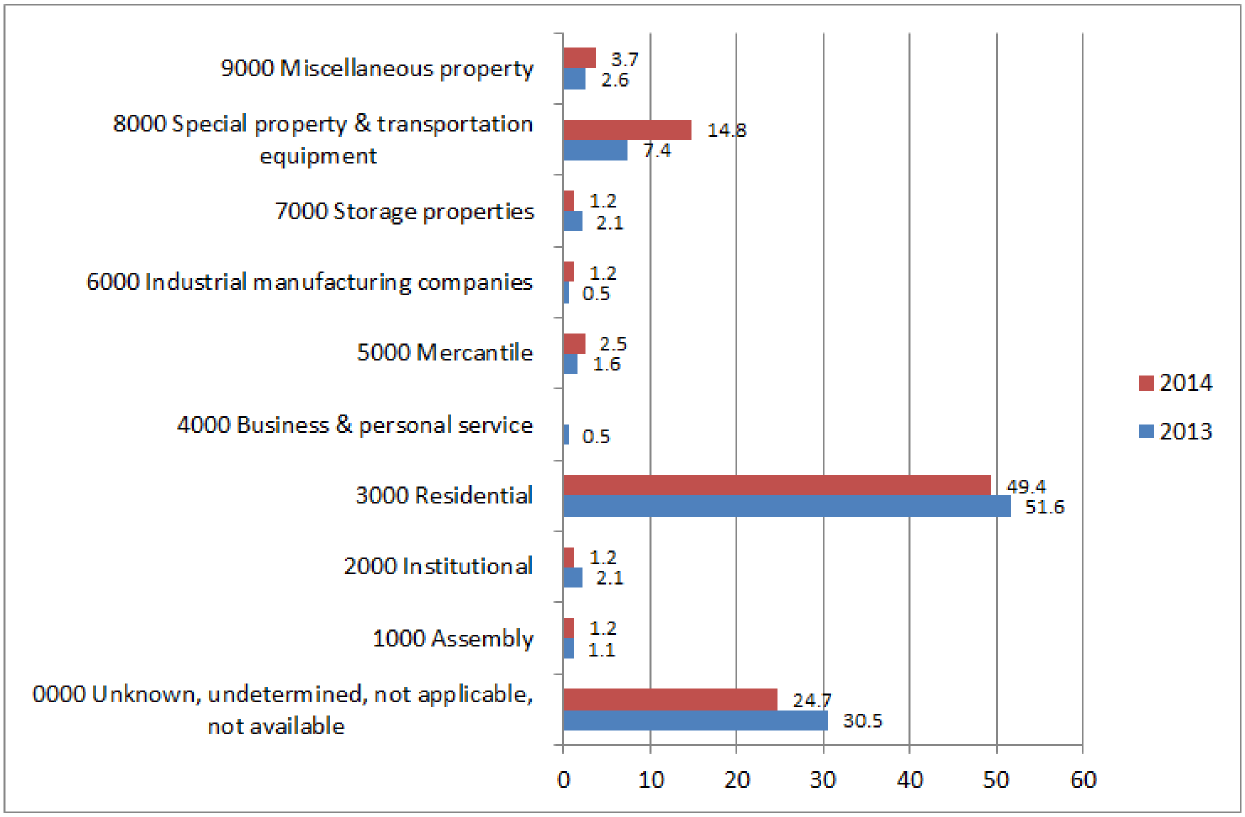
There is a noticeable difference between the number of fire incidents in the "*Special property & transportation equipment*" (code 8000) property class group in the ice storm (2013) dataset and the control dataset (2014) (refer to the Table 10.6 and Figure 10.6A and Figure 10.6B). While 14.8% of the fire incidents assigned to this class in the ice storm dataset, only 7.4% of fire incidents are categorized in this class for control dataset. This illustrates that the ice storm in December 2013 had an impact on the fire incidents happened in transportation facilities which are mostly located outdoor and are exposed to the harsh weather.

TABLE 10.6 PROPERTY CLASSES AND FIRE INCIDENTS, DECEMBER 21-27, 2013 AND 2014

PROPERTY CLASSIFICATION GROUP		2013		2014	
CODE	**DESCRIPTION**	**INCIDENTS**	**PERCENT**	**INCIDENTS**	**PERCENT**
0000	Unknown, undetermined, not applicable, not available	58	30.5	20	24.7
1000	Assembly	2	1.1	1	1.2
2000	Institutional	4	2.1	1	1.2
3000	Residential	98	51.6	40	49.4
4000	Business & personal service	1	0.5		
5000	Mercantile	3	1.6	2	2.5
6000	Industrial manufacturing companies	1	0.5	1	1.2
7000	Storage properties	4	2.1	1	1.2
8000	Special property & transportation equipment	14	7.4	12	14.8
9000	Miscellaneous property	5	2.6	3	3.7
Total		190	100	81	100

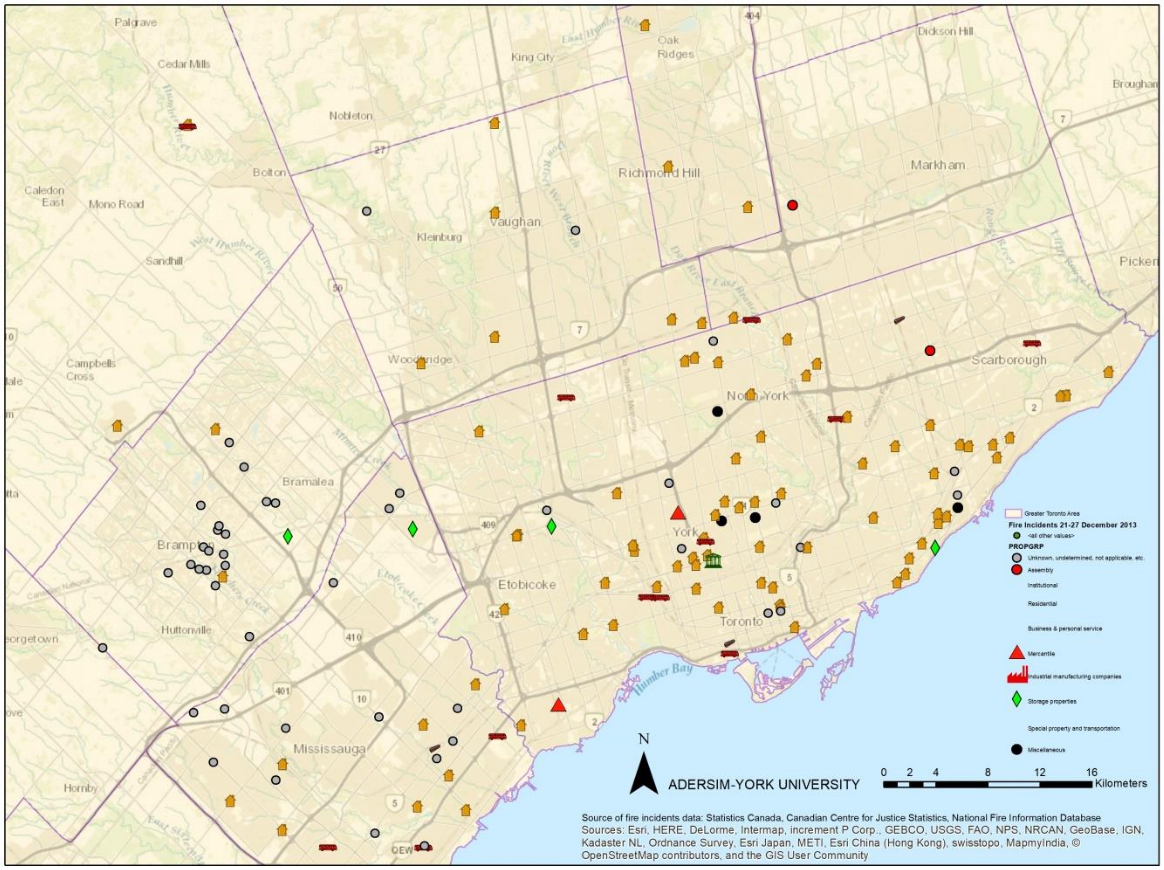
Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 10.6A PROPERTY CLASSES AND FIRE INCIDENTS, DECEMBER 21-27, 2013 AND 2014



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 10.6B PROPERTY CLASSES AND FIRE INCIDENTS, DECEMBER 21-27, 2013 AND 2014



Property Height

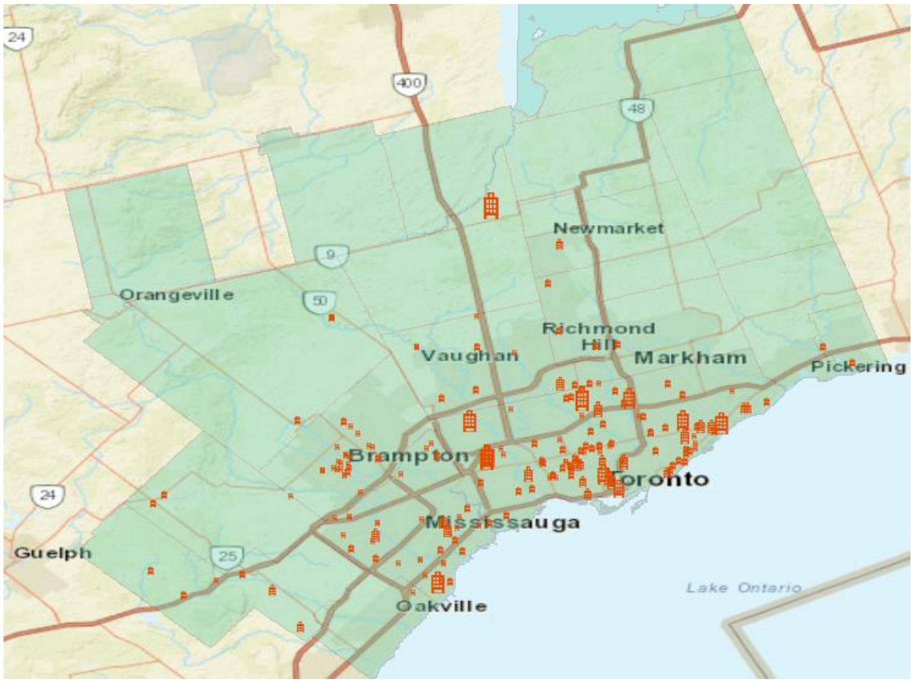
There are not many considerable differences between the ice storm dataset (2013) and control dataset (2014) regarding the property height variable (Table 10.7 and Figure 10.7). The percentage figures show a similar trend in property height variable in both datasets.

TABLE 10.7 PROPERTY HEIGHT AND FIRE INCIDENTS, DECEMBER 21-27, 2013 AND 2014

HEIGHT (stories)	2013		2014	
	INCIDENTS	PERCENT	INCIDENTS	PERCENT
0	79	41.6	35	43.2
1	23	12.1	7	8.6
2	52	27.4	23	28.4
3	6	3.2	5	6.2
4	6	3.2	2	2.5
6	2	1.1	1	1.2
7	5	2.6	1	1.2
8	1	0.5		
9	1	0.5		
10	2	1.1		
11	1	0.5		
12			1	1.2
14	1	0.5	1	1.2
15			1	1.2
16	2	1.1		
17	1	0.5		
19			1	1.2
20	1	0.5	2	2.5
22	2	1.1		
23	1	0.5		
24	1	0.5		
25	1	0.5		
26	1	0.5		
45	0	0	1	1.2
998	1	0.5		
Total	190	100	81	100

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 10.7 PROPERTY HEIGHT AND FIRE INCIDENTS, DECEMBER 21-27, 2013



FIRE PROTECTION FEATURES IN FIRE INCIDENTS DURING THE 2013 ICE STORM IN THE GREATER TORONTO AREA

Fire Protection Device

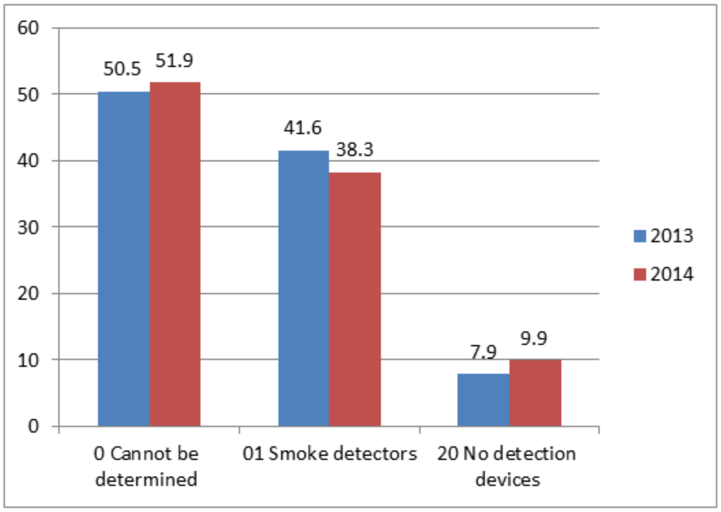
There are not considerable differences between ice storm dataset (2013) and control dataset (2014) regarding the Fire Protection Device variable (Table 10.8 and Figure 10.8). It means that the ice storm did not have a significant impact on occurrence of fire incidents.

TABLE 10.8 FIRE DETECTION DEVICE IN FIRE INCIDENTS, DECEMBER 21-27, 2013 AND 2014

FIRE DETECTION DEVICES		2013		2013	
CODE	DESCRIPTION	INCIDENTS	PERCENT	INCIDENTS	PERCENT
0	Cannot be determined	96	50.5	42	51.9
01	Smoke detectors	79	41.6	31	38.3
20	No detection devices	15	7.9	8	9.9
	Total	**190**	**100**	**81**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 10.8 FIRE DETECTION DEVICE IN FIRE INCIDENTS, DECEMBER 21-27, 2013 AND 2014



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

CIRCUMSTANCES CONTRIBUTING TO THE OUTBREAK OF FIRE

Igniting Object

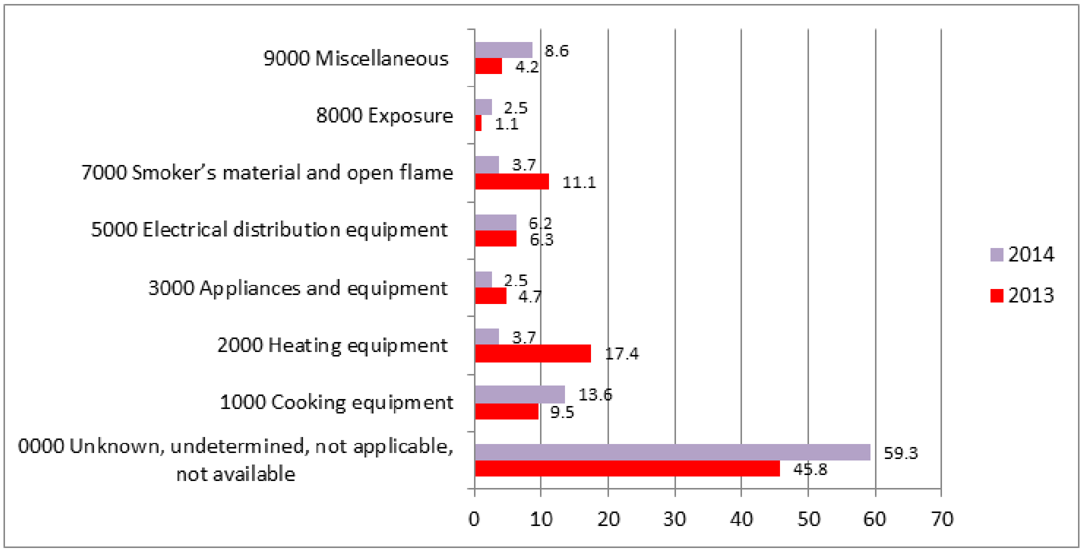
There are considerable differences between the ice storm dataset (2013) and control dataset (2014) regarding the igniting object variable (table 10.9 and figure 10.9). While 11.1% of fire incidents in the ice storm dataset (2013) are classified as "*Smoker's material and open flame*" in the igniting object group, this amount for the control dataset (2014) is 3.7% which is three times less than 2013 dataset. Moreover, while 17.4% of the fire incidents in ice storm dataset originated from "*heating equipment*", this number for control dataset is 3.7% which is almost five times smaller. It demonstrates that probably the ice storm affected the heating equipment such as furnaces, boilers, stokers, fire places, and chimneys and caused fire incidents. In addition, it might have impacted the smoker's material and equipment such as cigarettes, matches, pipes, cigars, lighters and welding equipment to cause a fire incident.

TABLLE 10.9 IGNITING OBJECT IN FIRE INCIDENTS, DECEMBER 21-27, 2013 AND 2014

IGNITING OBJECT GROUP		2013		2014	
CODE	**DESCRIPTION**	**INCIDENTS**	**PERCENT**	**INCIDENTS**	**PERCENT**
0000	Unknown, undetermined, not applicable, not available	87	45.8	48	59.3
1000	Cooking equipment	18	9.5	11	13.6
2000	Heating equipment	33	17.4	3	3.7
3000	Appliances and equipment	9	4.7	2	2.5
5000	Electrical distribution equipment	12	6.3	5	6.2
7000	Smoker's material and open flame	21	11.1	3	3.7
8000	Exposure	2	1.1	2	2.5
9000	Miscellaneous	8	4.2	7	8.6
Total		190	100	81	100

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 10.9 IGNITING OBJECT IN FIRE INCIDENTS, DECEMBER 21-27, 2013 AND 2014



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Fuel or Energy Associated with Igniting Object

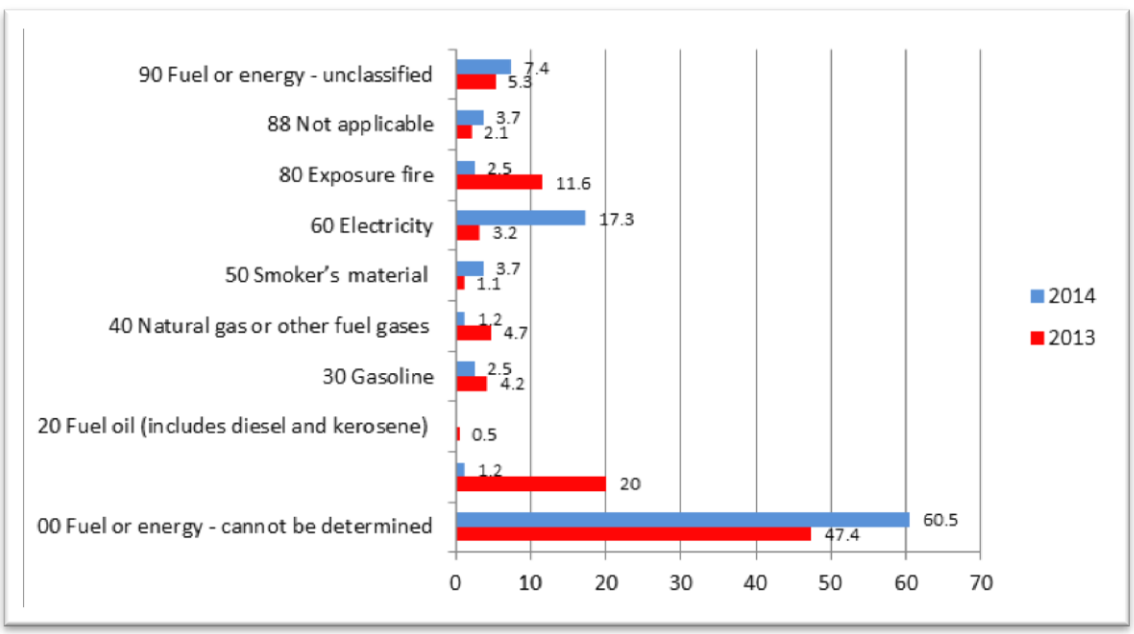
There are noticeable differences between the ice storm dataset (2013) and the control dataset (2014) regarding the fuel or energy associated with igniting object variable (Table 10.10 and Figure 10.10). While 20% of fire incidents in the ice storm dataset are classified as code 10 which is "*coal and wood*", this amount for the control dataset is only 1.2% which shows a huge gap. Also, in code 80 which is "*exposure fire*" the percentage for the ice storm dataset is dramatically higher than the control dataset. While 11.6% of the fire incidents in the 2013 dataset originated from exposure fire, this number for the 2014 dataset is 2.5%. Another difference is related to code 60 or "*Electricity*". 17.3% of fire incidents in the control dataset are assigned to the electricity in the control dataset while this number for the ice storm dataset is 3.2%. In sum, at the time of ice storm there are more fire incidents fueled by coal, wood and exposure fire and less fires related to electricity. Significantly less fire incidents associated with electricity is probably because of a week-long black out during the ice storm in December 2013 in Toronto; if there is no power, there will be no fire incidents ignited by electricity.

TABLE 10.10 ENERGY ASSOCIATED WITH IGNITING OBJECT IN FIRE INCIDENTS, DECEMBER 21-27, 2013 AND 2014

FUEL OR ENERGY ASSOCIATED WITH IGNITING OBJECT		2013		2014	
CODE	**DESCRIPTION**	**INCIDENTS**	**PERCENT**	**INCIDENTS**	**PERCENT**
00	Fuel or energy - cannot be determined	90	47.4	49	60.5
10	Coal, wood (includes coke, paper or waste used for lighting or incidental burning)	38	20	1	1.2
20	Fuel oil (includes diesel and kerosene)	1	0.5		
30	Gasoline	8	4.2	2	2.5
40	Natural gas or other fuel gases	9	4.7	1	1.2
50	Smoker's material	2	1.1	3	3.7
60	Electricity	6	3.2	14	17.3
80	Exposure fire	22	11.6	2	2.5
88	Not applicable	4	2.1	3	3.7
90	Fuel or energy - unclassified	10	5.3	6	7.4
Total		190	100	81	100

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 10.10 ENERGY ASSOCIATED WITH IGNITING OBJECT IN FIRE INCIDENTS, DECEMBER 21-27, 2013



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Material First Ignited Group

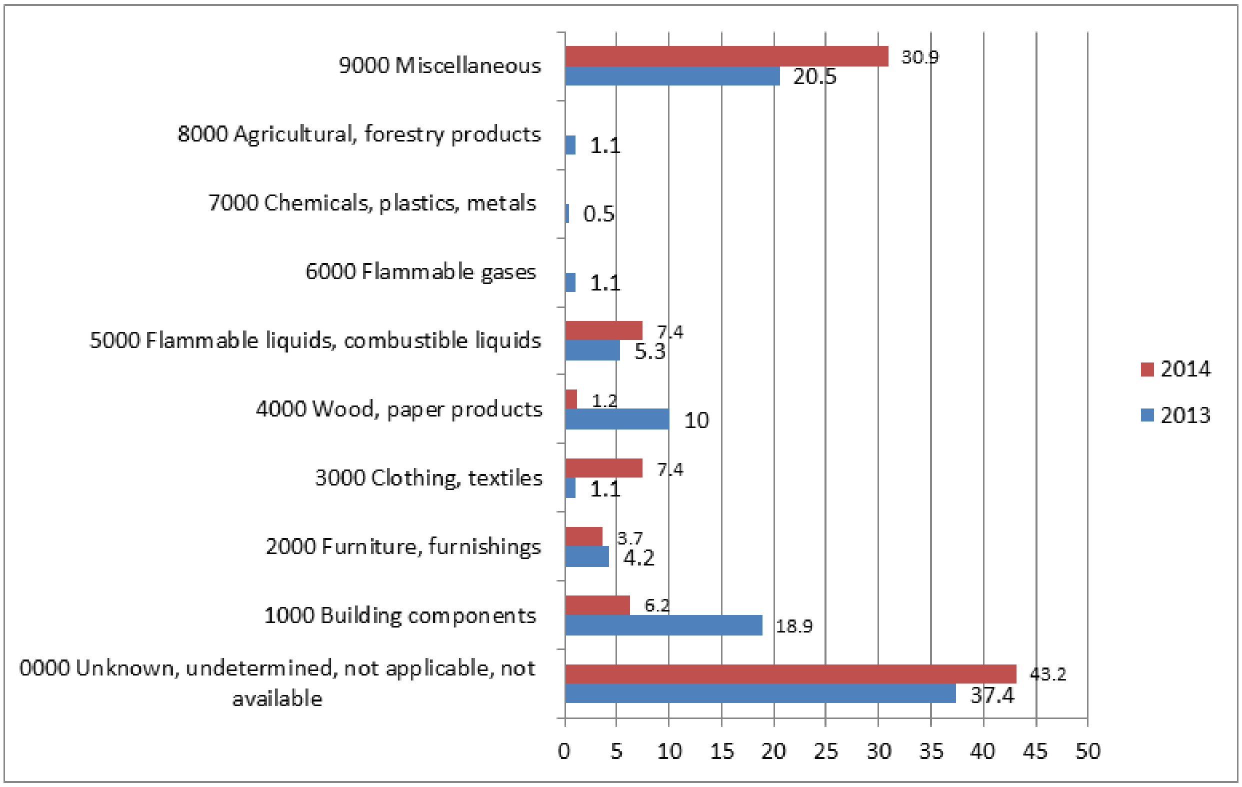
There are some considerable differences between the ice storm dataset and the control dataset regarding the material first ignited group variable (Table 10.11 and Figure 10.11). While 10% of fire incidents in the ice storm dataset (2013) are classified as code 4000 which is "*wood and paper products*", this amount for the control dataset (2014) is only 1.2% which is an indication that during the ice storm due to the power outage people used wood and paper to kindle fire. Another difference is related to code 1000 which is "*building components*". For this item the value of the ice storm dataset is almost 19% while the similar number for the control dataset is 6.2%. This probably because of the fires ignited inside the buildings to heat houses. Since there was power outage for a couple of days during the ice storm, people had to warm themselves with direct flames, and this increases the risk of fire occurrence.

TABLE 10.11 MATERIAL FIRST IGNITED IN FIRE INCIDENTS, DECEMBER 21-27, 2013

MATERIAL FIRST IGNITED GROUP		2013		2014	
CODE	**DESCRIPTION**	**INCIDENTS**	**PERCENT**	**INCIDENTS**	**PERCENT**
0000	**Unknown, undetermined, not applicable, not available**	71	37.4	35	43.2
1000	Building components	36	18.9	5	6.2
2000	Furniture, furnishings	8	4.2	3	3.7
3000	Clothing, textiles	2	1.1	6	7.4
4000	Wood, paper products	19	10	1	1.2
5000	Flammable liquids, combustible liquids	10	5.3	6	7.4
6000	Flammable gases	2	1.1		
7000	Chemicals, plastics, metals	1	0.5		
8000	Agricultural, forestry products	2	1.1		
9000	Miscellaneous	39	20.5	25	30.9
Total		**190**	**100**	**81**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 10.11 MATERIAL FIRST IGNITED IN FIRE INCIDENTS, DECEMBER 21-27, 2013



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Act or Omission

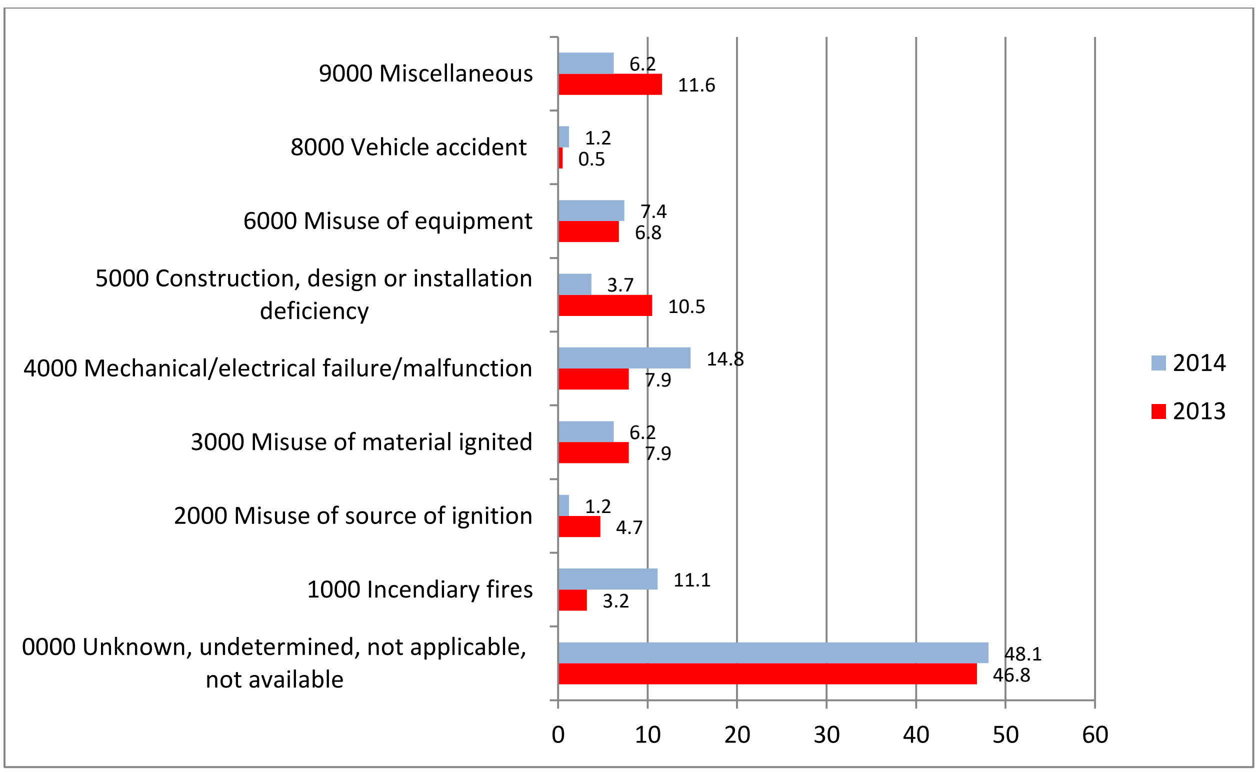
There are some differences between the ice storm dataset and the control dataset regarding the Act or Omission Group variable (Table 10.12 and Figure 10.12). While 10.5% of fire incidents in the ice storm dataset (2013) are classified as code 5000 which is "*construction, design or installation deficiency*", this amount for the control dataset (2014) is 3.7%. On the other hand, while the amount for items "*incendiary fires*" and "*mechanical/ electrical failures*" in the control dataset are 11.1% and 14.8% respectively, the numbers for the ice storm dataset are 3.2% and 7.9%. It illustrates that there are more fire incidents related to the building situation and less fires related to the electricity and mechanical issues during the ice storm which is compatible with previous findings.

TABLE 10.12 ACT OR OMISSION IN FIRE INCIDENTS, DECEMBER 21-27, 2013

ACT OR OMISSION GROUP		2013		2014	
CODE	**DESCRIPTION**	**INCIDENTS**	**PERCENT**	**INCIDENTS**	**PERCENT**
0000	Unknown, undetermined, not applicable, not available	89	46.8	39	48.1
1000	Incendiary fires	6	3.2	9	11.1
2000	Misuse of source of ignition	9	4.7	1	1.2
3000	Misuse of material ignited	15	7.9	5	6.2
4000	Mechanical/electrical failure/malfunction	15	7.9	12	14.8
5000	Construction, design or installation deficiency	20	10.5	3	3.7
6000	Misuse of equipment	13	6.8	6	7.4
8000	Vehicle accident	1	0.5	1	1.2
9000	Miscellaneous	22	11.6	5	6.2
Total		190	100	81	100

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 10.12 ACT OR OMISSION IN FIRE INCIDENTS, DECEMBER 21-27, 2013



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

ORIGIN AND SPREAD OF FIRE IN FIRE INCIDENTS DURING THE 2013 ICE STORM IN THE GREATER TORONTO AREA

Area of Origin

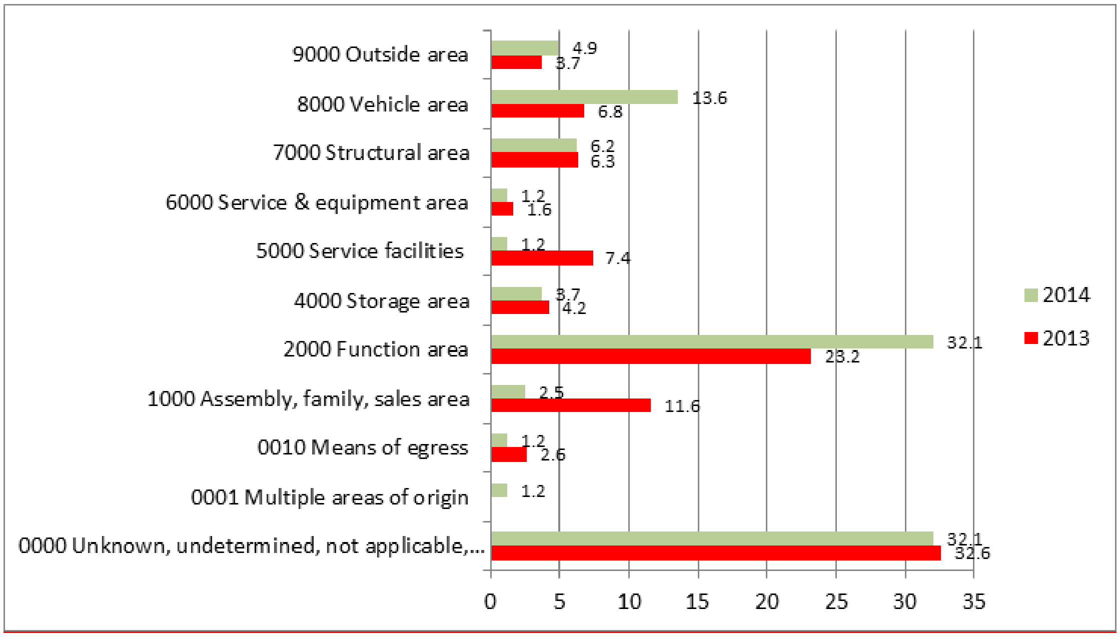
There are noticeable differences between the ice storm dataset and the control dataset regarding the Area of Origin variable (Table 10.13 and Figure 10.13). While 11.6% of fire incidents in the ice storm dataset (2013) are classified as code 1000 which is "*assembly, family, sales area*", this amount for the control dataset (2014) is 2.5%. Also, in the condition that the value of code 5000 which means "*service facility*" for the ice storm dataset is 7.4%, the similar number for control dataset is 1.2%. On the other hand, while the amount for items "*vehicle area*" in the control dataset is 13.6%, this number for the ice storm dataset is 6.8%. These figures demonstrate that there are more fires in houses, shops, and service parts of the buildings such as ducts and chimneys, and less fires in vehicles during the ice storm.

TABLE 10.13 AREA OF ORIGIN IN FIRE INCIDENTS, DECEMBER 21-27, 2013

AREA OF ORIGIN GROUP		2013		2014	
CODE	DESCRIPTION	INCIDENTS	PERCENT	INCIDENTS	PERCENT
0000	Unknown, undetermined, not applicable, not available	62	32.6	26	32.1
0001	Multiple areas of origin			1	1.2
0010	Means of egress	5	2.6	1	1.2
1000	Assembly, family, sales area	22	11.6	2	2.5
2000	Function area	44	23.2	26	32.1
4000	Storage area	8	4.2	3	3.7
5000	Service facilities	14	7.4	1	1.2
6000	Service & equipment area	3	1.6	1	1.2
7000	Structural area	12	6.3	5	6.2
8000	Vehicle area	13	6.8	11	13.6
9000	Outside area	7	3.7	4	4.9
Total		**190**	**100**	**81**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 10.13 AREA OF ORIGIN IN FIRE INCIDENTS, DECEMBER 21-27, 2013



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Level of Origin

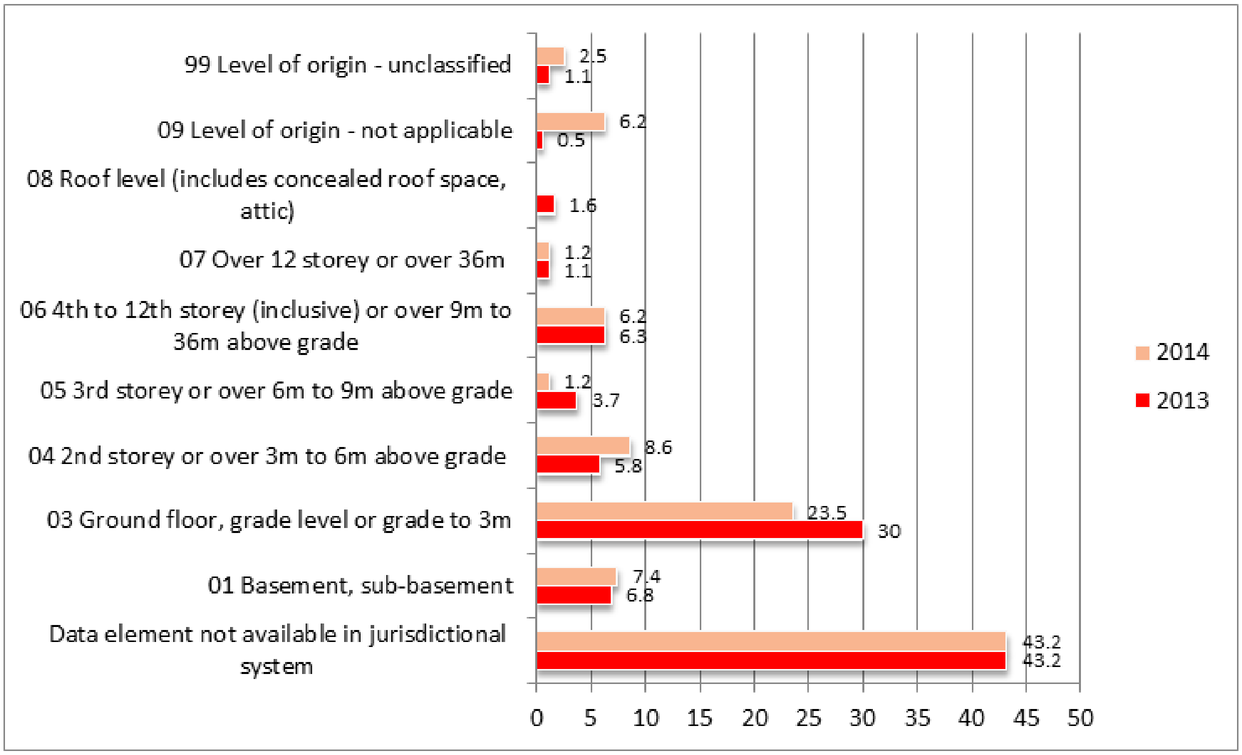
There are not many differences between the ice storm dataset and the control dataset regarding the Level of Origin variable (table 10.14 and figure 10.14). The only minor difference is related to code 03 which means "*ground floor*". While 30% of fire incidents in the ice storm dataset (2013) are at the ground floor, this number for the control dataset (2014) is 23.5%.

TABLE 10.14 LEVEL OF ORIGIN IN FIRE INCIDENTS, DECEMBER 21-27, 2013

LEVEL OF ORIGIN		2013		2014	
CODE	DESCRIPTION	INCIDENTS	PERCENT	INCIDENTS	PERCENT
	Data element not available in jurisdictional system	82	43.2	35	43.2
01	Basement, sub-basement	13	6.8	6	7.4
03	Ground floor, grade level or grade to 3m	57	30	19	23.5
04	2nd storey or over 3m to 6m above grade	11	5.8	7	8.6
05	3rd storey or over 6m to 9m above grade	7	3.7	1	1.2
06	4th to 12th storey (inclusive) or over 9m to 36m above grade	12	6.3	5	6.2
07	Over 12 storey or over 36m	2	1.1	1	1.2
08	Roof level (includes concealed roof space, attic)	3	1.6		
09	Level of origin - not applicable	1	0.5	5	6.2
99	Level of origin - unclassified	2	1.1	2	2.5
Total		**190**	**100**	**81**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 10.14 LEVEL OF ORIGIN IN FIRE INCIDENTS, DECEMBER 21-27, 2013



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIRE LOSS IN FIRE INCIDENTS DURING THE 2013 ICE STORM IN THE GREATER TORONTO AREA

Extent of Fire

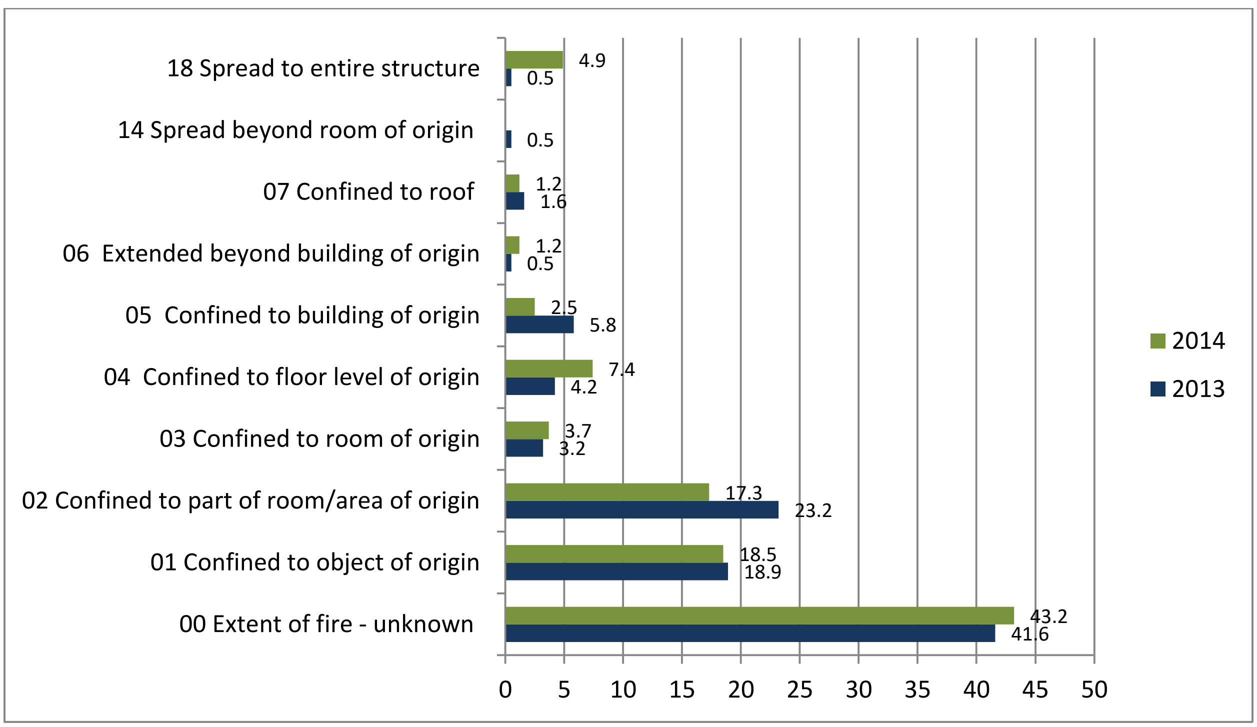
There are not major differences between the ice storm dataset and the control dataset regarding the Extent of Fire variable (table 10.15 and figure 10.15). The only minor differences are related to code 02 and 05 which means "*confined to part of room/area of origin*" and "*confined to building of origin*" respectively. While 23.2% of fire incidents are confined to part of room/area of origin in the ice storm dataset, this number for the control dataset is a bit smaller and equal to 17.3%. Also, in the condition that 5.8% of fire incidents in the ice storm dataset are assigned to "*confined to building of origin*", this number for the control dataset is 2.5%.

TABLE 10.15 EXTENT OF FIRE IN FIRE INCIDENTS, DECEMBER 21-27, 2013

EXTENT OF FIRE		2013		2014	
CODE	DESCRIPTION	INCIDENTS	PERCENT	INCIDENTS	PERCENT
00	Extent of fire - unknown	79	41.6	35	43.2
01	Confined to object of origin	36	18.9	15	18.5
02	Confined to part of room/area of origin	44	23.2	14	17.3
03	Confined to room of origin	6	3.2	3	3.7
04	Confined to floor level of origin	8	4.2	6	7.4
05	Confined to building of origin	11	5.8	2	2.5
06	Extended beyond building of origin	1	0.5	1	1.2
07	Confined to roof	3	1.6	1	1.2
14	Spread beyond room of origin	1	0.5		
18	Spread to entire structure	1	0.5	4	4.9
	Total	190	100	81	100

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 10.15 EXTENT OF FIRE IN FIRE INCIDENTS, DECEMBER 21-27, 2013 AND



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

DISCOVERY OF FIRE AND ACTIONS TAKEN IN FIRE INCIDENTS DURING THE 2013 ICE STORM IN THE GREATER TORONTO AREA

Initial Detection

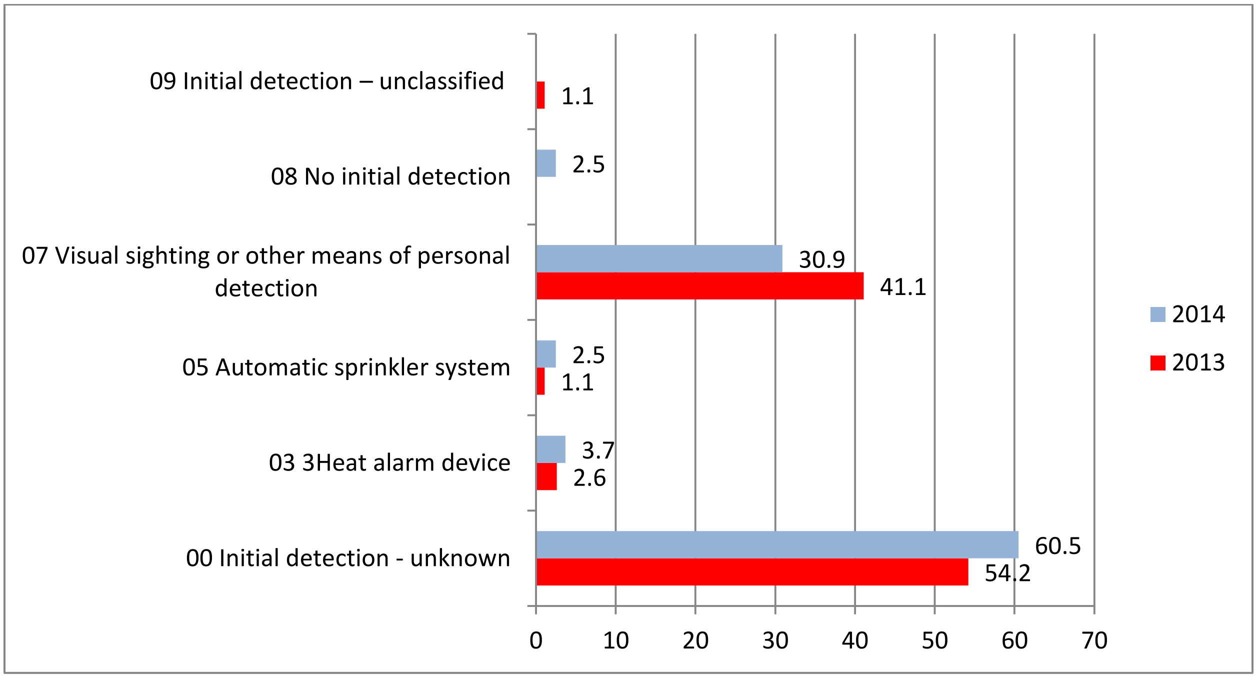
There are not many differences between the ice storm dataset and the control dataset regarding the Initial Detection variable (table 10.16 and figure 10.16). The only minor difference is related to code 07 which means "*Visual sighting or other means of personal detection*". While 41% of fire incidents in ice storm dataset are detected by visual sighting or personal detection, this number for the control dataset is 31%, which shows a small difference.

TABLE 10.16 INITIAL DETECTION OF FIRE IN FIRE INCIDENTS, DECEMBER 21-27, 2013

INITIAL DETECTION		2013		2013	
CODE	DESCRIPTION	INCIDENTS	PERCENT	INCIDENTS	PERCENT
00	Initial detection - unknown	103	54.2	49	60.5
03	Heat alarm device	5	2.6	3	3.7
05	Automatic sprinkler system	2	1.1	2	2.5
07	Visual sighting or other means of personal detection	78	41.1	25	30.9
08	No initial detection			2	2.5
09	Initial detection – unclassified	2	1.1		
Total		190	100	81	100

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 10.16 INITIAL DETECTION OF FIRE IN FIRE INCIDENTS, DECEMBER 21-27, 2013



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Action Taken

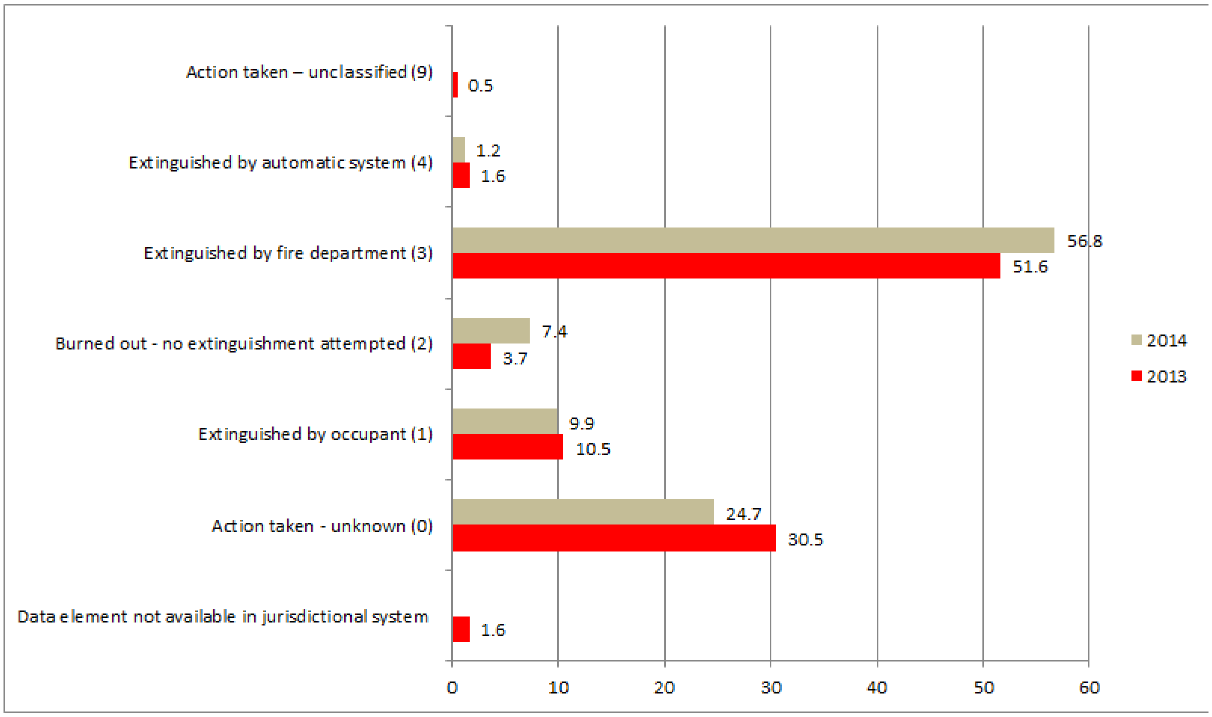
There are no major differences between the ice storm dataset and the control dataset regarding the Action Taken variable (table 10.17 and figure 10.17). There are some differences in code 2 "*Burned out*", and code 3 "*Extinguished by fire department*" but they are not significant and probably are due to a sampling error.

TABLE 10.17 ACTION TAKEN IN FIRE INCIDENTS, DECEMBER 21-27, 2013

ACTION TAKEN		2013		2014	
CODE	**DESCRIPTION**	**INCIDENTS**	**PERCENT**	**INCIDENTS**	**PERCENT**
	Data element not available in jurisdictional system	3	1.6		
0	Action taken - unknown	58	30.5	20	24.7
1	Extinguished by occupant	20	10.5	8	9.9
2	Burned out - no extinguishment attempted	7	3.7	6	7.4
3	Extinguished by fire department	98	51.6	46	56.8
4	Extinguished by automatic system	3	1.6	1	1.2
9	Action taken – unclassified	1	0.5		
Total		**190**	**100**	**81**	**100**

Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

FIGURE 10.17 ACTION TAKEN IN FIRE INCIDENTS, DECEMBER 21-27, 2013



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

CONCLUSION

The 2013 Ice Storm that occurred during December 20 and December 23, was one of the worst storms to hit Southern Ontario. The ice storm caused huge piles of debris across the Greater Toronto Area, taking down power poles, power cables, trees, homes, buildings and vehicles. During this disastrous event, fire incidents increased because many residents were left without power for an extensive amount of time. It is believed that many of the residents who were left without power, began to make their own source of heat using coal and wood to ignite fires. This statistic is echoed in the dataset, when looking at the category "*fuel or energy associated with igniting object*". 20% of fires during the ice storm were ignited using "*coal and wood*" only 3.2% were ignited with "*electricity*". There is significantly less fire incidents associated with electricity because of the week-long black out that occurred due to the ice storm.

11 CONCLUSION

Canada is exposed to a large number of different kinds of natural, technological and human made hazards that have the potential to create large scale disasters and emergencies. A large number of Canadians have experienced disaster and emergency events in their life time. According to the Canadian Disaster Database, The most common disaster events (from 1900-2016) in Canada are: Meteorological-Hydrological (73%), Transportation accidents (6%), Geological (4%), and Explosion (4%). Although the direct human impacts of disasters have been low, the direct and indirect economic costs have been huge and are increasing. Much of the costs of natural disasters in Canada are attributed to five major disasters: Fort McMurray Wildfire (2016), Southern Alberta Floods (2013), Great Ice Storm (1998), Toronto flood (2013), and Slave Lake Fire (2011).

This study examined fire incident patterns during these major disasters and emergencies in Canada. The results provide useful information about the variations and similarities of fire incident volume and characteristic during major disasters and emergencies. The findings provide valuable information to fire departments, as it relates to their operations and activities, especially those without prior recent experiences with major disasters and emergencies. This information should enable fire departments to more accurately assess the volume and nature of fire incidents during possible disaster events in their jurisdictions and plan accordingly. It will help fire departments to plan for the possible increase in demand, size, additional supports needed, impacts and consequences of such events.

Very few studies have examined the challenges that fire departments face during the major disaster and emergency situations. However, the existing research suggests that disasters and emergencies can minimize the capacity (human, equipment, communication) as well as the ability (access, environment, etc.) of fire departments to effectively perform their operations during major emergencies. Disaster situations can quickly overwhelm the fire departments existing or access to resources. Due to the rarity of disaster and emergency situations, only a very limited number of fire departments have experience in disaster situations.

During major emergencies, fire departments may need to deviate from normal procedures. Fire department employees and their families may be impacted by the disaster or become subject to additional safety and security risks during the operations. Long hours of work in complex emergency situation can result emergency responders suffering from post-traumatic stress disorder (PTSD). Major disasters may require mutual aid, but it can be available only when the nearby jurisdictions are not impacted by the same disaster at the same time.

The numbers of fire incidents during major emergencies in different jurisdictions are different from the number of fire incidents in normal situations. Jurisdictions with a larger number of fire incidents during normal situations do not necessarily have more fire incidents during emergency situations as well. Based on this study while Ontario has about 53.08% of fire incidents among the jurisdictions included in this study, British Colombia has the largest share of fire incidents (45.6%) during disaster and emergency days, followed by Alberta (34.6%) and Manitoba (12.2%).

While the number of fire incidents during normal situations show a downward trend during the study period (2005-2014) in most jurisdictions, the number of fire incidents during major disasters and emergencies display an increasing trend overall.

Six major disasters were examined in this study to further understand the similarities and differences of fire incidents patterns during normal and emergency situations. These cases were: Toronto Sunrise Propane Explosion, 2008; Slave Lake Wildfire, 2011; Vancouver Riot, 2011; Alberta Flood, 2013; Flash Flood in Toronto, 2013; Ice Storm in the Greater Toronto Area, 2013.

The Toronto Sunrise Propane Explosion was the first major emergency that was examined. During the sunrise propane explosion, fire incidents in Toronto increased by 20 times more than the average number of fire incidents. Majority of the reported fire incidents were related to the explosion.

Slave Lake Wildfire in 2011 was the second major disaster that was examined in more detail. In Canada, there seems to be an increasing trend in the number, intensity, and consequences of wildfires. The Slave Lake Wildfire created a significantly high number of fire incidents that required response by fire fighters from various fire departments in Alberta and beyond. About 1402 fire incidents were recorded in the Slave Lake Region on May 14, 2011 and mutual aid was heavily used in these fire incidents. Alberta fire incidents records have significantly changed as a result of this wildfire but have again drastically changed due to the Fort McMurray fire in 2016.

The third disaster case was a human made emergency, the 2011 Vancouver Riots. Fire incidents during the Vancouver riot in June 15 and 16, 2011 were examined in more details and compared with the fire incidents reported in the rest of British Columbia (BC) on the same day. A significant difference between the combinations of fire incidents in terms of property class was observed during the riot days compared with fire incidents in the rest of BC. "*Trash, rubbish and recyclables*" consisted of more than 70% of the fire incidents in Vancouver. Majority of riot incidents were in "outside areas and vehicles" in terms of the fire's ground floor area attribute.

The fourth case study was the Southern Alberta Flood of June/July 2013. While fire incidents are not expected to happen as the direct result of flooding, fire incidents were thought to increase due to a large number of secondary hazards associated with flooding events such as power outages, vehicle accidents, and release of hazardous materials. Overall, the Southern Alberta Flood did not change the number of fire incidents very much, when compared to normal situations.

The Flash Flood in Toronto which occurred on July 8, 2013 was the fifth case study. This case study was selected because of its impact to a large populated area as well as its significant economic costs. The flash flood caused major disruptions in the city and the surrounding areas. At the time with more than $944 million insured and infrastructure losses, it was recorded as the most expensive disaster for the province of Ontario and among the top 10 costliest disasters in Canada. Fire incidents during this event (July 8 to July 10) were compared with the fire incidents on the same days in Toronto in 2014. Overall, 30 fire incidents have been reported for July 8-10, 2013 and 30 fire incidents for July 8-10 2014. However, smaller fire crew sizes were used more often in response to fire incidents during the flash flood in Toronto. It was also found that distance to emergencies has increased during the flash flood days. The number of fire incidents with electricity as the fuel or energy was higher during the flash flood days, which could be because of the massive power outages in the area.

The last emergency case that was examined in this study was the December 2013 Ice Storm in the Greater Toronto Area. This ice storm caused massive power outages, and more than 600,000 households were without power, some for more than a week. According to Toronto Fire Services database (not the NFID) on December 22, there were 3820 service requests received. Fire incidents for December 21-27, 2013 (190 cases) were compared with the fire incidents for the same days in 2014 (81 cases). Close to half of the fire incidents during the ice storm occurred in the City of Toronto and majority of the remaining in Brampton (17%) and Mississauga (16%). It appears from the findings that mutual aid was not used in this case. It is not clear whether it was because there was no need or because all neighboring fire departments were experiencing similar event at the same time.

It has to be mentioned that due to large volumes of unknowns for many of the fire incidents attributes, it was not possible to examine all attributes in details. Also, due to the unavailability of exact locations for some fire incidents, it was not possible to carry out spatial analysis on all the data. Availability of such information could provide opportunities for more complex statistical and spatial analyses. However, despite the limitations, this study was able to provide some useful results out of the NFID fire incidents records. More studies will be needed to examine fire incidents during major studies from other aspects.

While fire incidents have been examined in normal conditions at different geographical scales in different contexts, the study of fire incidents during major disaster and emergency situations are rare globally and extremely limited in Canada. Studies show that during most disaster and emergency situations the total number of emergency calls increases and the demand for and pressure on emergency services rise. This, in turn may impact response times and effectiveness due to possible communication, power, water, and transportation disruptions. Change in people's behaviour in such situations may also impact the number and nature of fire incidents as well as the way they react to them. Also, the various secondary hazards associated with disasters may complicate the situations even further and generate new sets of fire incidents in the disaster impacted areas.

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APPENDICES

APPENDIX 1: DISASTERS INCLUDED IN THE ANALYSIS

Disaster event	Province	Location	Start Year	Start Month	Start Date	End Year	End Month	End Date
Wildfire	BC	British Columbia	2014	7	1	2014	9	30
Flood	MB	Southern Manitoba	2014	6	25	2014		
Flood	SK	Southern Saskatchewan	2014	6	25	2014	7	14
Flood	AB	Southern Alberta	2014	6	15	2014		
Winter Storm	ON	Southern Ontario	2013	12	21	2013		
Winter Storm	NB	Ontario, Quebec and New Brunswick	2013	12	-	2014	1	3
Flood	ON	Toronto ON	2013	7	8	2013	7	8
Flood	AB	Southern Alberta	2013	6	19	2013	6	28
Wildfire	AB	Lethbridge and Coalhurst AB	2012	9	10	2012	9	11
Wildfire	BC	Peachland BC	2012	9	9	2012	9	12
Wildfire	ON	Sandy Lake First Nation ON	2012	7	31	2012	8	6
Flood	ON	Thunder Bay ON	2012	5	28	2012	5	28
Wildfire	ON	Kirkland Lake ON	2012	5	20	2012	5	29
Tornado	ON	Goderich ON	2011	8	21	2011	8	22
Rioting	BC	Vancouver BC	2011	6	15	2011	6	16
Flood	MB	Southern Manitoba	2011	6	2	2011	7	9
Flood	AB	Calgary AB	2011	5	29	2011	5	31
Wildfire	AB	Slave Lake AB	2011	5	15	2011	5	22
Flood	MB	Brandon MB	2011	5	10	2011	5	28
Wildfire	BC	British Columbia	2010	7	28	2010	9	8
Storm/Unspecified	AB	Calgary AB	2010	7	12	2010	7	12
Tornado	SK	Saskatchewan	2010	6	29	2010	6	2
Wildfire	MB	Cranberry Portage MB	2010	6	23	2010	6	6
Tornado	ON	Midland ON	2010	6	23	2010	6	23
Flood	MB	Winnipeg MB	2010	5	28	2010	5	30
Wildfire	AB	County of Thorhild AB	2010	5	12	2010	5	12
Tornado	ON	Toronto, Windsor, Vaughan and Newmarket ON	2009	8	20	2009	8	20
Storms and Severe Thunderstorms	MB	Winnipeg and Steinbach MB	2009	8	14	2009	8	14
Storms and Severe Thunderstorms	AB	Southern Alberta	2009	8	1	2009	8	3
Heat Event	BC	Vancouver and Fraser BC	2009	7	27	2009	8	3
Storms and Severe Thunderstorms	AB	Edmonton AB	2009	7	18	2009	7	18
Wildfire	BC	Kelowna, Kamloops and Cariboo BC	2009	5	1	2009	8	31
Storms and Severe Thunderstorms	ON	Ottawa, Toronto and Windsor ON	2009	4	25	2009	4	25
Flood	MB	Roseau River First Nation, Sioux Falls, Peguis First Nation, St. Andrews, St. Clements and Selkirk MB	2009	3	24	2009	5	21
Storms and Severe Thunderstorms	BC	Vancouver, Fraser Valley and the Greater Vancouver Regional Districts BC	2009	1	6	2009	1	8
Storms and Severe	BC	Greater Vancouver and Fraser	2009	1	6	2009	1	8

Thunderstorms		Valley BC						
Non-Residential	ON	Toronto ON	2008	8	10	2008	8	10
Tornado	MB	Winnipeg MB	2008	7	11	2008	7	11
Wildfire	MB	Pukatawagan MB	2008	6	10	2008	6	10
Wildfire	MB	Norway House and Sherridon MB	2008	5	28	2008	5	28
Flood	AB	High River AB	2008	5	24	2008	5	24
Flood	ON	Belleville ON	2008	4	14	2008	4	14
Flood	ON	Port Bruce ON	2008	2	18	2008	2	18
Flood	BC	Prince George BC	2007	12	10	2007	12	10
Storms and Severe Thunderstorms	BC	Vancouver BC	2007	11	12	2007	11	12
Wildfire	BC	Kootenay BC	2007	8	1	2007	8	1
Residential	AB	Edmonton AB	2007	7	21	2007	7	21
Storms and Severe Thunderstorms	AB	Calgary, Edmonton, St. Albert, the town of Stony Plain, Parkland County, Two Hills County, Kneehill County, Camrose, and the municipal districts of Rocky View and Bighorn AB	2007	6	5	2007	6	5
Non-Residential	ON	Hamilton ON	2007	6	3	2007	6	3
Non-Residential	ON	Windsor ON	2007	5	25	2007	5	25
Flood	MB	Selkirk MB	2007	4	3	2007	4	13
Storms and Severe Thunderstorms	BC	Vancouver BC	2006	12	11	2006	12	11
Storms and Severe Thunderstorms	ON	Ontario and Quebec	2006	10	29	2006	10	29
Fire	ON	Amherstburg ON	2006	8	15	2006	8	15
Leak / Spill Release	BC	Abbotsford BC	2005	9	28	2005	9	28
Wildfire	BC	Kelowna BC	2005	8	28	2005	8	28
Flood	AB	Southern Alberta	2005	6	6	2005	6	8
Flood	MB	Manitoba	2005	6	2	2005	6	2
Landslide	BC	North Vancouver BC	2005	1	17	2005	1	31

APPENDIX 2: DISTRIBUTION OF FIRE INCIDENTS IN BY MONTH IN REPORTING JURISDICTIONS 2005-2014

TABLE A2.1 DISTRIBUTION OF FIRE INCIDENTS IN ONTARIO BY YEAR AND MONTH

	Month											
Year	1	2	3	4	5	6	7	8	9	10	11	12
2005	1775	1505	1746	4340	3471	2676	3253	2403	2043	2010	1889	1679
2006	1544	1490	2305	3286	2952	2486	2421	2446	1706	1858	1808	1607
2007	1538	1497	1938	2715	3465	2791	2879	2927	2336	1871	1659	1432
2008	1575	1308	1453	2741	2475	1853	1964	2064	1599	1829	1529	1526
2009	1443	1329	2426	3081	2967	2262	1992	1929	1913	1565	1675	1385
2010	1361	1233	2404	4130	2829	1722	2242	2020	1749	1818	1581	1242
2011	1222	1132	1647	2269	2027	2273	2952	2004	1560	1593	1643	1288
2012	1262	1140	2205	3304	2980	2321	3380	2136	1740	1378	1525	1124
2013	1267	1008	1259	2001	2810	1655	1787	1901	1359	1302	1403	1406
2014	1247	1093	1281	2016	2283	1850	1855	1754	1376	1355	1333	1251
Total	**14234**	**12735**	**18664**	**29883**	**28259**	**21889**	**24725**	**21584**	**17381**	**16579**	**16045**	**13940**
%	**6.03%**	**5.40%**	**7.91%**	**12.66%**	**11.98%**	**9.28%**	**10.48%**	**9.15%**	**7.37%**	**7.03%**	**6.80%**	**5.91%**

Note: 6 incidents in 2013 and 31 incidents (0.02%) in 2014 classified as 99

FIGURE A2.1 DISTRIBUTION OF FIRE INCIDENTS IN ONTARIO BY YEAR AND MONTH

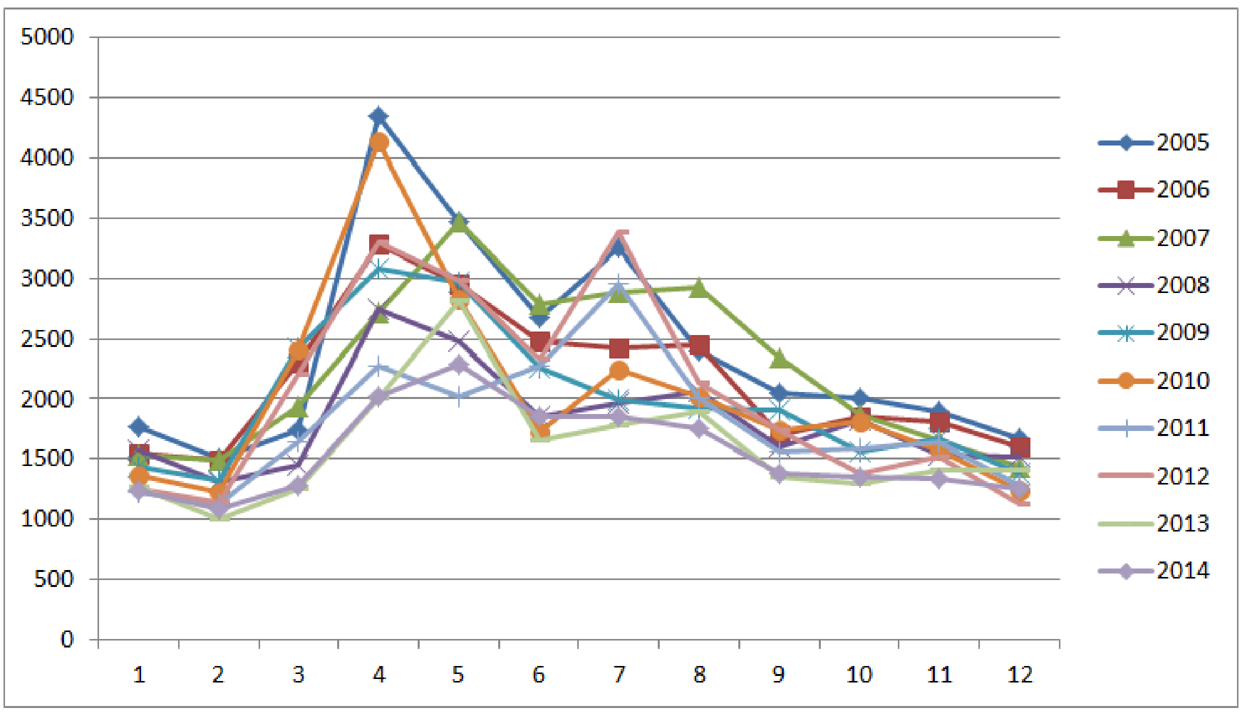


TABLE A 2.2 DISTRIBUTION OF FIRE INCIDENTS IN MANITOBA BY YEAR AND MONTH

	Month											
Year	1	2	3	4	5	6	7	8	9	10	11	12
2005	297	250	294	704	645	412	464	563	527	580	296	284
2006	272	299	292	777	572	631	803	748	601	492	336	267
2007	284	276	305	1076	620	446	546	657	516	539	458	263
2008	243	266	264	799	913	525	485	542	455	420	318	241
2009	248	265	328	477	944	507	501	440	538	440	560	281
2010	224	233	481	1278	611	449	489	430	429	548	402	230
2011	199	202	279	415	516	473	556	740	531	629	348	282
2012	261	226	477	916	492	529	544	509	655	369	160	190
2013	203	163	191	270	749	364	324	385	342	315	246	202
2014	188	178	218	292	653	354	312	294	283	393	250	209
2015	179	140	242	714	486	270	266	272	246	244	174	187
Total	**2598**	**2498**	**3371**	**7718**	**7201**	**4960**	**5290**	**5580**	**5123**	**4969**	**3548**	**2636**
%	4.68%	4.50%	6.07%	13.91%	12.98%	8.94%	9.53%	10.06%	9.23%	8.95%	6.39%	4.75%

FIGURE A.2.2 DISTRIBUTION OF FIRE INCIDENTS IN MANITOBA BY YEAR AND MONTH

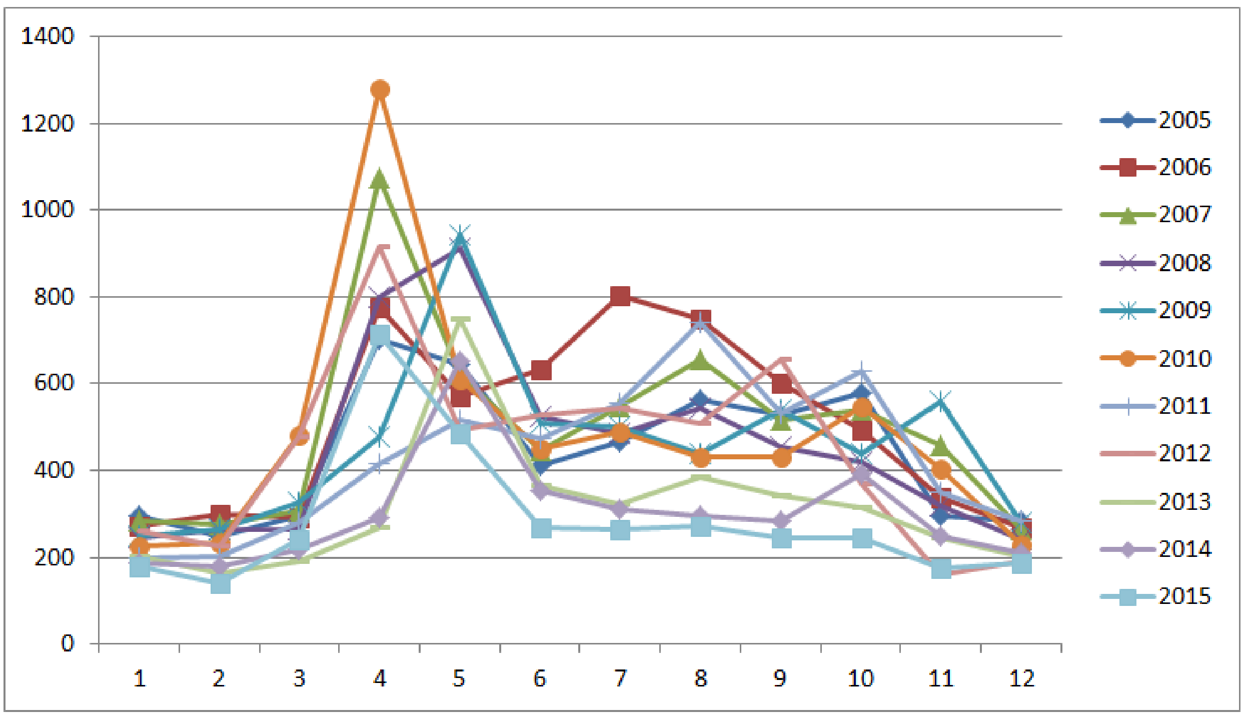


TABLE A3.3 DISTRIBUTION OF FIRE INCIDENTS IN SASKATCHEWAN BY YEAR AND MONTH

	Month											
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
2012	165	141	195	280	300	215	257	281	371	158	133	148
2013	165	107	130	137	342	204	198	272	363	245	126	143
2014	131	140	116	180	476	195	198	140	272	252	160	139
2015	195	106	148	360	237	261	254	215	221	213	136	119
Total	**656**	**494**	**589**	**957**	**1355**	**875**	**907**	**908**	**1227**	**868**	**555**	**549**
%	6.60%	4.97%	5.93%	9.63%	13.63%	8.80%	9.12%	9.13%	12.34%	8.73%	5.58%	5.52%

FIGURE A3.3 DISTRIBUTION OF FIRE INCIDENTS IN SASKATCHEWAN BY YEAR AND MONTH

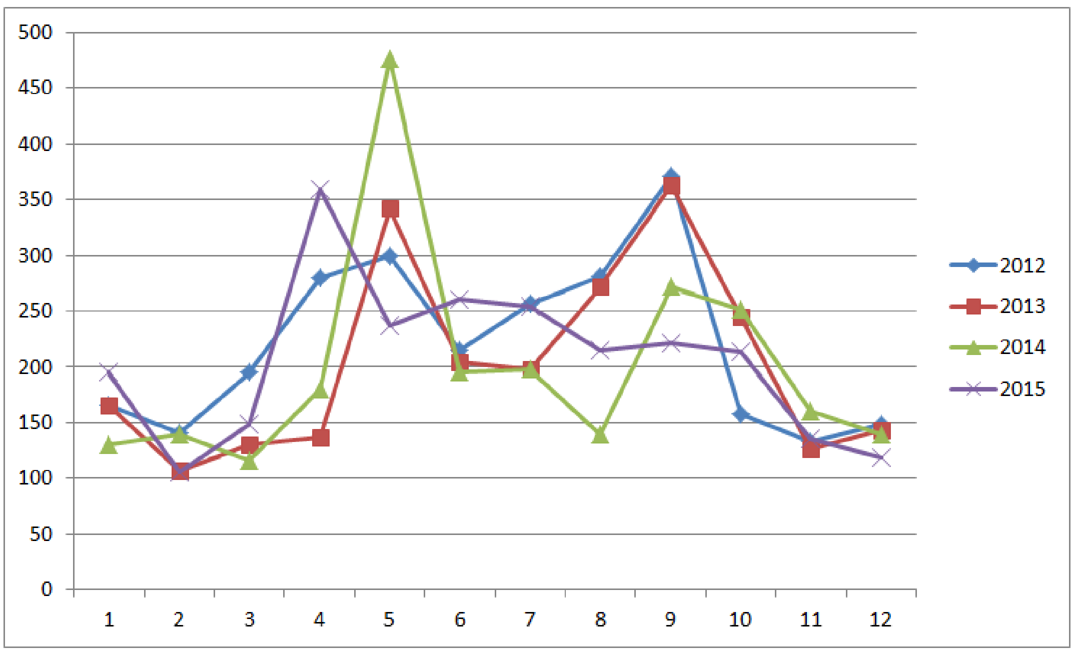


TABLE A3.4 DISTRIBUTION OF FIRE INCIDENTS IN ALBERTA BY YEAR AND MONTH

	Month											
Year	1	2	3	4	5	6	7	8	9	10	11	12
2005	362	324	382	563	586	349	392	417	458	485	410	392
2006	370	336	311	561	520	376	452	508	465	390	354	381
2007	348	255	389	387	410	440	670	414	440	472	461	392
2008	438	384	478	446	594	460	435	455	467	535	390	422
2009	388	303	376	450	579	501	435	381	435	308	403	430
2010	429	324	447	491	475	507	407	429	321	461	444	349
2011	454	361	399	404	2462	439	574	504	564	470	463	330
2012	550	455	438	511	579	436	523	602	591	477	386	445
2013	372	393	393	438	763	456	467	502	628	533	366	423
2014	493	376	500	479	533	477	661	435	474	497	412	398
2015	403	401	456	596	704	591	574	537	453	516	398	393
Total	**4607**	**3912**	**4569**	**5326**	**8205**	**5032**	**5590**	**5184**	**5296**	**5144**	**4487**	**4355**
%	7.47%	6.34%	7.40%	8.63%	13.30%	8.15%	9.06%	8.40%	8.58%	8.34%	7.27%	7.06%

FIGURE A3.4 DISTRIBUTION OF FIRE INCIDENTS IN ALBERTA BY YEAR AND MONTH

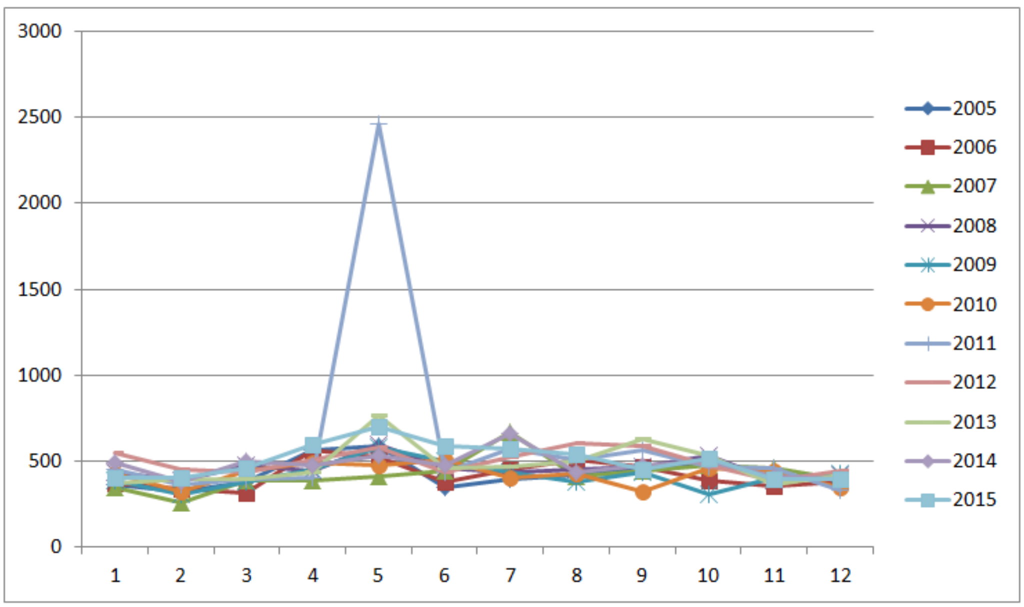
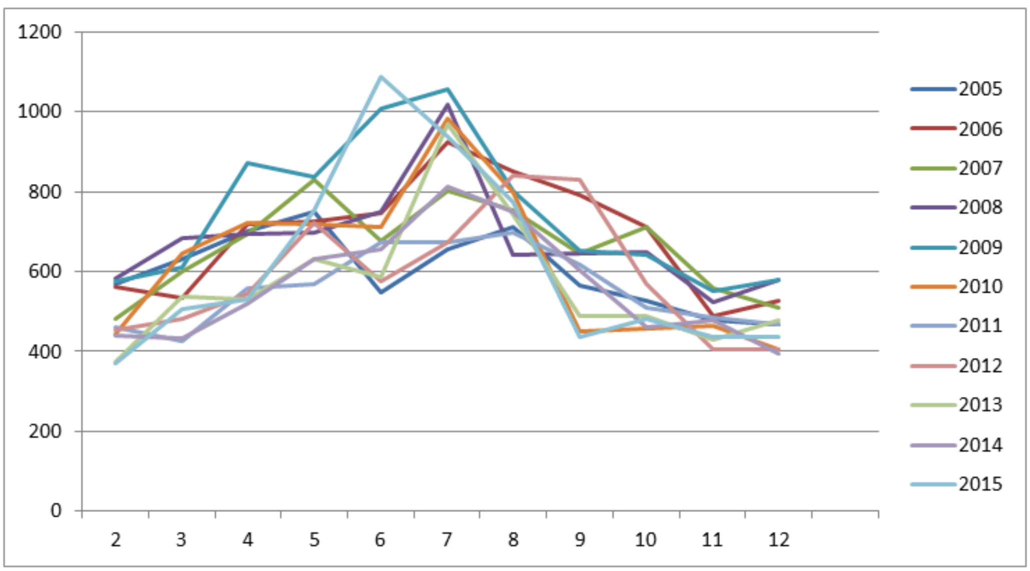


TABLE A3.5 FIRE INCIDENTS IN BRITISH COLOMBIA BY YEAR AND MONTH

	Month											
Year	1	2	3	4	5	6	7	8	9	10	11	12
2005	647	570	630	702	750	548	655	710	567	527	477	467
2006	489	563	534	719	725	745	925	851	793	713	489	527
2007	579	483	599	694	830	678	801	754	646	713	559	510
2008	623	583	685	695	698	751	1017	643	645	649	525	578
2009	532	576	609	873	837	1008	1056	802	654	642	550	581
2010	504	444	646	721	717	712	983	799	452	458	465	404
2011	492	462	426	560	568	675	672	698	617	511	485	469
2012	554	454	482	544	721	576	672	841	831	569	405	406
2013	417	375	539	530	632	586	970	742	488	489	431	477
2014	418	439	434	520	630	655	814	750	602	461	477	393
2015	403	370	505	531	755	1087	937	775	435	483	438	435
Total	**5658**	**5319**	**6089**	**7089**	**7863**	**8021**	**9502**	**8365**	**6730**	**6215**	**5301**	**5247**
%	6.95%	6.53%	7.48%	8.71%	9.66%	9.85%	11.67%	10.28%	8.27%	7.64%	6.51%	6.45%

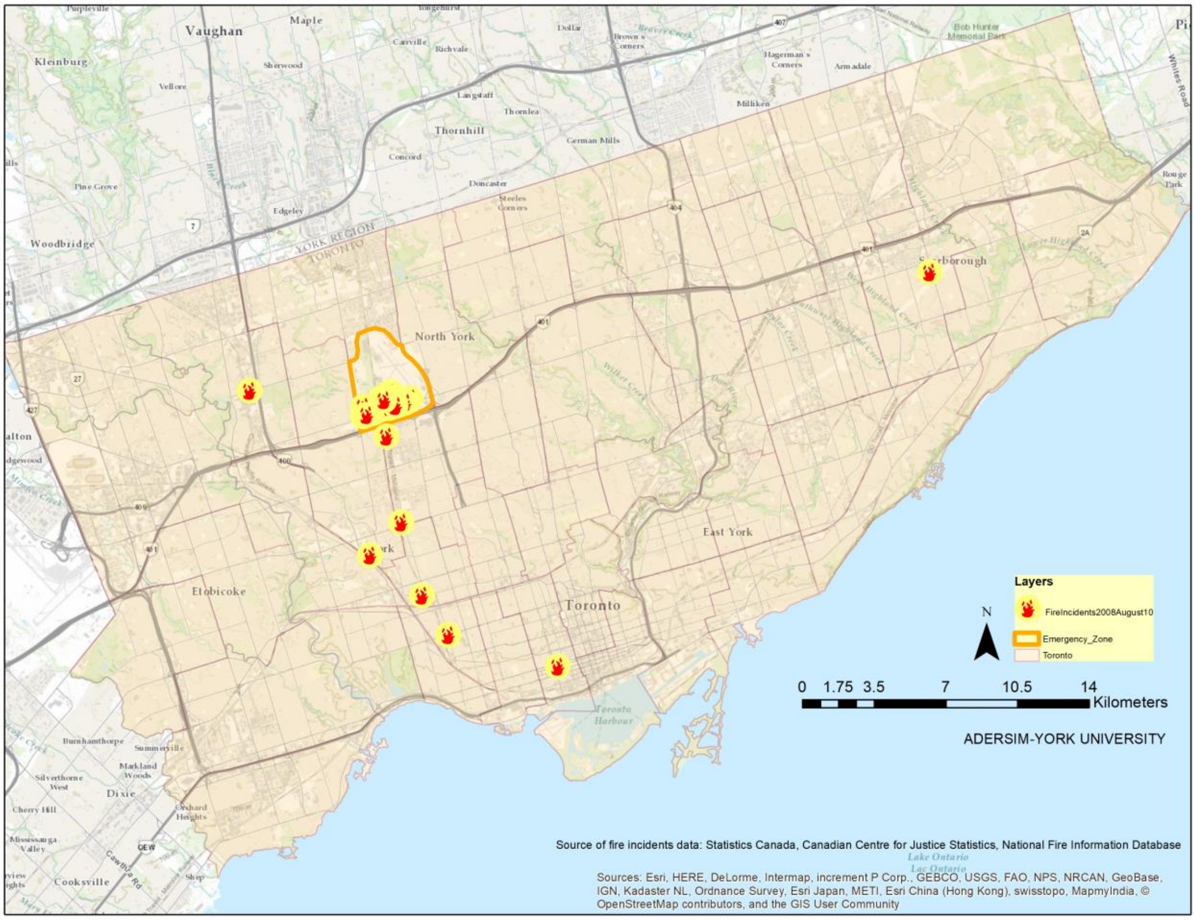
FIGURE A3.5 FIRE INCIDENTS IN BRITISH COLOMBIA BY YEAR AND MONTH



APPENDIX 3

Firure 5.5 shows the spatial distribution of the fire incidents in August 10, 2008 in the city of Toronto.

FIGURE 3.1 SPATIAL DISTRIBUTION OF FIRE INCIDENTS IN THE CITY OF TORONTO ON AUGUST 10 2008

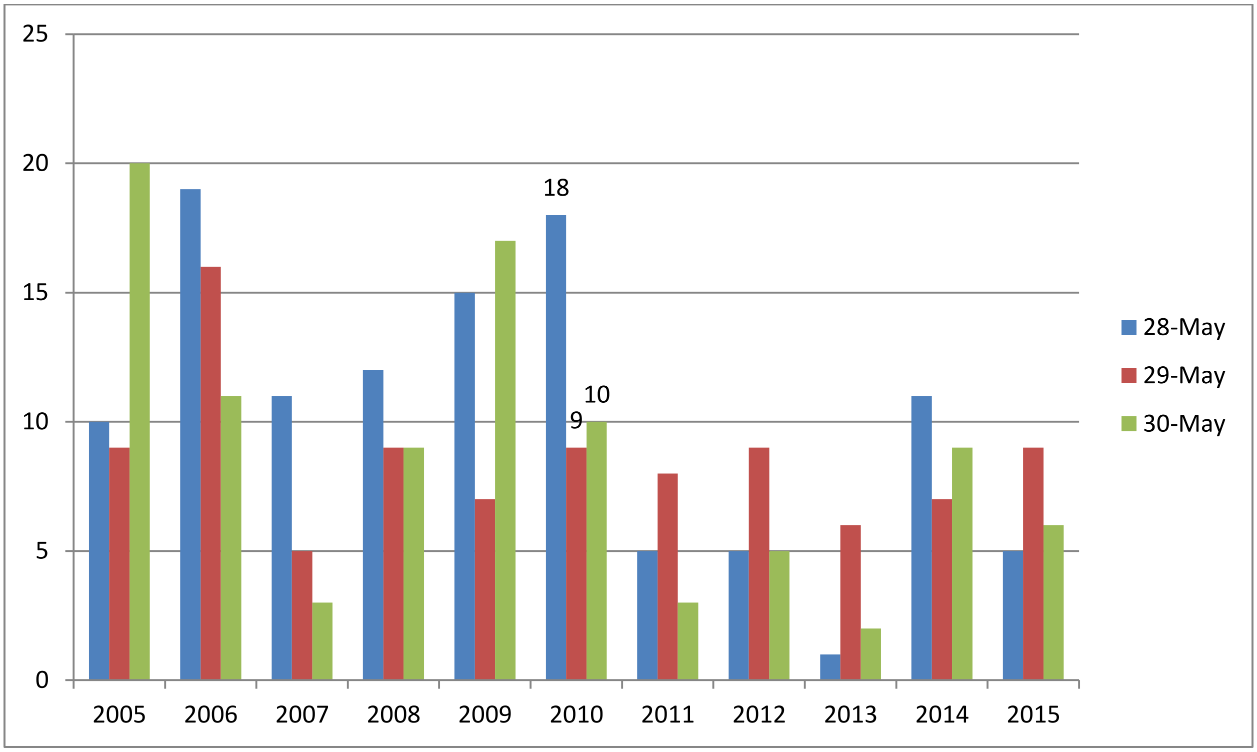

Layers
FireIncidents2008August10
Emergency_Zone
Toronto
N
0 1.75 3.5 7 10.5 14
Kilometers
ADERSIM-YORK UNIVERSITY
Source of fire incidents data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database
Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
Vaughan
North York
Etobicoke
Toronto
East York
Scarborough

APPENDIX 4

2010 Winnipeg Flood

"*Winnipeg MB, May 29, 2010. Heavy rains over the course of a week caused significant flooding in Winnipeg and the surrounding area. Out of the 180,000 residential properties in Winnipeg, 619 reported being flooded. As a result, 420 were damaged by overland flooding, while 199 suffered sewage backups. The province offered disaster financial assistance for the flood event alongside other events which occurred over the spring and summer*." (Canadian Disaster Database, 2017).

A4.1NUMBER OF FIRE INCIDENTS IN WINNIPEG BEFORE, DURING AND AFTER THE FLOOD OF 2010

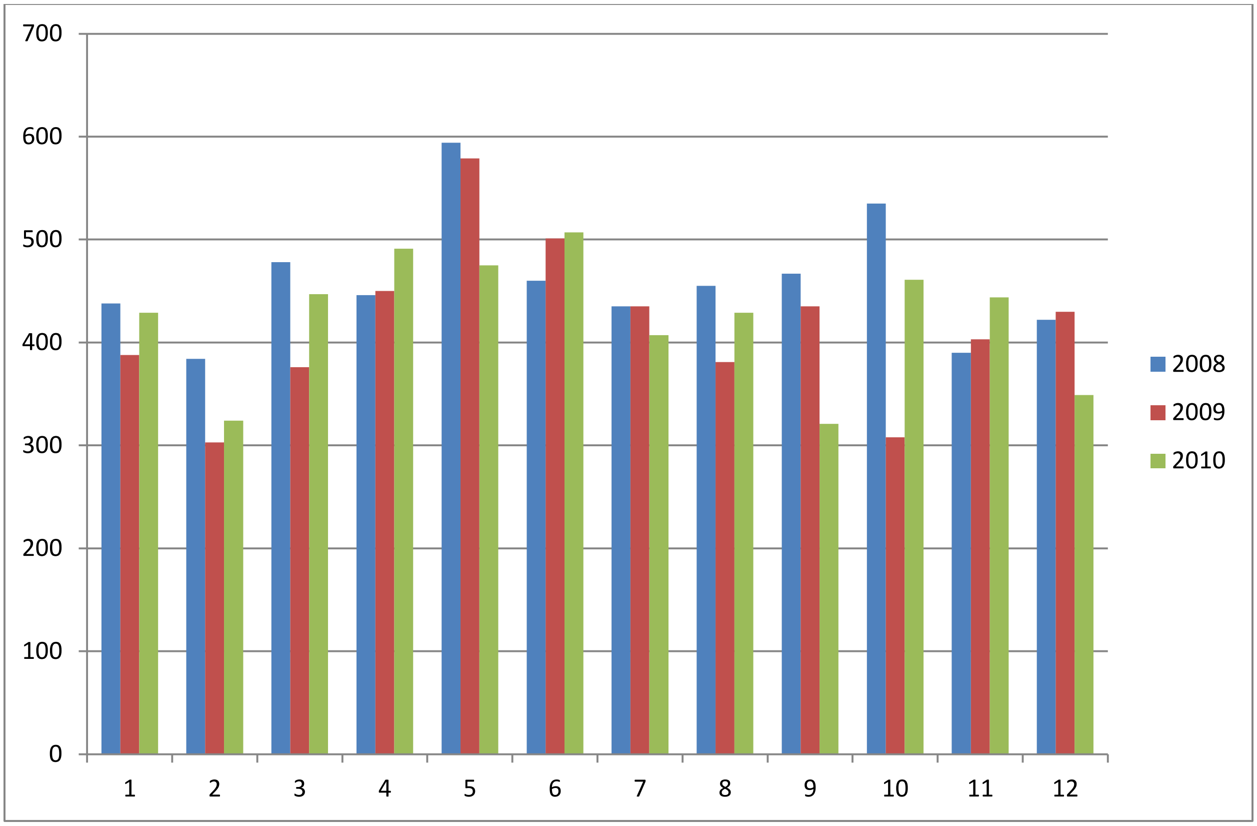


Saskatchewan and Alberta Drought in 2009

"Saskatchewan and Alberta, March 1 to July 1, 2009. The Canadian Wheat Board projected lower crop prospects by 20 per cent across the Prairies. A dozen counties and municipal districts in Alberta declared a state of drought emergency or disaster. For example, Saskatoon had less than one-quarter of the usual amount of spring precipitation, making the months of March, April and May the driest since record-keeping began in 1892. It wasn't just spring that was dry. The soil moisture recharge period between September 1, 2008 and March 31, 2009 had less than 60 per cent of normal precipitation. To the west, in Alberta, conditions were even drier, as illustrated by precipitation amounts in Edmonton, where the 12- month total rain and snow from July 2008 to June 2009 was only 234 mm, less than half of normal and the driest such period with records dating back to 1880. Making matters worse, eight of the last ten years in Alberta's capital of Edmonton had less rain and snow than the 30-year average total, but no year was as scanty as the most recent. Not surprisingly, the flow of the North Saskatchewan River was at its third lowest level in nearly a century." (Canadian Disaster Database, 2017)

A4.2 FIRE INCIDENTS DURING THE ALBERTA FLOOD IN 2009 AND CONTROL YEARS (2008 AND 2010)

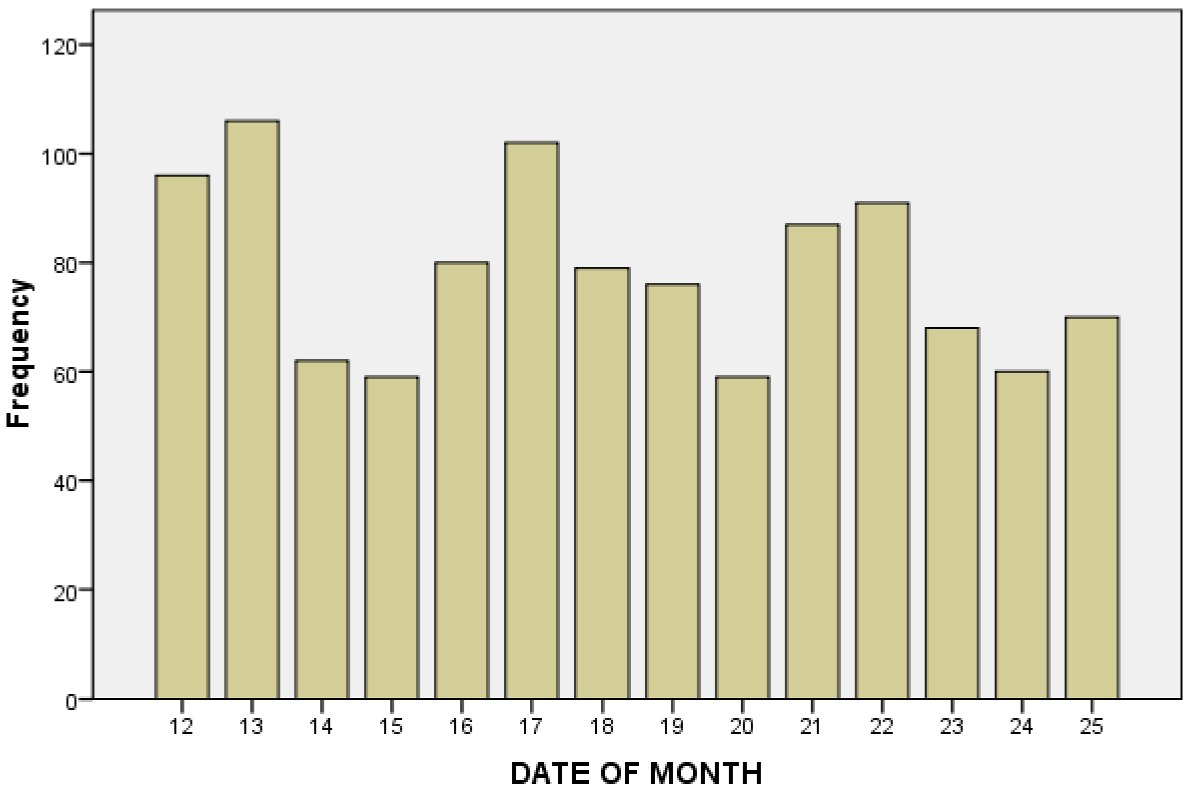
A4.3 FIRE INCIDENTS DURING THE ALBERTA FLOOD IN 2009 AND CONTROL YEARS (2008 AND 2010) BY MONTH



Southern Ontario tornado in August 2005

"Southern Ontario ON, August 19, 2005. A series of severe thunderstorms tracked eastward across southern Ontario from Kitchener to Oshawa. The system spawned two F2 tornadoes with gusts between 180 and 250 km/h. The first tracked through Milverton to Conestogo Lake and the second from Salem to Lake Bellwood. The tornadoes downed power lines, uprooted trees, ripped into several homes, cottages and barns, and overturned vehicles. Within one hour, torrential rains dumped 103 mm in North York, 100 mm in Downsview and 175 mm in Thornhill, leading to flash flooding. Fire fighters rescued four people who fell into the fast moving currents of the Don River. Thirty metres of Finch Avenue West was washed out. Early estimates report more than 15,000 insurance claims were submitted for structural and non-structural damages caused by torrential rains and high winds. Not included in insured losses were infrastructure damages". (Canadian Disaster Database, 2017)

A4.4 FIRE INCIDENTS IN ONTARIO IN AUGUST 2006

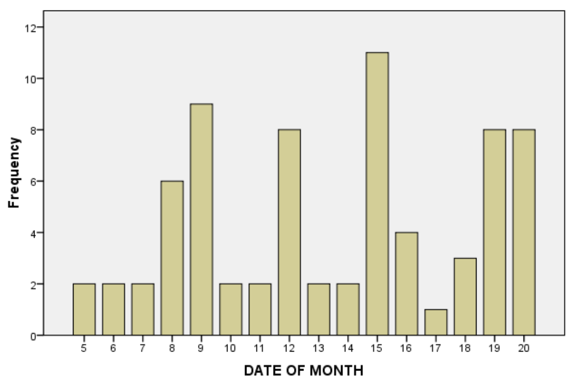


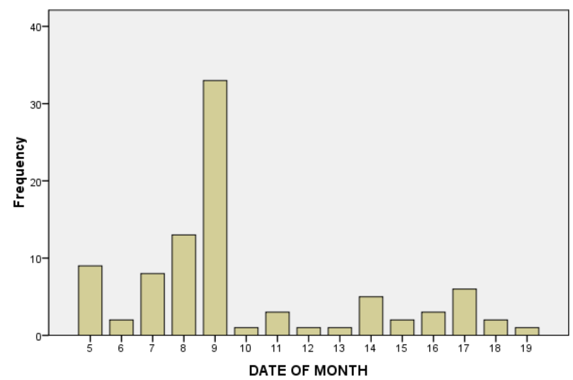
By comparing the same period for 2005 and 2006 there is no significant difference observed between the number of fire incidents in 19th of August and other date of the month in 2005 and between 2005 and 2006.

Calgary AB hailstorm in July 2010

"Calgary AB, July 12, 2010. A massive 30-minute long hailstorm pelted the city of Calgary on July 12. The hail ranged from 4 cm in diameter to baseball-sized hail balls. Apart from the hail, the storm brought along with it heavy rain, strong wind gusts, thunder and lightning. The storm caused severe damages throughout the city as hail broke windows, dented cars and destroyed crops. The hailstorm decimated over 90,000 hectares of cropland near Strathmore and Hussar. Crop damage claims were estimated at $18.5 million. In total, the estimated dollar value of damage claims was over $400 million, making it the costliest hailstorm in Canada to date" (Canadian Disaster Database, 2017).

AP4.5 FIRE INCIDENTS IN CALGARY IN JULY 2010 AND 2012



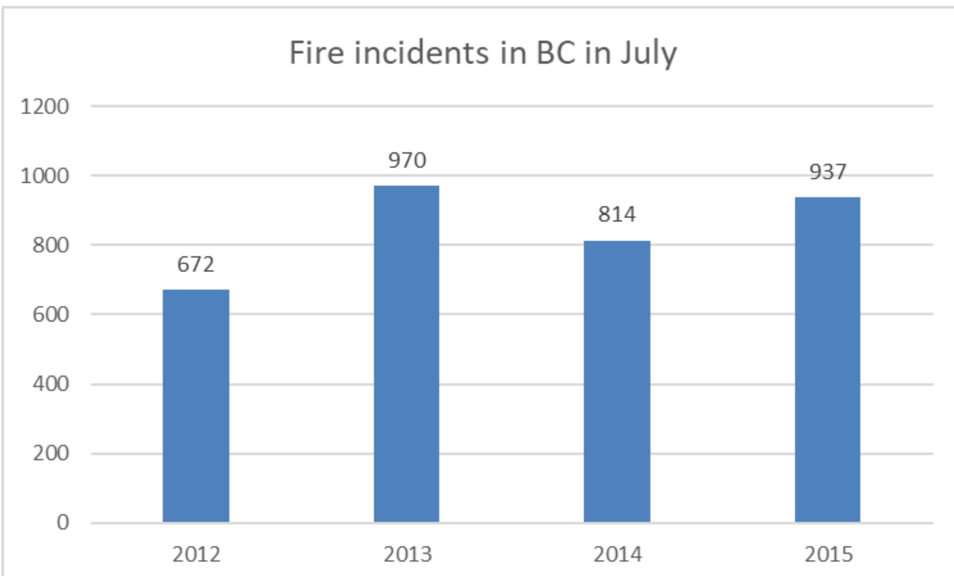


There is a spike in the number of fire incidents on 12th compared to two days after and before, but in comparison to the seven days before and seven days after there is not a significant change.

British Columbia wildfire in July 2014

"British Columbia, July 1 to September 30, 2014. A significant heat wave across British Columbia in July and August led to record breaking dry conditions and high to extreme fire danger ratings in most of the province. Almost 360,000 hectares of land was burned the third highest in the history of the province. Over 4,500 people were forced to evacuate throughout the season with the largest evacuations taking place in West Kelowna where 2,500 people fled and Hudson Hope where 1,150 people fled in July due to wildfires. At its peak, over 3000 firefighters and frontline crews worked at combating the fires, and as a result, significant damage to infrastructure and communities was avoided. As of November 2014, the Government of British Columbia estimated it spent approximately $300 million dollars responding to wildfires for the 2014 season" (Canadian Disaster Database, 2017)

A4.6 FIRE INCIDENTS DURING THE BRITISH COLOMBIA WILDFIRE IN JULY 2014



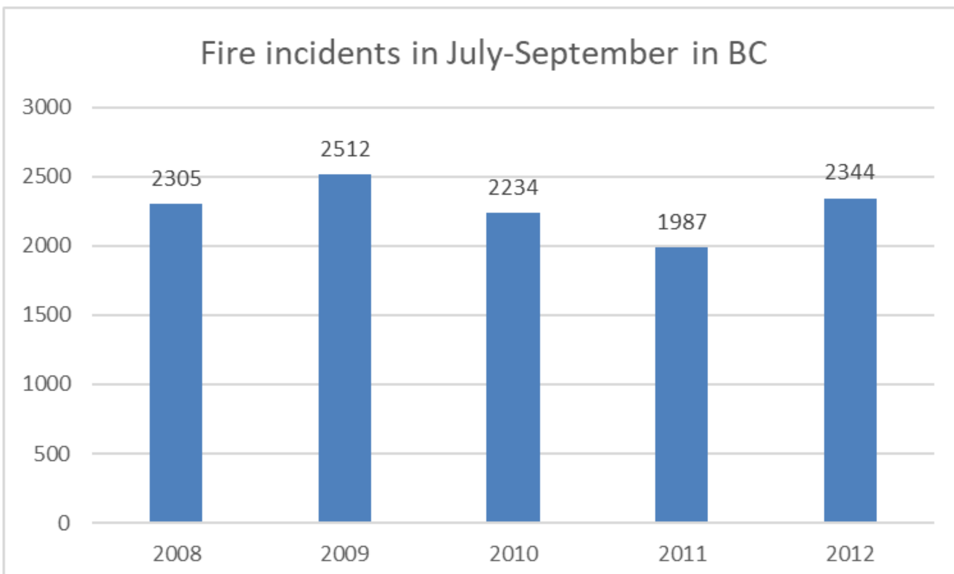
Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

There is no significant change in the number of fire incidents in British Columbia in July 2014 compare to the year after and before.

British Columbia wildfire in summer 2010

"British Columbia, July 28 to September 8, 2010. Due to little precipitation and lightning strikes, from July 28 to July 31, the number of fires in British Columbia went from 600 to 1,100. On August 18, strong winds blew through the interior causing substantial growth of the fires. Throughout the wildfire season, approximately 461 homes (1,383 individuals) were ordered to evacuate the region and hundreds of other homes were put on evacuation alert. The hardest hit areas were Chilcotin, Houston, Williams Lake, Burns Lake and Frase Lake. All evacuation orders and alerts were removed by the first week of September. Approximately 330,000 hectares burned due to 1,673 fires. Over 1,400 personnel from out-of-province assisted with fighting the fires. Two air tanker pilots died in a plane crash while fighting the fires. Both the city of Vancouver and the Government of Alberta issued air quality warnings due to smoke caused by the fires" (Canadian Disaster Database, 2017)

A4.7 FIRE INCIDENTS DURING THE BRITISH COLOMBIA WILDFIRE IN THE SUMMER JULY 2010



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

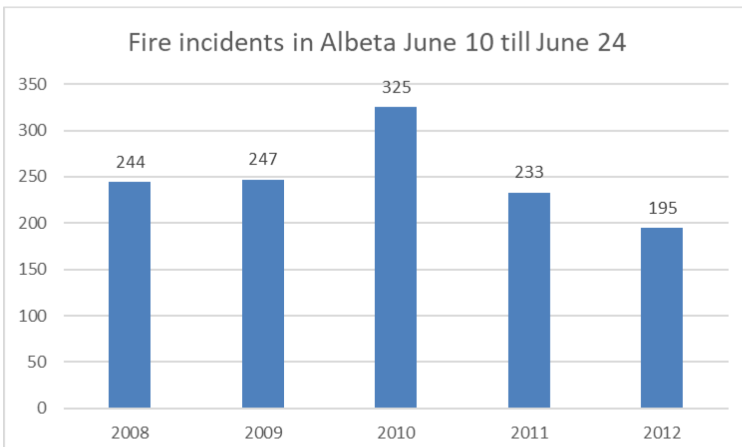
No significant changes in fire incidents observed in 2010 for the period of July to September compare to years before and after.

Southern Alberta and Saskatchewan flood in June 2010

"Southern Alberta and Saskatchewan, June 17, 2010. Record rainfall resulted in extensive flooding in Alberta and Saskatchewan, washing out a portion of the Trans-Canada highway and shutting down part of the Canadian Pacific rail line. Forty people from the Blood Tribe reserve, 75 homes in Maple Creek, and 600 households in Medicine Hat were forced to evacuate. Disaster financial assistance was provided by both provinces" (Canadian Disaster Database, 2017).

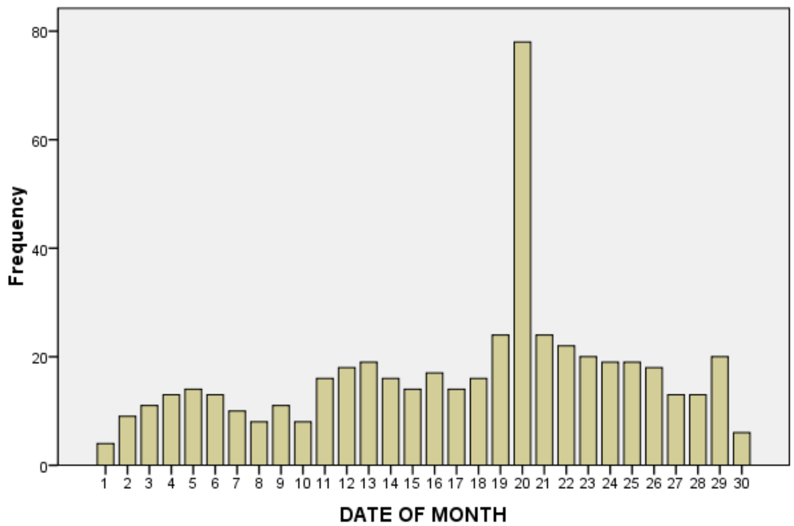
Dataset adjustment: As we do not have data for Saskatchewan, we just selected the data for the province of Alberta during the period of June 10^{th} till June 24 (seven days after and seven days before the incident) and compare this period for two years before and after the incidents (here 2008 till 2012).

A4.8 FIRE INCIDENTS DURING ALBERTA 2010



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

A4.9 FIRE INCIDENTS DURING SASKATCHEWAN FLOOD IN JUNE 2010



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

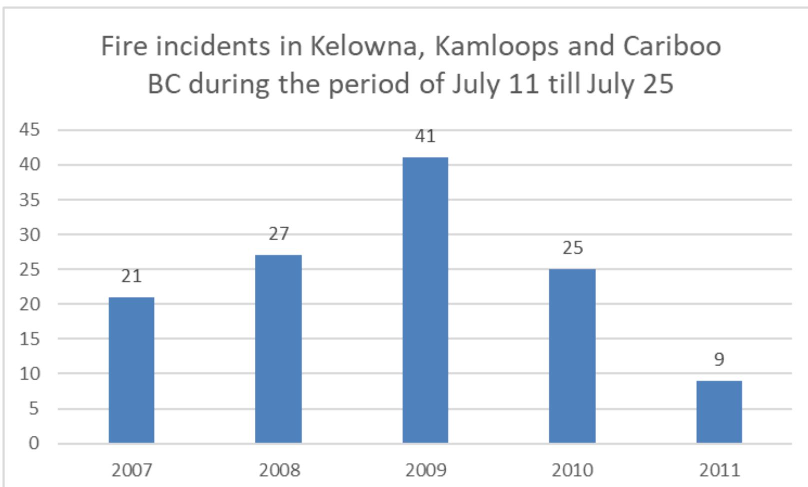
As it is obvious, no specific change happened on the date of flood (June 17, 2010) instead there is a sharp spike in the number of fire incidents on June 20th.

No significant change has observed at the time of incident on July 8, 2013.

Kelowna BC wildfire in July 2009

"Kelowna, Kamloops and Cariboo BC, May 1 to August 31, 2009. Fire season 2009 had 3,200 fires, 213 of which were wildland-urban interface fires. On July 18, fires broke out in the Glenrosa and Rose Valley communities of West Kelowna, combined with the Terrace Mountain fire west of Fintry, which led to multiple evacuation orders and alerts. July also saw an abundance of lightning storms leading to other fires of note throughout the province. Temperatures continued to break record highs and little precipitation was received in most areas. As September began, all personnel continued to work hard to contain fires across the Kamloops and Cariboo regions. The Lava Canyon fire, the largest, was nearly 55,000 hectares and growing. There were over 100 notable fires during this fire season: at least 27 caused evacuation orders and at least a dozen more caused evacuation alerts. Approximately 20,000 people were evacuated. One helicopter pilot lost his life in the line of duty" (Canadian Disaster Database, 2017).

AP4.10 FIRE INCIDENT BETWEEN JULY 11 AND JULY 25 IN KELOWNA, KAMLOOPS AND CARIBOO BC

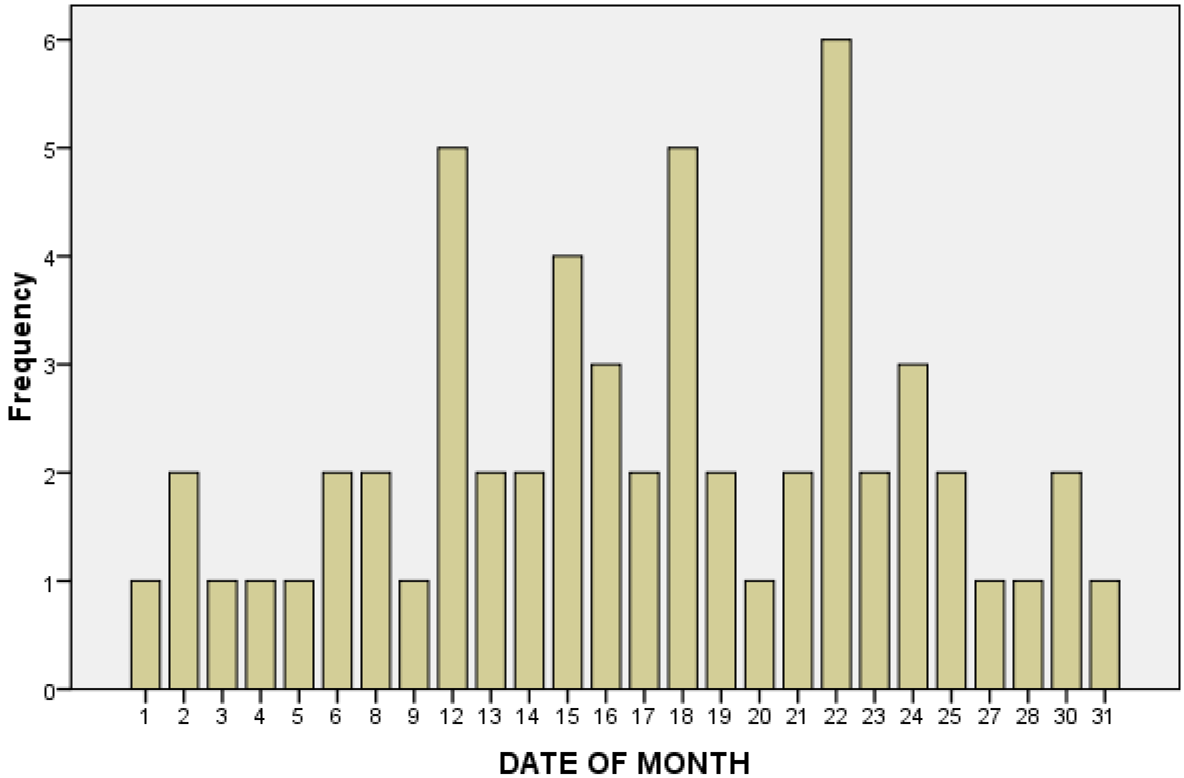


Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Fire incidents in the same period are slightly higher in 2009 compare to two year after and before.

Fire incidents in the month of July in 2009 in Kelowna, Kamloops and Cariboo BC

AP4.11 FIRE INCIDENTS IN THE MONTH OF JULY IN 2009 IN KELOWNA, KAMLOOPS AND CARIBOO BC



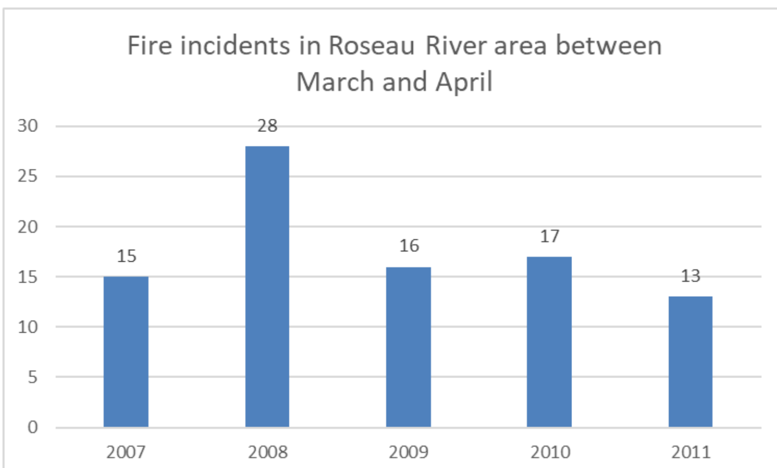
Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

The number of fire incidents on July 18, 2009 is slightly higher that this number for a day after and before.

Roseau River MB flood in March 2009

"Roseau River First Nation, Sioux Falls, Peguis First Nation, St. Andrews, St. Clements and Selkirk MB, March 24 to May 21, 2009. Overland flooding caused by a combination of snowmelt, seasonal precipitation and the spring breakup affected southern Manitoba's watershed areas of the Red, Pembina, Assiniboine, and Souris Rivers. The event caused flooding of houses and evacuations from communities including Roseau River First Nation, Sioux Falls, Peguis First Nation, St. Andrews, St. Clements and Selkirk. The flooding also resulted in damage to public infrastructure such as bridges, roads, and highways. Three principal factors led to the spring flooding: 1) Heavy autumn rains, about 43 per cent more than normal, saturated the ground just before freezing in early December, which left little room for absorbing snow melt in the spring; 2) It was a snowy winter in southern Manitoba with some 25 per cent more snowfall than normal. Heavy snowfalls and copious spring rains swelled the critical headwaters of North Dakota sending excessive waters north into Canada via the Red River and its tributaries; and, 3) An unseasonably cold spring slowed basin snow melting, ice decaying in rivers, and overland flow from ditches and culverts" (Canadian Disaster Database, 2017)

AP4.12



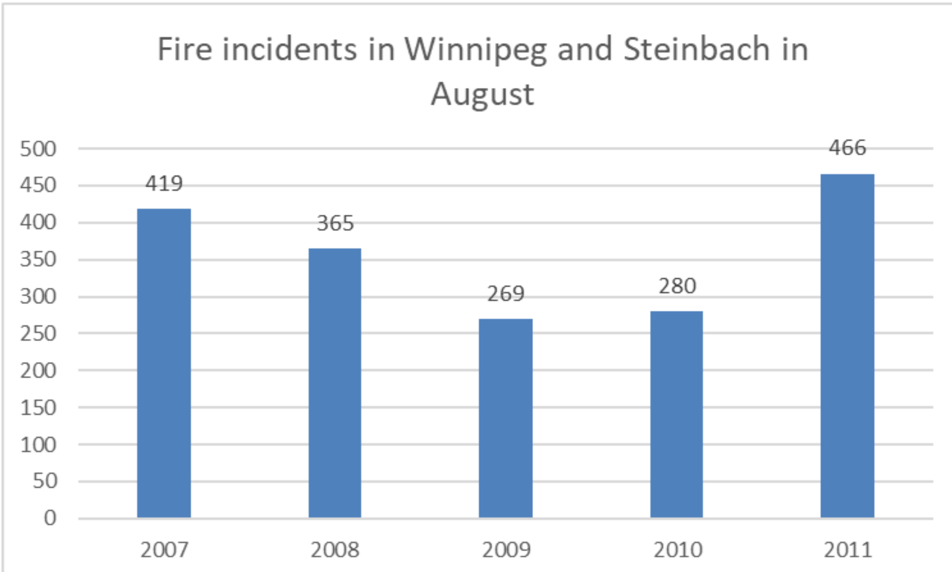
Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

- No significant change has been observed in number of fire incidents during this period in 2009.

Winnipeg MB Thunder storms in August 2009

"Winnipeg and Steinbach MB, August 14, 2009. Powerful thunderstorms, spectacular lightning strikes and baseball-sized hail hammered a wide area of southern Manitoba from Winnipeg to Steinbach. More than 7000 instances of damage to houses and vehicles were reported and losses ranged between $50-75 million. The storm also knocked out power to approximately 4000 homes (12,000 individuals)" (Canadian Disaster Database, 2017)

AP4.13

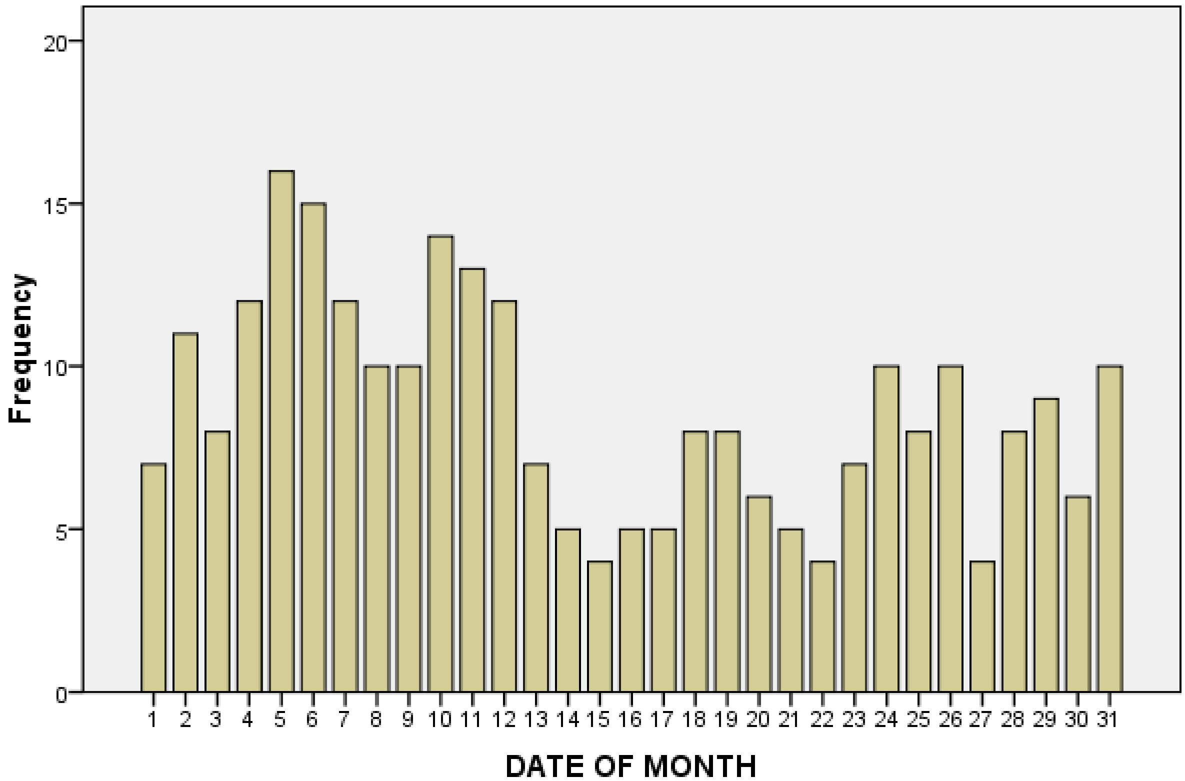


Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

A slight drop in the number of fire incidents in Winnipeg and Steinbach in August 2009 is observed.

Fire incidents in Winnipeg and Steinbach in August 2009

AP4. 14 NUMBER OF FIRE INCIDENTS IN WINNIPEG AND STEINBACH IN DAYS OF AUGUST 2009



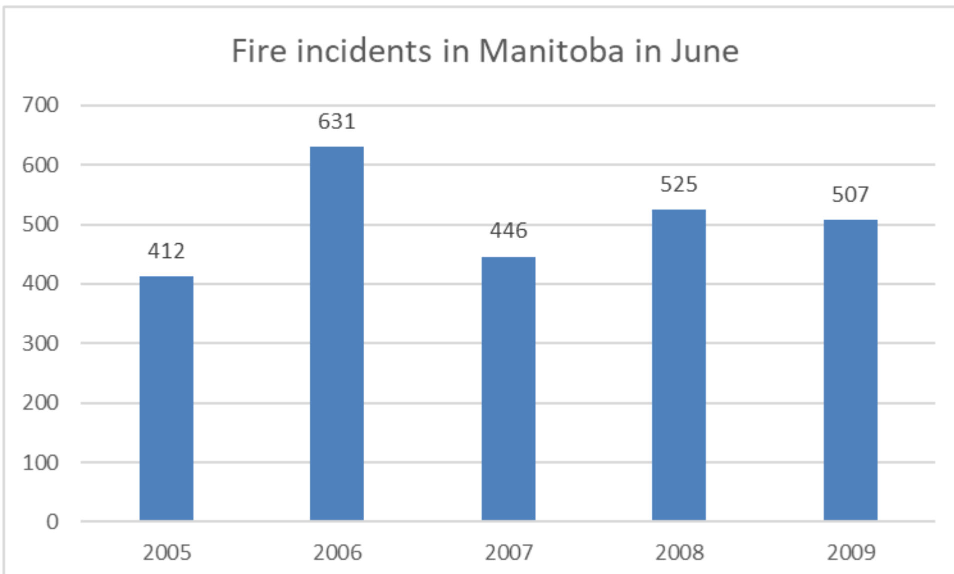
Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

No significant change has been observed between August 14th (the date of incident) and the days after of before. There is slightly higher number of fires between August 2nd and 12th that might not be significant.

Manitoba flood in June 2005

"Manitoba, June 2, 2005. Manitoba received between 100-175 mm of rain resulting in severe flooding. Regional municipalities of Daly, Sifton, Blanshard, Strathclair and Woodworth as well as the towns of Oak Lake and Rivers encountered major problems of seepage and basement flooding, damage to municipal roads and overland flooding of agricultural lands. Forty-four provincial highways and over 100 municipal roads were damaged. Approximately, 380 homes and 19 families (approximately 1,197 individuals) were forced out of their homes due to the flooding. Thirteen municipalities declared a local state of emergency and more than 100 requested disaster financial assistance. The cost of the flood was estimated at more than $350 million including crop damage" (Canadian Disaster Database, 2017).

AP4.16



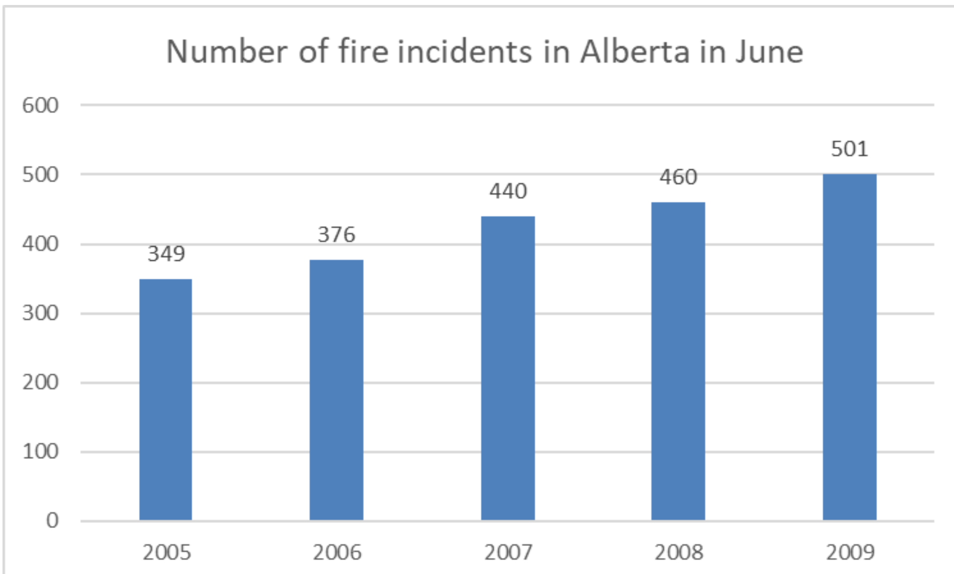
Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

No significant change has been observed between the number of fire incidents in June 2005 and other years.

Alberta thunderstorm in June 2007

"Calgary, Edmonton, St. Albert, the town of Stony Plain, Parkland County, Two Hills County, Kneehill County, Camrose, and the municipal districts of Rocky View and Bighorn AB, June 5, 2007. A severe rainstorm on June 5 affected the cities of Calgary, Edmonton, and St. Albert, the town of Stony Plain, Parkland County, the County of Two Hills, Kneehill County, Camrose, County , and the Municipal Districts of Rocky View and Bighorn. Many residences and small businesses experienced flooding resulting in loss of contents and structural damage. Infrastructure damage to municipal roads and storm sewer lines, and provincial parks also occurred" (Canadian Disaster Database, 2017)

AP4.17



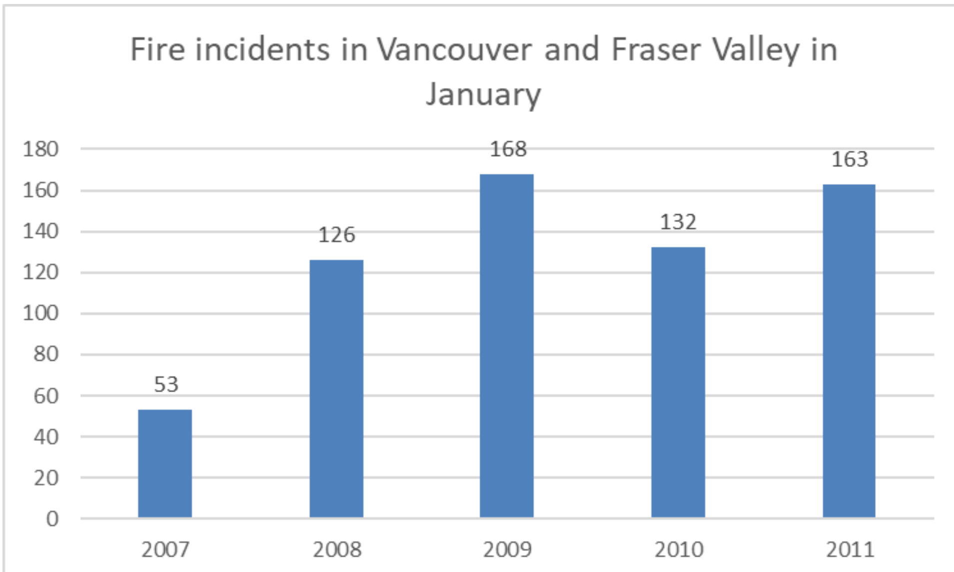
Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

No significant change has been observed in June 2007 compare to the similar period two years after and two years before.

Vancouver BC Thunderstorms in January 2009

"Vancouver, Fraser Valley and the Greater Vancouver Regional Districts BC, January 6 to 8, 2009. A severe rainstorm from January 6 to January 8 affected Vancouver, Fraser Valley and the Greater Vancouver Regional Districts causing overland flooding, mudslides and landslides until January 31. Preliminary eligible costs are estimated at $16,500,000, which would result in a federal share of approximately $6,900,000" (Canadian Disaster Database, 2017).

AP4.18



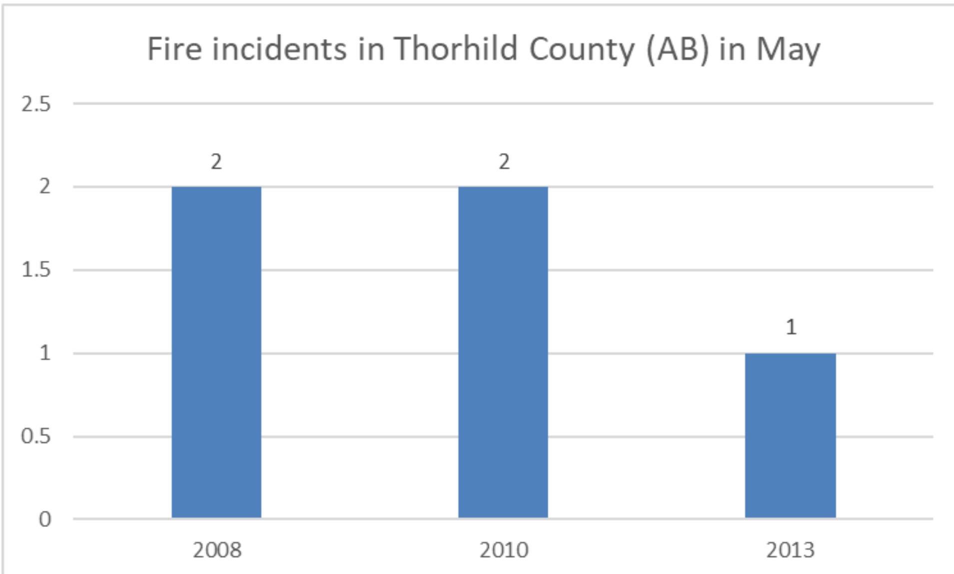
Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

Number of fire incidents in January 2009 is slightly higher than similar period within the interval of 2007-2011.

County of Thorhild AB wildfire in May 2010

“County of Thorhild AB, May 12, 2010. A wildfire in the county of Thorhild, north of Edmonton, affected thousands of acres of land. The community of Opal experienced numerous evacuation orders, which affected up to 100 homes on May 17. The Province of Alberta provided $10 million in funding under the Municipal Wildfire Assistance Program to aid in the community's recovery.” (Canadian Disaster Database, 2017)

AP4.19



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

No significant difference between May 2010 and other years is observed.

Cranberry Portage MB wildfire in June 2010

"Cranberry Portage MB, June 23 to July 6, 2010. A wildfire 13 kilometres east of Cranberry Portage prompted mandatory and voluntary evacuation orders. Residents from Cranberry Portage were advised to evacuate on June 23 due to smoke from the approaching flames. The Iskwasum and Gyles campgrounds in the Grass River Provincial Park were under a mandatory evacuation order. The road between Cranberry Portage and Sherridon was temporary closed to local traffic due to concerns over visibility. On June 24, approximately 200 people voluntarily evacuated from Cranberry Portage as the fire grew in size. The wildfire reached a maximum size of approximately 55,000 hectares and there were 440 firefighters, 13 helicopters and 13 water bombers combating the flames. On July 6, the travel restrictions near Cranberry Portage were lifted." (Canadian Disaster Database, 2017)

Data adjustment: Cranberry Portage Manitoba, June and July 2010.

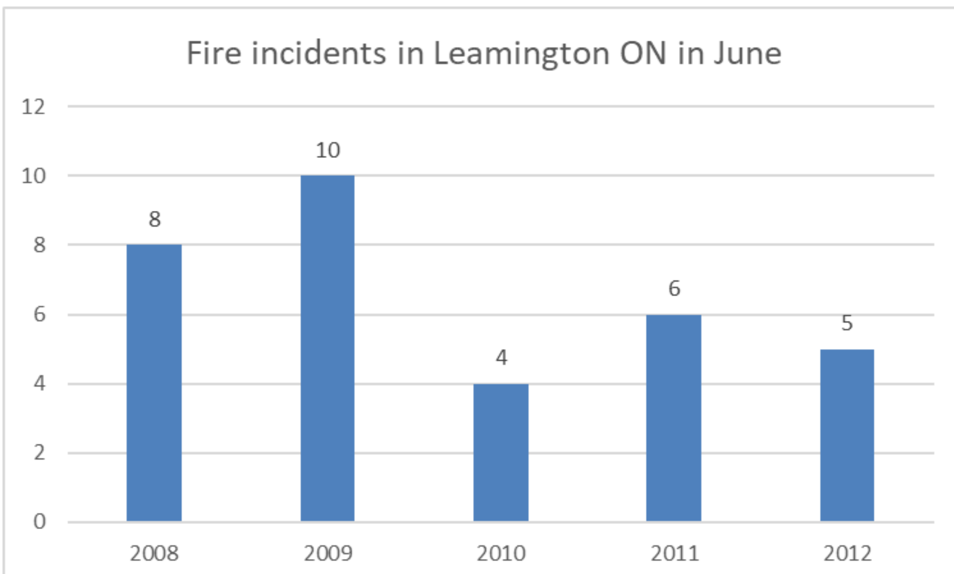
Inconclusive: just one fire incident in Cranberry Portage Manitoba in June 2010.

Leamington ON tornado in 2010

"Leamington ON, June 6, 2010. An F1 tornado touched down in Leamington prompting city officials to declare a local state of emergency. The small community located in the southern region of Essex County was hit by an F1 tornado as well as a series of strong winds called downbursts early in the morning on June 6. The F1 tornado produced winds of up to 180 km/h, which destroyed approximately 12 homes, downed power lines and uprooted trees. Approximately 4,500 hydro customers (13,500 individuals) were left without power. The Canadian Red Cross assisted with response efforts by providing an emergency shelter. There were no reported injuries or fatalities" (Canadian Disaster Database, 2017)

Dataset adjustment: Leamington, ON, June 2010

AP4.20



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

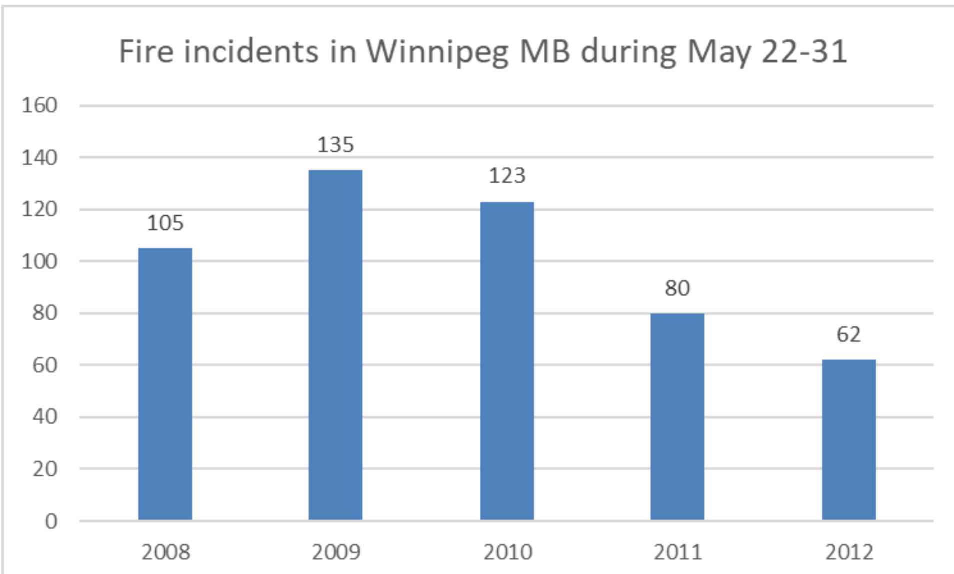
- No significant difference between June 2010 and other years is observed.

Winnipeg MB flood in May 2010

"Winnipeg MB, May 29, 2010. Heavy rains over the course of a week caused significant flooding in Winnipeg and the surrounding area. Out of the 180,000 residential properties in Winnipeg, 619 reported being flooded. As a result, 420 were damaged by overland flooding, while 199 suffered sewage backups. The province offered disaster financial assistance for the flood event alongside other events which occurred over the spring and summer" (Canadian Disaster Database, 2017).

Dataset adjustment: Winnipeg, Manitoba, May 22-31.

AP4.21



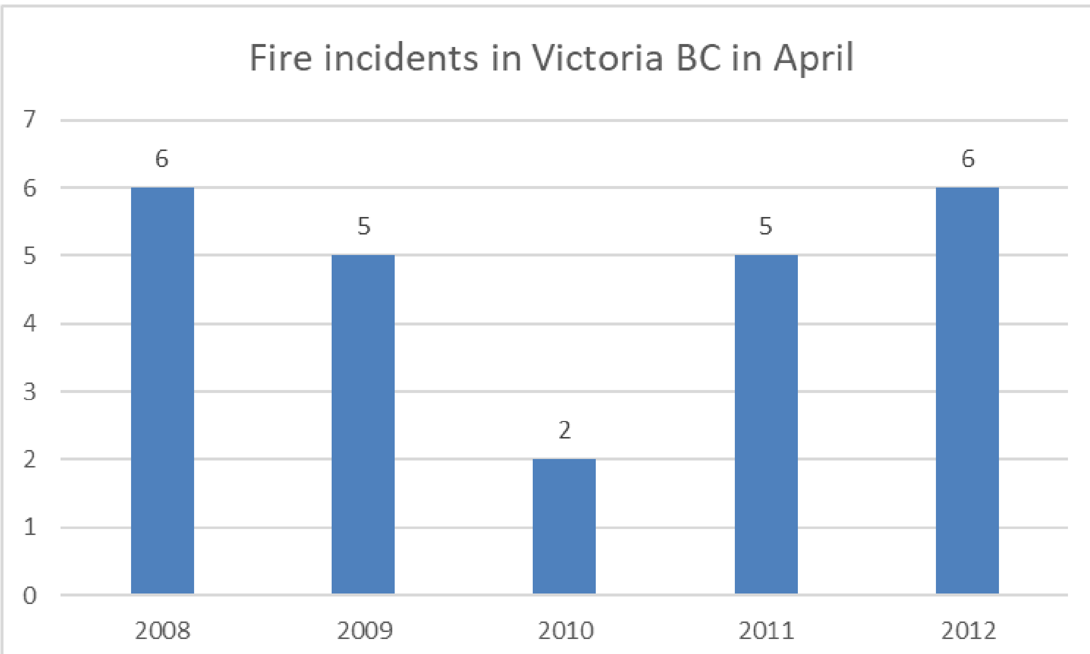
Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

- No significant difference between 2010 and other years are observed.

Victoria BC Epidemic in April 2010

"Glengarry Hospital, Victoria BC, April 6, 2010. A Norovirus outbreak at the Chandler Unit was declared on April 6 and affected a total of 39 residents. A respiratory outbreak was later declared on April 22 after an increase in the number of cases and several deaths which occurred in the Chandler Unit. On April 29, two residents at the Fairfield Unit also became ill with respiratory symptoms. No new cases of respiratory illness occurred in the Fairfield Unit after April 29. A total of 21 residents at Glengarry Hospital (19 at the Chandler Unit and 2 at the Fairfield Unit) were affected by the respiratory illness. Of these 21 individuals, 10 have died (9 at the Chandler Unit, 1 at the Fairfield Unit). Three staff members also experienced respiratory symptoms" (Canadian Disaster Database, 2017)

AP4.22



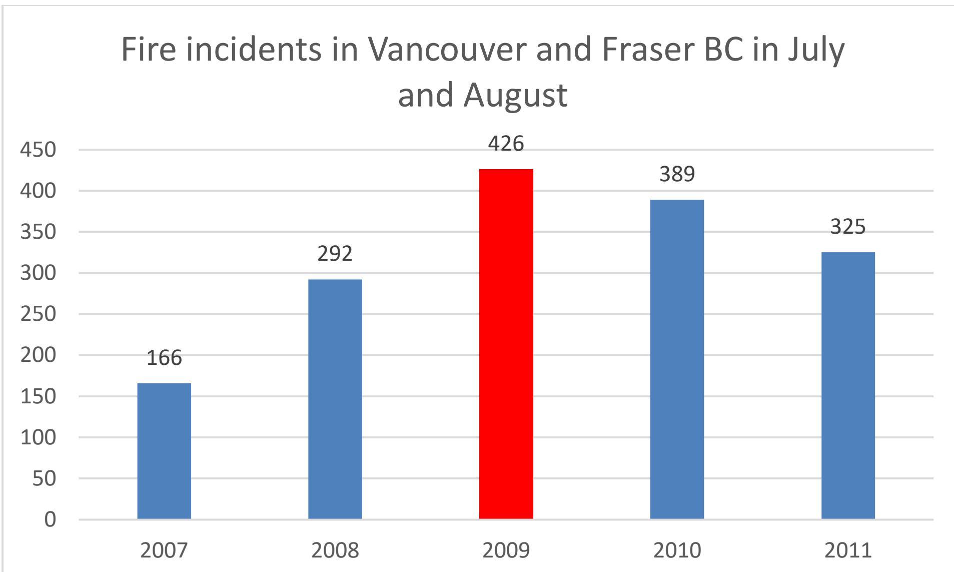
Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

- Dataset adjustment: Victoria, British Columbia, April.
- No significant difference between April 2010 and other years is observed. In fact there is slight drop in the number of fire incidents in 2010.

Vancouver and Fraser BC Heat wave in July and August 2009

"Vancouver and Fraser BC, June 27 to August 3, 2009. Temperatures of up to 34.4 degrees centigrade were measured at Vancouver International Airport during an eight-day period from July 27 to August 3. According to the Fraser and Vancouver Health Authorities, in the past during the same eight-day period from July 27 to August 3, the average number of deaths was 321, but in 2009 during this time, there was a registered 455 deaths. It is believed that the heat greatly contributed towards the unusually high number of deaths" (Canadian Disaster Database, 2017)

AP4.23



Source of data: Statistics Canada, Canadian Centre for Justice Statistics, National Fire Information Database

- There is spike in 2009, needs more research.
- Dataset adjustment: Vancouver, North Vancouver city, North Vancouver district, West Vancouver, Fraser Valley regional district, July and August.

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