



Wildfire as an increasingly common natural disaster facing Canada: understanding the 2016 Fort McMurray wildfire

Aaida A. Mamuji¹ · Jack L. Rozdilsky¹

Received: 1 June 2018 / Accepted: 18 September 2018 / Published online: 25 September 2018
© Springer Nature B.V. 2018

Abstract

On May 3, 2016, a wildfire swept into the city of Fort McMurray, Alberta. This natural disaster was significant in both its scale and impact, as the fire prompted a sudden onset evacuation of 88,000 persons. As we reflect on the 150th Commemoration of Canada's confederation, this 2016 natural disaster ranks as Canada's most costly disaster. The fire resulted in over \$3.5 billion in insured losses. Approximately 2400 buildings were destroyed. In looking towards the future, climate change impacts are expected to cause wildfires that will be progressively worse. This paper explores the Fort McMurray wildfire through the lens of the four pillars of emergency management: response, recovery, mitigation, and preparedness. By exploring aspects of Canada's most recent mass evacuation, the country can better ready itself for a future where fire will be one of the primary natural disasters reshaping Canadian landscapes.

Keywords Wildfire · Wildfire evacuation · Emergency management · Fort McMurray · Canada · Disaster mitigation · Preparedness · Emergency response · Recovery

1 Introduction

The Fort McMurray wildfire of May 2016 (also known as the Wood Buffalo Wildfire or Horse River Wildfire) is one of the most significant disaster events in Canadian history. The fire, which was nicknamed “The Beast” due to its unpredictable nature, began on May 1, 2016, and burned 589,995 hectares of land—even crossing provinces from Alberta to Saskatchewan—until it was declared under control on July 5, 2016. During its path, it caused the largest Canadian wildfire evacuation on record, forcing the rapid evacuation of 88,000 residents on May 3, 2016. With the destruction of 2400 homes and businesses, the fire resulted in commercial and personal damages from the wildfire estimated at \$6 billion, with almost \$3.6 billion in insured losses (Insurance Bureau of Canada 2016), making the Fort McMurray wildfire the most expensive natural disaster in Canadian history.

✉ Aaida A. Mamuji
amamuji@yorku.ca

Jack L. Rozdilsky
rozdilsk@yorku.ca

¹ Disaster & Emergency Management, York University, Toronto, Canada

Through a combination of planned and ad hoc activities, the evacuation was very successful. Credit is due to the public safety authorities, businesses, and citizens of northeastern Alberta who all banded together to engage in pro-social activities to facilitate safe passage. It is very significant that in this largest evacuation in recent Canadian history, no one was killed directly as a result of the wildfire. There was, however, one motor vehicle accident on Highway 881 on May 4, 2016, when an SUV collided with a tractor-trailer, resulting in two fatalities (Mertz 2016).

As Canada celebrated the anniversary of its first 150 years after confederation in 2017, reflecting on the past indicates that natural hazards have been a constant part of Canada's landscape. In the Canadian Disaster Database, a diversity of threats characterized as falling under three origins—natural, technological and conflict, are highlighted. Natural hazards are subsequently subdivided into biologically, geologically, and meteorological-hydrological-based threats (Public Safety Canada Public Safety Canada 2015). Wildfires fall into the latter category, along with floods, avalanches, heat events, hurricanes, tornadoes, and winter storms, amongst others. Wildfires are one of the primary hazards of the past and present, and they will continue to play an increasingly important role in Canada's natural hazard future.

Wildfires originate from a combination of three ingredients: ignition, weather, and dry fuels. All of these ingredients are being influenced by climate change. Climate change is resulting in higher temperatures, extended heat warnings, and droughts, all of which result in drier fuels that lead to higher intensity wildfires which are beyond conventional fire suppression activities (Flannigan and Wotton 2017). In fact, 547 wildfire evacuation events were documented in Canada in 1980–2007 alone (Beverly and Bothwell 2011). Climate change modelling that is used to predict fire conditions suggests “a substantial increase in wildfire activity in years to come—especially in the Western United States and Canadian boreal forest” (Ferguson 2017, p. 182). As the natural hazard threat of wildfires is increasing, calls to action are being made that the “business as usual” approach to dealing with wildfire is not going to be successful.

From an emergency management perspective, there is no doubt that there is a lot to learn from the Fort McMurray wildfire. The Government of Alberta released three after-action reports during 2016–2017, all of which provide detail on the context of the wildfire as well as lessons learned (see Government of Alberta 2016a; MNP Consulting 2017; KPMG Consulting 2017). In this paper, we explore this significant Canadian natural disaster through the lens of the four pillars of comprehensive emergency management: response, recovery, mitigation, and preparedness.¹ Exploring these aspects of Canada's most recent mass evacuation can help better ready the country for a future where fire will continue to be one of the primary natural disasters reshaping Canadian landscapes. We begin by providing an overview of Canada's evacuation history and by situating the study in disaster management literature.

¹ Research for this paper included a visit to Fort McMurray by the co-authors in May 2017, to coincide with the one-year anniversary of the wildfire. A number of regional stakeholders and community members were interviewed. In addition to this field visit, research consisted of document analysis of publicly available sources, including official reports, government websites, media coverage, statistical information and others, spanning the duration of May 2016 to 2018.

2 Evacuation in the Canadian context

When populated areas are threatened by natural hazards, public safety authorities can call for evacuations on either the tactical (immediate life safety) basis or on a planned (ordered pre-emptive) basis. Evacuation describes “the withdrawal actions of persons from a specific area because of a real or anticipated threat or hazard” (Sorensen and Sorenson 2007, p. 183). While natural hazards in Canada—specifically fires and floods—have resulted in significant evacuations, Canada’s largest disaster-related evacuation was due to a technological disaster in the greater Toronto area. In November 1979, a train transporting dangerous chemicals derailed, exploded, and burned near Mississauga, Ontario. This hazardous material incident resulted in the evacuation of 218,000 persons, making it the largest mass evacuation in Canadian history (Weinman 2016; Burton 1981). The Fort McMurray wildfire evacuation, however, is the largest mass evacuation of a single concentrated region due to a natural hazard in Canadian history.

Mass evacuations due to floods cause ongoing small-scale evacuations in the springtime across Canada and at times have resulted in tens of thousands of persons being evacuated during flood events. For example, in 1950, heavy snow followed by heavy rain flooded the city of Winnipeg and more than 100,000 persons were evacuated (Weinman 2016). More recently in 2013, severe flooding in Southern Alberta’s Calgary area resulted in five lives lost and over 80,000 persons evacuated in the city (Water Services 2017). Up until the 2016 Fort McMurray wildfire, the Calgary flooding was considered to be Canada’s costliest natural disaster, with an estimated total property damage of \$5 billion (Sutherland 2016). A McEwan University assessment of the total financial impact of the Fort McMurray wildfire estimated both direct and indirect costs and suggested the disaster’s cost was approximately \$9 billion (Snowdon 2017).

With respect to fire evacuations in particular, a study of wildfire evacuation events in Canada has indicated that, “Between 1980 and 2007, an annual average of only 7469 people (0.03% of the Canadian population) were evacuated” (Beverly and Bothwell 2011, p. 591). The Canadian Forest Service maintains a wildfire database which indicates that from 1980 to 2017, there have been 448,444 persons in Canada evacuated due to wildfire (Christianson 2017). While the data referenced compare both average and cumulative numbers, such numbers highlight the situation of more persons being evacuated in the last decade than in the previous 27 years. These numbers are indicative of factors at play, such as changes in land use due to population increase in Canada’s western provinces, and increasing risk due to climate change.

In terms of the size of fire evacuations, from 1980 to 2013, over 400 evacuation events consisted of the movement of less than 100 persons, while less than 50 evacuation events consisted of movement of more than 2000 persons (Christianson 2017). Such data indicate that large-scale mass evacuations of a single city, such as that of Fort McMurray in 2016, are relatively rare. More common is the evacuation of portions of larger cities or the entire evacuation of many small communities over a wide geographic area.

In the proximity of Kelowna, British Columbia, the Okanagan Mountain Park fire of August and September 2003 consumed over 25,000 hectares of forest and park land south and east of Kelowna, forcing the evacuation of more than 27,000 people on the southern edge of the city (City of Kelowna 2016). An example of a smaller community facing mass evacuation due to fire was in May 2011, when a fire swept into Slave Lake, Alberta. The entire community of 6800 was evacuated (Henton 2013). During the 2017 fire season in British Columbia, widespread fires prompted the evacuation of over 50,000 persons from

many small communities in the south–central region of the province (The Canadian Press 2017).

3 Disaster management literature

The basic premises for studying disaster mass evacuation have been well established in the disaster social science literature, as studies of public mass evacuations reach back to at least 40 years (see for instance Quarantelli 1980). Burton (1981) researched the emergency evacuation caused by the train derailment in Mississauga, Ontario, in 1979. More recent summaries of evacuation literature include the work of Tierney et al. (2001).

The literature on wildfire evacuations in particular addresses a variety of topics, ranging from urban to wildland interface concerns (Cova 2005); evacuation behaviour issues during wildfires (Cohn et al. 2006); and the use of social media in decision making related to fire evacuation (Sutton et al. 2008). Other related literature explores a direct relationship between wildfire evacuation and visible minority communities. In Canada, most research focus on communities affected by natural hazards has focused on First Nations peoples (see for instance Ashfaw 2017 and Christianson et al. 2013), although research on the experiences of the Muslim community during the 2016 Fort McMurray wildfire evacuation has been conducted (Mamuji and Rozdilsky 2017).

There are three general concentrations of time that can be considered when analysing disasters: pre-event, during event, and post-event. The complexity of disasters has necessitated a further break down of temporality concentrations. The most widely accepted understanding of disaster relief, known as Comprehensive Emergency Management, consists of four phases: mitigation, preparedness, response, and recovery (National Governors' Association 1979).² These phases are typically depicted in a cycle, as shown in Fig. 1.

The *mitigation* phase of comprehensive emergency management involves steps to reduce vulnerability to disaster impacts such as injuries and loss of life and property. *Preparedness* focuses on understanding how a disaster might impact the community and how education outreach and training can build capacity to respond to and recover from a disaster. *Response* refers to addressing the immediate threats presented by a disaster event, including saving lives, meeting humanitarian needs (food, shelter, clothing, public health and safety), cleanup, damage assessment, and the start of resource distribution. *Recovery* refers to the restoration of all aspects of the disaster's impact on a community and the return of the local economy to some sense of normalcy. It typically consists of two periods, the short term (6 months–1 year), where the focus is on providing immediate services to

² This paper has been purposely developed using the commonly adopted framework of the four phases of comprehensive emergency management: Mitigation, Preparedness, Response and Recovery. Some jurisdictions in Canada as well as the USA have adopted the five phases or five pillars approach (see for instance Region of Peel n.d.). This approach divides the mitigation phase of the four phases approach into mitigation and prevention. Mitigation in the five phases approach refers to structural and non-structural measures taken to limit the impacts of disasters, and Prevention refers to additional preventative measures, such as the development of plans, standards, and by-laws. A five-phase approach is also adopted in the National Preparedness Goal established for the United States Department of Homeland Security (U.S. Department of Homeland Security 2011). Here, in addition to response, recovery, and mitigation, which remain similar, two additional phases are used in lieu of preparedness—prevention and protection. Prevention is defined as the capabilities necessary to avoid, prevent, or stop a threatened or actual act of terrorism. Protection is the capabilities necessary to strengthen the homeland against acts of terrorism and manmade or natural disasters. For the purposes of this paper, the authors are comfortable taking the four-phase approach to dealing with natural hazard threats in a Canadian context.

Fig. 1 Phases of the Emergency Management Cycle



the disaster-affected communities, and the long term (which can go up to decades) aimed at addressing the more serious or permanent impacts of a disaster.

In order to capture the many facets and opportunities for learning from the Fort McMurray wildfire event, we organize this paper into the four phases of comprehensive emergency management. We recognize, however, that this breakdown is most effective as a heuristic tool, and that effective emergency management often sees phases occurring in parallel as they feed into each other. We also recognize that given the diversity inherent amongst individuals, experiences in the comprehensive emergency management cycle may vary from one person to the next.

4 Fort McMurray and its 2016 wildfire

Fort McMurray is a city located in the Northeastern portion of the Province of Alberta. The city is classified technically as an urban service area that is a part of the vast Regional Municipality of Wood Buffalo (RMWB). According to (2015a) data from Alberta's Municipal Services Branch, Fort McMurray has a population of 82,724 (Government of Alberta 2015). In addition, the Regional Municipality has a rural service area with a population of 42,308, making for a total regional population of 125,032. The region also has a significant shadow population defined as temporary residents.

Fort McMurray is in close proximity to vast oil sands deposits. Canada's energy industry has many large, high intensity industrial developments nearby the city. Surface mines for the extraction of oil sands along with the associated industrial infrastructures for the production and transportation of bitumen and synthetic crude oil are present at massive scales. Approximately 35% of the population is considered as temporary workers, making up the sizeable shadow population, many of whom staff the oil sands mines and related industrial facilities. Given that 88,000 persons fled the city as compared to the population base, one can see the significance of the evacuations to the city as a whole.

Despite its rather remote northern location, Fort McMurray has grown into a regional focal point for many urban functions. With the exception of the city's external highway connections, which are limited to one main artery to exit the city to the south (and limited options to travel north), the city has a full complement of urban services. Ranging from the seat of regional governance, to a mercantile centre, to a social services hub, the city's residents enjoy all aspects of life common in any contemporary Canadian city, including diversity. Over 28% of the population self-identify as belonging to a visible minority

group, and 23% are immigrants (Statistics Canada 2017), with over 80 languages represented in the community (Huncar 2016).

Fort McMurray is made up of a number of neighbourhoods, including Abasand Heights, Beacon Hill, Gregoire, the Lower Townsite, Parsons Creek, Thickwood Heights, Timberlea, and Waterways (RMWB 2015a). A number of Fort McMurray's neighbourhood districts including Waterways, Abasand, and Beacon Hill were devastated; Beacon Hill alone lost nearly 70% of its houses to fire. Figure 2 shows the neighbourhoods in Fort McMurray and highlights the level of damage experienced.

The following sections analyse the 2016 Fort McMurray wildfire in each of the phases of the emergency management cycle. We begin by discussing the response phase of the evacuation to correspond with the actual events on the ground.

5 Response

The fire that burned its way into Fort McMurray was first detected on Sunday, May 1, and was two hectares in size and located approximately seven kilometres southwest of the city.³ By the evening, the fire grew to 120 hectares and was now 4.8 km west of Gregorie, directly southwest of Fort McMurray. The Regional Emergency Operations Centre (EOC) in Fort McMurray was activated. As the fire moved east, the Regional Municipality of Wood Buffalo asked individuals living in trailers in the Centennial Park Campground, west of Highway 63, to leave. Receiving updates through local radio, social media outlets, and provincial websites and emergency apps, residents in Beacon Hill, Gregoire, and Prairie Creek were soon put under a mandatory evacuation order, and an evacuation centre was opened in the centre of the city on MacDonald Island. By Monday, May 2, due to very hot, dry, and windy conditions, the fire escaped initial containment efforts and continued to burn west towards the Athabasca River and Fort McMurray. As the wind began blowing the fires away from the city, the previous evacuation orders were lifted and replaced by shelter-in-place orders.

Tuesday May 3 was a catastrophic day. By 10:30 am the fire's size grew to 2600 ha, temperatures were as high as 33 °C, and the humidity was very low at 12%. Fluctuating winds caused an inversion, keeping smoke close to the ground, which gave the perception that the fire died down due to low smoke levels. However, by noon erratic winds pushed the fire to jump the Athabasca River and flames headed into the northwest portion of Fort McMurray, giving many residents little time to evacuate. By 2 pm, people living in the neighbourhoods of Abasand, Grayling Terrace, and Beacon Hill received mandatory evacuation notices. About an hour later, the fire entered those neighbourhoods, and at 6:25 pm all of Fort McMurray was put under mandatory evacuation orders. Between 2 pm and 6 pm, when tens of thousands of residents rapidly fled the city, many evacuees faced bumper-to-bumper traffic on Highway 63 heading south out of town, on the only highway available for evacuation. Fort McKay First Nation, located north of Fort McMurray, welcomed approximately 2000 evacuees (Bell 2016).

³ For a detailed synopsis of the May 2016 Fort McMurray fire and corresponding response efforts, useful resources include the MNP consulting review report (MNP Consulting 2017) prepared for Alberta Agriculture and Forestry; local media disaster timelines (see for instance French 2016; Phillips 2016; Kohut 2016) and other coverage and reports on the disaster (see for instance Giacalone et al. 2016; Markusoff et al. 2016). Details on the response described herein were compiled using these sources.

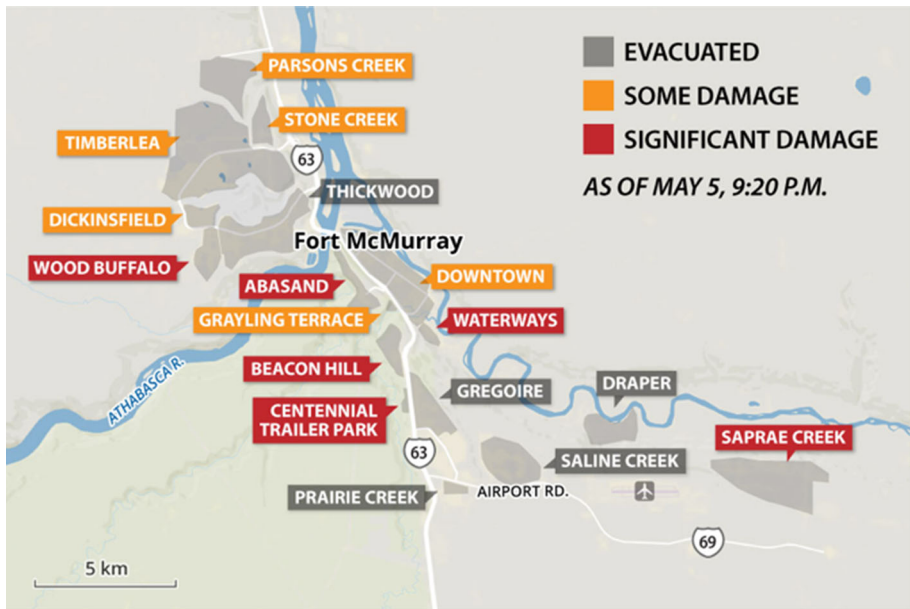


Fig. 2 Fort McMurray Neighbourhoods affected by the May 2016 wildfire. *Source:* Canadian Press Staff 2016

On Wednesday May 4, the fire grew to 10,000 hectares and approximately 1600 structures were destroyed. As a result of the unpredictable fire patterns that day, the EOC had to undergo two relocations (Bartko and Mertz 2016). At around noon on May 4, the EOC was relocated from Fort McMurray to Long Lake. At 3 pm, a provincial state of emergency was declared for Alberta. Before midnight, the EOC was evacuated from Long Lake and relocated once again, this time to Lac La Biche (Bartko and Mertz 2016). On Thursday May 5, it was reported that 1110 firefighters, 145 helicopters, and 22 air tankers were battling 49 fires. The fire's size was then 85,000 hectares. A firefighting plane slid off a runway near Manning, Alberta, but all crew members escaped the crash unharmed (Heidenreich 2016).

On Friday May 6, the fire's size was now at 101,100 ha. The first damage assessments of Fort McMurray's neighbourhoods indicated neighbourhoods on the wildland–urban interface lost up to 70% of all structures. On May 7, Fort McKay was also evacuated. The fire continued to grow in size over the weekend, and by Sunday May 8 its size was at 161,197 ha. In mid-May, the wildfire continued to grow sporadically. By that point, the damage was done to Fort McMurray and due to the low population density in Northern Alberta, there were no other communities that were put at risk. The fire was declared under control on July 4 and its final size was estimated to be 589,552 ha. Peak deployment of fire personnel was reached in late May and early June with a total of 126 crews, 2197 total personnel, 18 air tankers, and 269 pieces of heavy equipment. A number of mutual aid agreements between fire crews across Canada, the USA, and the broader international community facilitated these numbers. Fort McMurray's Water Treatment Plan was spared during the wildfire and continued operation, facilitating fire suppression activities.

From the fire response perspective, the Fort McMurray fire was very challenging to suppress as pre-existing forest conditions were highly susceptible to wildfire: reduced

winter snowpack; an absence of rain in late April and early May; and abnormally hot, dry and windy weather (MNP Consulting 2017). Bulldozers were used to clear trees and vegetation in the wildland–urban interface in order to create firebreaks. In some cases, these firebreaks, consisting of barren gaps of land which function to starve the fire of fuel, worked to slow the fire’s spread and give fire crews time to catch up. However, as the fire grew in size, embers blew over the firebreaks igniting trees and adjacent houses. In such cases, the drastic step of knocking down houses, not yet impacted by the fire, was taken to create additional firebreaks within housing areas. During the state of emergency, a number of homes were selected in strategic areas to be demolished in order to save entire neighbourhoods.⁴

First-hand accounts such as *Inside the Inferno* (Asher and Mouallem 2017) and *Into the Fire* (Hawley et al. 2017) have been published detailing the heroic exploits of local and regional firefighters in the early hours and days of the catastrophe. Despite the bravery, after-action reports suggested that different approaches may have been tried. The complexity and rapid nature of change of wildfire behaviour were especially difficult to deal with and demanded “skills and experience levels that are not normally present among initial attack crews or first responders” (MNP Consulting 2017, p. 30).

Many residents used private vehicles to head south on the only route out of town, Highway 63. Those persons experienced a slow-moving line of traffic, often going on a trek of hundreds of kilometres in the direction of Edmonton to seek safety. Once leaving Fort McMurray on Highway 63, the geographic setting is mostly forests with very minimal to no services for travellers for the first 200 km south. Others heading north to escape the flames were able to get as far as the oil sands industrial sites before the paved roads physically end at the Athabasca River at what locals call the “Bridge to Nowhere”. Past that bridge, at 57.1° north latitude, other than scattered oil sands work site encampments, there are no other urban destinations reachable by paved roads in the vast northern expanses. In the case of those who were forced to flee the flames in a northerly direction, private sector energy firms assisted anyone in need with many modes of evacuation, including air evacuation to destinations in Canada’s south including Edmonton and Calgary, with some flying as far as Vancouver or even Toronto (see Woo et al. 2017).

6 Emergency social services

When evacuations take place, emergency social services are activated to preserve the wellbeing of the population. Due to lessons learned from the Slave Lake wildfires in 2011, the province of Alberta had since developed a framework for service delivery along with an Emergency Coordination Centre to facilitate emergency social services delivery on a widespread basis for events impacting multiple jurisdictions (Government of Alberta 2016b). In May of 2016, during the Fort McMurray wildfires, Alberta’s Provincial Emergency Support System Framework, as well as the Provincial Emergency Operations Centre were fully activated. The Regional Municipality of Wood Buffalo was the local area emergency social services coordinator tasked with meeting the basic essential needs of affected individuals, households, and communities during the response and recovery process (Government of Alberta 2016a). Both short-term services related to temporary relief from disaster circumstances, as well as longer term services to enable individuals and

⁴ In the months following the fire, recognizing that these sacrifices were made for the common good, the Regional Municipality developed compensation plans for homeowners who had lost homes to firebreaks, so that they would not have to make claims on their own insurance (Thurton 2016).

families to rebound after the disaster, were provided by the municipality, as well a variety of local and regional social service agencies.

To support the local effort, Alberta Human Services staff, community-based volunteers, and social (non) profit organizations provided a variety of specialized services to wildfire evacuees. A convergence of local social welfare and faith-based organizations as well the Canadian Red Cross also provided services. Services included food, clothing, basic first aid medical support, emotional support, pet care, and family reunification (RMWB [n.d.—a](#)), and the Red Cross provided evacuees with cash up front. The Canadian Red Cross reported that about 90,000 persons from 46,000 households had registered for disaster relief. Eligible evacuees also received support from their insurance companies. A number of reception centres, facilities established by emergency social service teams as “safe gathering places” for people displaced from their homes as a result of a disaster, were established.

For those who participated in vehicle evacuations of Fort McMurray, reception centres along highways south of the city were able to provide services for meeting immediate term needs such as resting places, feeding and refuelling stops, and temporary shelter during the long drive to host communities. In addition, once evacuees arrived at their host communities, other reception centres provided medium to long-term assistance such as providing disaster information, facilitating financial aid, providing for basic living needs, and assisting with the movement from temporary living quarters to more semi-permanent living arrangements, as some Fort McMurray evacuees had to wait weeks to months before returning to their fire-stricken community. For the Fort McMurray wildfires, thirteen formal reception centres were established at the provincial level (Government of Alberta [2016a](#)). Locations included the Edmonton EXPO Centre, the Northlands Exhibition Centre, University of Alberta, University of Calgary, and MacEwan University. Smaller reception centres were also set up by private entities.

Emergency management authorities began their staggered lift of Fort McMurray’s evacuation order a month later. Some essential personnel, such as medical professionals, city planners, and law enforcement, were asked to return prior to the general public in order to assist with establishing the recovery efforts. Essential business such as banks, pharmacies, and grocery stores was also opened prior to re-entry.

7 Recovery

Disaster recovery is one of the most complicated and long-lasting phases of the disaster management cycle. Response activities such as fire suppression, search and rescue, and evacuation management soon transitioned to short-term recovery activities such as damage assessment, restoration of lifelines, clearing of debris, and re-entry. There was also a need to embark on a multi-year long-term recovery process. At the 6-month point after the fire disaster, The Government of Alberta estimated its response and recovery costs in the Home Again Report. Response and recovery costs for the wildfire were put at \$647 million (Government of Alberta [2016a](#)).

Following the major fire damages on May 3 and 4, phased re-entry of evacuees started in earnest on June 1 for most areas. The province rescinded its State of Emergency on June 30. However, due to especially heavy damages in some neighbourhoods, like Abasand and Beacon Hill, re-entry to those areas was not allowed until August 31 (KPMG [2017](#)). Upon repatriation, some persons were able to return to smoke-damaged properties and have the damages repaired. Other smoke-damaged properties were vacated due to the presence of

potentially dangerous levels of antimony, a chemical known to cause medical conditions such as chronic bronchitis, increased blood pressure, diarrhoea, and skin inflammation (Sundar and Chakravarty 2010). Many other residents faced complete physical reconstruction of their dwellings.

To guide the long-term recovery process, a recovery task force was formed within weeks of re-entry to Fort McMurray to handle administrative tasks associated with wildfire recovery. Dana Woodworth headed the initial team of 70, which included government agencies, committees, task forces and NGOs. This number was downsized to 15 within a year and a half of the incident, as fewer staff members were required to handle recovery operations (Bird 2017). The taskforce issued the Regional Municipality of Wood Buffalo's (2016) Wildfire Recovery Plan in order "bring the region out of a post-disaster state and enable an effective recovery using a build back better philosophy" (RMWB 2016, p. 15).

The recovery plan is organized into five pillars—People, Environment, Economy, Rebuild and Mitigate—which are used as an alignment tool for sub-committees and assist with the division of responsibilities (RMWB 2016). The *People* pillar aims at ensuring that residents are engaged and informed throughout the recovery process, and includes considerations such as education, recreation, arts, culture, spiritual needs, as well as psychosocial and physical supports. Under *Environment*, officials are tasked with identifying, assessing, and mitigating environmental damage. Activities in the *Economy* area are meant to stimulate the economy through focusing on local/regional business and supporting the workforce. *Rebuild* is about repairing homes, businesses and infrastructure and engaging with relevant supporting agencies. And finally, efforts and activities that are aimed at improving the resiliency of the region, including FireSmart initiatives, are included as part of the *Mitigate* pillar. The Recovery Task Force established major tasks to be completed within each pillar over a 2-year window. It also established partnerships with the McMurray Métis and the Athabasca Tribal Council to assist First Nations and Métis communities in Wood Buffalo with recovery, especially since 80 per cent of the McMurray Métis community was living in the most damaged neighbourhoods (Walsh 2017). Looking back at the first 2 years following the fire and evacuations, the long-term recovery continues.

On the 2-year anniversary of the disaster, the most recent insurance data indicated that insurers saw 27,000 personal property insurance claims after the wildfire and that 90% of them have been resolved, with only the most complicated claims remaining unsettled (Thurton 2018). Despite this progress, even if individuals resolve their insurance claims, the physical reconstruction of dwellings is a multi-step process that can take months to implement, leaving many residents frustrated. Steps include demolition and land clearing, housing design, land preparation, acquiring permits, scheduling contractors, and obtaining materials for reconstruction.

While the recovery plan estimated the bulk of residential recovery being complete by the end of 2018 (RMBW 2016), the construction boom in Fort McMurray's devastated neighbourhoods continues at a slow pace. In addition to wildfire impacts, 2 months after the fire broke out, areas of Fort McMurray experienced torrential rain which destroyed approximately 40 homes that had survived the fire, further slowing the recovery process (Halinda 2016). As of May 2018, 523 homes have been fully rebuilt and another 1458 are still under construction (Dirks 2018; McDermott and Beamish 2018). Data from the regional municipality suggest that only 20.3% of damaged homes have been rebuilt (Thurton 2018 and RMWB 2018a), with local contractors upset at the number of out-of-town contractors selected for development projects—many whom they believe have taken advantage of residents (Bellefontaine 2018). Fort McMurray has seen a spike in water

treatment costs and food-grade chemical use needed to remove burnt forest floor ash and carcinogenic by-products which flushed into the municipality's drinking water supply during the wildfire (Thurton 2017a).

Recovery of Fort McMurray's economy also continues. In the past, the city's economy had prospered from oil sands related industrial megaprojects. However, in the year following the fire, oil prices were about one-half of the level that they were at 20 months before the fire, and the unemployment rate was more than double what it was at the height of the oil sands boom (Markusoff 2017). Whether as a result of a drop in population or more frugal residents, local businesses are reported to be "scrambling for customers" (Gerein 2017) and have experienced delays in receiving small business loan money (Thurton 2017b). Fort McMurray's local food bank has also reported a significant increase in use, especially by seniors (Kraus 2018). Fort McMurray's economic fate is further impacted by the national policy debates concerning pipelines. Efforts by neighbouring provinces to block the Kinder Morgan Trans Mountain pipeline expansion, which would carry oil produced in the nearby oil sands plants to Canada's West Coast (Cattaneo 2018) and the Federal Government's decision to purchase and assume control of the pipeline, will impact the city's economy (Harris 2018). As Fort McMurray's recovery continues, the city is still finding its post-fire new normal.

One important consideration related to recovery is the mental health of those impacted by disaster, including children and first responders. Whereas Alberta Health Services would normally record approximately 1000 contacts related to mental health in the Wood Buffalo region annually, this number has skyrocketed (Beamish 2018). 29,000 contacts related to mental health were recorded immediately after the wildfire, between May 2016 and March 2017. Between March 2017 and January 2018, this number remained high at 15,000 contacts. In response, the regional municipality has created an internal Critical Incident Stress Management team, and district school boards have hired more full-time counsellors and mental health workers (Beamish 2018). It will likely take many more years of coping in order to deal with this aspect of the community's recovery.

8 Mitigation

The mitigation phase of the Emergency Management Cycle involves steps to reduce vulnerability to disaster impacts such as injuries and loss of life and property. Fire mitigation generally involves addressing issues present at the wildland–urban interface, namely any area where combustible wildland fuels are found adjacent to homes, farm structures, and other outbuildings (Partners in Protection Canada 2003). Fire mitigation activities in Fort McMurray have been present well before the 2016 fires.

In Fort McMurray, urban development and wildland fuels (forest vegetation) meet at a well-defined boundary. In this interface area, mitigation efforts have included activities such as risk and hazard assessment, specific structural techniques to reduce fire risk, development of emergency response programmes, training for interface firefighters, community education on risk reduction, and land use and regional planning efforts to lessen fire risk (Partners in Protection Canada 2003).

In 1997, the Alberta Environment, Land and Forest Service identified Fort McMurray as one of three pilot communities to engage in a multi-faceted interface fire planning process. That work was intended to make recommendations to help Fort McMurray become an early example of a FireSmart community (Partners in Protection Canada 2003). Since then, the Mutual Aid Fire Control Agreement has legislatively directed mitigation work. Under

that agreement, the Regional Municipality of Wood Buffalo holds the primary responsibility for the mitigation of fire risk in Fort McMurray. For other areas in the RMWB, the responsibilities are shared as the RMWB is responsible for structural fire jurisdiction and the provincial department of Alberta, Agriculture and Forestry is responsible for mitigation efforts in the wildland fire jurisdiction (KPMG Consulting 2017).

FireSmart is a comprehensive programme, operated by Partners in Protection. Partners in Protection is an Alberta-based non-profit organization that has the mandate of facilitating interagency cooperation in the promotion of awareness and education aimed at reducing risk of loss of life and property from fire in the wildland–urban interface (Partners in Protection Canada 2018a). In 1999, Partners in Protection first published the technical manual “*FireSmart Protecting your Community from Wildfire*” (Partners in Protection Canada 2003) which acts as a standard for fire mitigation activities. Today, these guidelines are used in Canada, Australia, New Zealand, and the USA.

For its fire mitigation programming, the RMWB has taken an approach that has been guided by FireSmart-based activities. In the recent past, these activities have included vegetation management, activities focusing on signage and public education, and the 2010 development of a Wildfire Mitigation Strategy (KPMG 2017). The 2010 Wildfire Mitigation Strategy was developed by drawing on principles from FireSmart.

In a post-incident assessment concerning lessons learned and future recommendations following the 2016 wildfire, it was recommended that the RMWB should, “enhance support for disaster risk management” including creating a more robust community programme that addresses all seven disciplines of FireSmart (KPMG Consulting 2017, pp. 40–41). These disciplines include education, vegetation management, legislation and planning, development considerations, interagency cooperation, emergency planning, and cross-training (Partners in Protection Canada 2018b).

The regional municipality has taken actions to act on that recommendation. At a January 30, 2017 Special Council Meeting, a motion was introduced and approved that the new Regional Municipality of Wood Buffalo Wildfire Mitigation Strategy dated December 7, 2017 be approved for use as a guiding document (RMWB 2018b). This mitigation strategy presented 15 recommendations that were consistent with addressing the seven disciplines of FireSmart (Walkinshaw 2017). Highlights of this 5-year mitigation strategy included more tree and brush clearing to reduce fuel loads and a call for residents to remove any combustible material within 1.5 metres of their homes (Canadian Press Staff 2016).

One of the more visible mitigation efforts that has been implemented since the 2016 fires has been the actions to make permanent 502 hectares of firebreaks around the city. During the 2016 fires, as the flames closed in on residential neighbourhoods, bulldozers cleared firebreaks between the forest and urban neighbourhoods. The intention of the firebreaks was to have the open spaces impede the spread of flames and to give fire fighting crews a better chance to save urban areas on the interface. However, it was noticed, that by Autumn 2017, the open spaces had become eroded and overgrown with weeds. The mitigation plan for these firebreaks is to make them permanent by clearing a 30 m wide area of vegetation and remaining trees away from homes to replace them with grass and walking and/or bike trails (Thurton 2017c).

9 Preparedness

Preparedness refers to actions taken before a disaster to allow those that may be impacted to respond effectively, and to equip them with the tools to minimize their losses and increase their chances of survival. In addition to learning from previous natural hazard-related emergencies, a number of characteristics of Fort McMurray contributed to the successful May 2016 evacuation. The KPMG After-Action Report suggests that, “Ultimately, the success of the evacuation during the wildfire was largely due to the young demographics of the community, and how the community rallied together to help one another evacuate safely” (KPMG Consulting 2017, p. 69). Almost 78% of the Fort McMurray population is between 15 and 64 years (Statistics Canada 2017). Furthermore, the overwhelming majority of Fort McMurray households have access to their own vehicles, something that was integral in facilitating the evacuation effort. According to 2016 census data, of the 37,270 residents that make up the employed labour force aged 15 years and over living in private households, 62% use a car, truck or van as a driver or passenger (Statistics Canada 2017).

Fort McMurray is known for having a safety-orientated culture. This is influenced by both the “safety first” standard of the oil industry, and as a result of the regular occurrence of natural hazards such as wildfires and floods. Fort McMurray hosts public events focused around safety each year, including the region’s Emergency Preparedness Week (May 1–7). Public awareness signs that provide safety advice—such as not starting campfires in the forest between certain months, and numbers to call in case a fire is spotted, are common. Residents also engage in regular fire, evacuation and lockdown drills at schools and in some businesses (NIN 2017). This safety culture played an important role in the successful evacuation on May 3, 2016.

The Regional Municipality of Wood Buffalo makes preparedness resources accessible to both individuals and small businesses (see RMWB 2015b). Available both in print and in online, tips for personal preparedness include: preparing a 72-h kit; developing an emergency plan; always having a full tank of gas in the car and a list of important documents to keep in a secure location. Purchasing of insurance is also encouraged. Hazard specific guides covering threats ranging from wildfires, to river breakups and severe storms, and instructions on how to shelter in place are provided. Residents also have the option of requesting the Regional Emergency Services personnel to deliver in-person emergency preparedness presentations to local community groups and small businesses.

Business continuity resources are also available (RMWB n.d.—b). The Business Continuity Guidebook, complete with a template, is meant to guide businesses in planning for unexpected events by helping to understand the risks faced as well as steps required to ensure continued operation during and after a disruption. Residents of Alberta are also requested to sign-up to receive alerts during an emergency with Alberta Emergency Alert.

Preparedness efforts that focus on reducing fire risk from windblown embers are amongst some of the new approaches being taken to prevent the next fire. Drawing directly from concepts that are advocated for preparedness in FireSmart-based programmes, actions such as not storing firewood beside homes, keeping roofs and gutters free of organic litter such as leaves and pine needles, and avoiding the use of wood mulch are encouraged. These activities are important since they reduce the risk of home ignition from burning embers; wind-driven embers are considered to be a greater source for home ignition than radiant heat from walls of flames (McGillivray 2016).

One aspect of Fort McMurray that is particularly unique is its diversity. Fort McMurray is one of Canada's most diverse cities—arguably more diverse, per capita, than Toronto (Huncar 2016). From an emergency social services perspective, while authorities were able to meet the basic needs of residents during the evacuation, studies that explore the lived experience of Fort McMurray's diverse groups—including visible minorities, faith communities, and marginalized populations, are encouraged (Mamuji and Rozdilsky 2017). These can help individuals to reflect on their own personal preparedness, as well as to guide emergency social services personnel towards providing more specific and culturally appropriate care.

10 Conclusion

Fort McMurray's 2016 wildfire is an important case to study. The successful evacuation of 88,000 residents as a city became engulfed in flames offers important observations in the phases of response, recovery, preparedness, and mitigation for those committed to improving emergency management. Looking at this significant wildfire through the lens of comprehensive emergency management helps to organize a holistic approach, identify areas of overlap, and assist with drawing good practices for dealing with future hazardous events.

Just over a year after the 2016 wildfire that hit Fort McMurray, fires in British Columbia in early July and the end of August 2017 set a new record for land consumed by fire in Canada. Over 1.2 million hectares burned, surpassing the previous record of 857,000 hectares burned in 1958 (Flannigan 2017). A year after that, in late August 2018, the British Columbia government extended a state of emergency to mid-September due to a particularly intense wildfire season, where more than 12,984 km² of the province were burning (Lindsey 2018a). This surpassed the previous record of land area burnt during 2017. Wildfire ecologist Robert Gray stated, "What we thought was going to be an average condition in 2050, we're starting to see those conditions coming a lot sooner" (Lindsey 2018b).

While it is beyond the scope of this paper to attempt to relate specific hazard occurrences to climate change impacts, the 2017 and 2018 Canadian wildfire seasons do give emergency managers pause, if it is in any way a predictor of what the future may hold. As communities will continue to be evacuated and recovery efforts will ensue, it goes without saying that there is much to learn from Canada's largest evacuation in recent history.

References

- Asher D, Mouallem O (2017) Inside the inferno: a firefighter's story of the brotherhood that saved Fort McMurray. Simon and Schuster Canada, Toronto
- Ashfaw HW (2017) 2011 Wildfire evacuation experiences of Sandy Lake First Nation. Oral Presentation at the First Nations Emergency Management Forum, 28–30 Mar 2017, Calgary, Alberta
- Bartko K, Mertz E (2016) Fort McMurray wildfire: shifting weather forces more evacuations. Global News. Retrieved from <https://globalnews.ca/news/2679178/fort-mcmurray-wildfire-how-many-homes-have-been-lost-in-the-fire/>
- Beamish L (2018) Mental health still a priority two-years after Fort McMurray wildfire. Edmont J. Retrieved from <http://edmontonjournal.com/news/local-news/mental-health-still-a-priority-two-years-after-fort-mcmurray-wildfire>

- Bell R (2016) Fort McKay welcomed evacuees, 4 days later the wildfire came knocking. Canadian Broadcasting Corporation News. Retrieved from <https://www.cbc.ca/news/canada/edmonton/fort-mckay-welcomed-evacuees-4-days-later-the-wildfire-came-knocking-1.3598685>
- Bellefontaine M (2018) Byelection candidates counter rosy evaluation of Fort McMurray rebuild. Canadian Broadcasting Corporation News. Retrieved from <https://www.cbc.ca/news/canada/edmonton/fort-mcmurray-conklin-byelection-debate-1.4734041>
- Beverly JL, Bothwell P (2011) Wildfire evacuations in Canada 1980–2007. *Nat Hazards* 59(1):571–596
- Bird C (2017) Recovery task force downsizing, council told. Fort McMurray Today. Retrieved from <http://www.fortmcmurraytoday.com/2017/08/23/recovery-task-force-dissolves-transfers-duties>
- Burton I (1981) The mississauga evacuation: final Report. Institute for Environmental Studies, University of Toronto, Toronto
- Canadian Press Staff (2016) Fort McMurray wildfire: map of neighbourhoods affected. Retrieved. Global News. Retrieved from <https://globalnews.ca/news/2679330/fort-mcmurray-wildfire-map-of-neighbourhoods-affected/>.
- Cattaneo C (2018) In the shadow of the Beast: two years after the monster fire, Fort McMurray struggles for a different future. *Financial Post*. Retrieved from <http://business.financialpost.com/feature/in-the-shadow-of-the-beast-two-years-after-the-monster-fire-fort-mcmurray-struggles-for-a-different-future>
- Christianson A (2017). Wildland fire evacuations in Canada. Presented at the Canadian Institute of Forestry E-Lecture Series. Retrieved from <https://www.cif-ifc.org/wp-content/uploads/2017/10/20171101-E-Lecture.pdf>
- Christianson A, McGee T, L'Hirondelle L (2013) How historic and current wildfire experiences in an aboriginal community influence mitigation preferences. *Int J Wildland Fire* 22(4):527–536
- City of Kelowna (2016) Okanagan mountain park fire. Retrieved from <https://www.kelowna.ca/city-services/emergency-services/fire-department/okanagan-mountain-park-fire>
- Cohn PJ, Carroll MS, Kumagai Y (2006) Evacuation behavior during wildfires: results of three case studies. *West J Appl For* 21(1):39–48
- Cova TJ (2005) Public safety in the urban–wildland interface: should fire-prone communities have a maximum occupancy? *Nat Hazards Rev* 6(3):99–108
- Dirks J (2018) Two years later: 20 per cent of homes lost during Fort McMurray wildfires fully rebuilt. CTV News. Retrieved from <https://www.ctvnews.ca/canada/two-years-later-20-per-cent-of-homes-lost-during-fort-mcmurray-wildfires-fully-rebuilt-1.3914654>. Accessed 31 May 2018
- Ferguson G (2017) Land on fire: the new reality of wildfire in the West. Timber Press, Portland
- Flannigan M (2017) The 2017 Canadian wildfire season. *Can Wildland Fire Smoke Newsl*, Fall 2017, p 19. Retrieved from https://docs.wixstatic.com/ugd/90df79_bfcc500b532a4e38abaa78e1ecfd26b.pdf
- Flannigan M, Wotton M (2017) How will Canada manage its wildfires in the future? *The Conversation*. Retrieved from <http://theconversation.com/how-will-canada-manage-its-wildfires-in-the-future-86383>. Accessed 26 Nov 2017
- French J (2016) Timeline of evacuation and return to Fort McMurray. Edmont J. Retrieved from <http://edmontonjournal.com/news/insight/timeline-of-evacuation-and-return-to-fort-mcmurray>. Accessed 31 May 2018
- Gerein K (2017) A year after the fire, Fort McMurray residents report an uneven recovery. Edmont Sun. Retrieved from <https://edmontonsun.com/2017/04/25/a-year-after-the-fire-fort-mcmurray-residents-report-an-uneven-recovery/wcm/315f53a3-53b1-40c0-b391-a44d4e3694da>. Accessed 31 May 2018
- Giacalone R, Muzumdar T, Wollard L (2016) Chapter one: overview of the Fort McMurray Wildfire. In from the ashes: government and non-profit cooperation in emergency management, a policy paper written by graduate students in Ryerson's Masters of Public Policy and Administration (Instructor Alex Gill) p 96. Toronto, Ontario: Ryerson University. Retrieved from https://www.ryerson.ca/content/dam/politics/docs/news/I60627-From_the_Ashes-PA8209_Policy_Paper.pdf. Accessed 31 May 2018
- Government of Alberta (2015) 2015 municipal affairs population list. A report of the Alberta Office of the Municipal Services Branch. Retrieved from http://municipalaffairs.alberta.ca/documents/msb/2015_Municipal_Affairs_Population_List.pdf. Accessed 31 May 2018
- Government of Alberta (2016a) Home again: recovery after the Wood Buffalo wildfire. A report of the Alberta Office of the Minister of Municipal Affairs. Retrieved from <https://www.alberta.ca/documents/Wildfire-Home-Again-Report.pdf>. Accessed 31 May 2018
- Government of Alberta (2016b) Provincial emergency social services framework. A report of the Alberta Emergency Management Agency (AEMA). Retrieved from <http://www.aema.alberta.ca/documents/PESS-Framework-Final-Document-01182016.pdf>. Accessed 31 May 2018
- Halinda G (2016) Fort McMurray hit with 'biblical' flood amid wildfire recovery efforts. *The Globe and Mail*. Retrieved from <https://www.theglobeandmail.com/news/national/fort-mcmurray-hit-with-biblical-flood-amid-wildfire-recovery-efforts/article31250698/>. Accessed 31 May 2018

- Harris K (2018) Liberals to buy Trans Mountain pipeline for \$4.5B to ensure expansion is built. Canadian Broadcasting Corporation News. Retrieved from <http://www.cbc.ca/news/politics/liberals-trans-mountain-pipeline-kinder-morgan-1.4681911>. Accessed 31 May 2018
- Hawley J, Hurley G, Sackett S (2017) Into the fire: the fight to save Fort McMurray. Place of publication not identified. McClelland & Stewart, Toronto
- Heidenreich P (2016) Firefighting plane crashes in northwest Alberta. Global News. Retrieved from <https://globalnews.ca/news/2683868/firefighting-plane-crashes-in-northwest-alberta/>. Accessed 31 May 2018
- Henton D (2013) Report reveals mayhem as fire swept through Slave Lake. Calgary Herald. Retrieved from <http://www.calgaryherald.com/news/alberta/report+reveals+mayhem+fire+swept+through+slave+lake/8385090/story.html>. Accessed 31 May 2018
- Huncar A (2016) Fort McMurray now one of Canada's most diverse cities. CBC News. Retrieved from <http://www.cbc.ca/news/canada/edmonton/fort-mcmurray-now-one-of-canada-s-most-diverse-cities-1.3451087>. Accessed 31 May 2018
- Insurance Bureau of Canada. (2016). Northern Alberta wildfire costliest insured natural disaster in Canadian history. Retrieved from <http://www.ibc.ca/bc/resources/media-centre/media-releases/northern-alberta-wildfire-costliest-insured-natural-disaster-in-canadian-history>. Accessed 26 May 2018
- Kohut, T. (2016). Fort McMurray fire: timeline of events. Global News. Retrieved from <https://globalnews.ca/news/2681249/fort-mcmurray-wildfire-timeline-of-events/>. Accessed 31 May 2018
- KPMG Consulting (2017) Lessons learned and recommendations from the 2016 Horse River Wildfire. Retrieved from <https://www.alberta.ca/assets/documents/Wildfire-KPMG-Report.pdf>. Accessed 31 May 2018
- Kraus S (2018) Food bank still dealing with fallout from Fort McMurray wildfire. Global News. Retrieved from <https://globalnews.ca/news/3994408/fort-mcmurray-food-bank-demand-wildfire/>. Accessed 31 May 2018
- Lindsey B (2018a) State of emergency extended as 2018 becomes worst B.C. wildfire season on record. Canadian Broadcasting Corporation News. Retrieved from <https://www.cbc.ca/news/canada/british-columbia/state-of-emergency-extended-as-2018-becomes-worst-b-c-wildfire-season-on-record-1.4803546>. Accessed 31 May 2018
- Lindsey B (2018b) The future looks grim after 2 years of devastating B.C. wildfires. Canadian Broadcasting Corporation News. Retrieved from <https://www.cbc.ca/news/canada/british-columbia/the-future-looks-grim-after-2-years-of-devastating-b-c-wildfires-1.4801181>. Accessed 31 May 2018
- Mamuji A, Rozdilsky JL (2017). Understanding issues faced by residents of Fort McMurray during the 2016 wildfire evacuations: a focus on the Muslim community. Presentation at the 2017 Canadian Risk and Hazards Network 2017 annual symposium. Halifax, Nova Scotia. October 25
- Markusoff J (2017) Why Fort McMurray will never be the same. MacLeans.ca. Retrieved from <https://www.macleans.ca/news/canada/why-fort-mcmurray-will-never-be-the-same/>. Accessed 31 May 2018
- Markusoff J, Macdonald N, Gillis C (2016) The great escape. MacLeans.ca. Retrieved from Maclean's. Retrieved from <http://www.macleans.ca/fort-mcmurray-fire-the-great-escape/>. Accessed 31 May 2018
- McDermott V, Beamish L (2018) Frustration with rebuild, optimism looking forward marks two years since wildfire. Fort McMurray Today. Retrieved from <http://www.fortmcmurraytoday.com/2018/05/03/pace-of-rebuild-frustration-and-a-stubborn-streak-of-optimism-marks-two-years-since-wildfire>. Accessed 31 May 2018
- McGillivray G (2016) After the fire, lessons from Fort McMurray. The Globe and Mail. Retrieved from <https://www.theglobeandmail.com/opinion/after-the-fire-the-lessons-from-fort-mcmurray/article31985790/>. Accessed 31 May 2018
- Mertz E (2016) Fort McMurray triplet killed fleeing fires was daughter of deputy fire chief. Global News. Retrieved from <https://globalnews.ca/news/2680870/horrific-crash-on-albertas-highway-881-sparks-blaze/>. Accessed 27 May 2018
- MNP Consulting (2017) A review of the 2016 Horse River Wildfire. A report prepared for forestry division, Alberta agriculture and forestry. Retrieved from <https://www.alberta.ca/assets/documents/Wildfire-MNP-Report.pdf>. Accessed 31 May 2018
- National Governors' Association (1979) Comprehensive emergency management: a governor's guide. United States. Defense Civil Preparedness Agency, Department of Defense
- Newcomer Interagency Network, NIN (2017) Wood buffalo wildfire 2016 newcomers: emergency readiness & response. Internal Report
- Partners in Protection (Canada) (2003) FireSmart: protecting your community from wildfire. Edmonton: Partners in Protection. Retrieved from <http://catalog.hathitrust.org/api/volumes/oclc/52457694.html>. Accessed 31 May 2018
- Partners in Protection (Canada) (2018a) About FireSmart Canada. Retrieved from <https://www.firesmartcanada.ca/about>. Accessed 31 May 2018

- Partners in Protection (Canada) (2018b) What is firesmart? Retrieved from <https://www.firesmartcanada.ca/what-is-firesmart>. Accessed 31 May 2018
- Phillips CJ (2016) 2016 Fort McMurray Wildfire—a timeline of events. Your McMurray magazine. Retrieved from <http://yourmcmurraymagazine.com/special-editions/commemorative-issues/2016-wildfire-commemorative-edition/the-story/1786/2016-fort-mcmurray-wildfire-a-timeline-of-events>. Accessed 31 May 2018
- Public Safety Canada (2015). The Canadian disaster database. Retrieved from <https://www.publicsafety.gc.ca/cnt/rsrsc/cndn-dsstr-dtbs/index-en.aspx>. Accessed 31 May 2018
- Quarantelli EL (1980) Evacuation behavior and problems: Findings and implications from the research literature. Disaster Research Center. Ohio State University, Columbus
- Regional Municipality of Wood Buffalo, RMWB (2015a) The municipal census 2015 report. Retrieved from <https://www.rmwb.ca/Assets/Corporate/Census+Reports/Municipal+Census+2015+Report.pdf>. Accessed 31 May 2018
- Regional Municipality of Wood Buffalo, RMWB (2015b) Emergency preparedness guide. Retrieved from https://www.rmwb.ca/Assets/Departments/Emergency+Management/Brochures/EmergencyPreparednessGuide_2015.pdf. Accessed 31 May 2018
- Regional Municipality of Wood Buffalo, RMWB (2016) RMWB 2016 wildfire recovery plan. Retrieved from <http://asset.rmwb.ca/files/RMWB-2016-Wildfire-Recovery-Plan.pdf?v3>. Accessed 31 May 2018
- Regional Municipality of Wood Buffalo, RMWB (2018a) Recovery task force—rebuild pillar progress update. Retrieved May 26, 2018, from <http://www.rmwb.ca/News-Room/RMWB-Wildfire-Information/Recovery-Progress-Updates/Rebuild-Pillar-Progress.htm>. Accessed 31 May 2018
- Regional Municipality of Wood Buffalo, RMWB (2018b) Special council meeting agenda for January 30. Jubilee Centre Council Chamber, Fort McMurray, Alberta. Retrieved from <http://woodbuffalocn.igm2.com/Citizens/FileOpen.aspx?Type=1&ID=1071&Inline=True>. Accessed 31 May 2018
- Region of Peel (n.d.) What is emergency management? Retrieved from <https://www.peelregion.ca/prep/emergmanage/management.htm>
- Regional Municipality of Wood Buffalo, RMWB (n.d.—a) Emergency social services. Retrieved from https://www.rmwb.ca/Municipal-Government/municipal_departments/Emergency-Services—Law-Enforcement/Emergency-Management/Emergency-Social-Services.htm
- Regional Municipality of Wood Buffalo, RMWB. (n.d.—b) Business continuity guidebook. Retrieved from https://www.rmwb.ca/Municipal-Government/municipal_departments/Emergency-Services—Law-Enforcement/Emergency-Management/BPC.htm
- Snowdon W (2017) Fort McMurray wildfire costs to reach almost \$9B, new report says. Canadian Broadcasting Corporation News. Retrieved from <http://www.cbc.ca/news/canada/edmonton/fort-mcmurray-wildfire-costs-to-reach-almost-9b-new-report-says-1.3939953>. Accessed 27 May 2018
- Sorensen JH, Sorenson BV (2007) Community processes: warning and evacuation. In: Rodriguez H, Quarantelli EL, Dynes RL (eds) Handbook of disaster research. Springer, New York, pp 183–199
- Statistics Canada (2017) Fort McMurray [Population centre], Alberta and Alberta [Province] (table). Census profile. 2016 census. Statistics Canada catalogue No. 98-316-X2016001. Ottawa. Released November 29, 2017
- Sundar S, Chakravarty J (2010) Antimony toxicity. *Int J Environ Res Public Health* 7(12):4267–4277. <https://doi.org/10.3390/ijerph7124267>
- Sutherland S (2016) Three years later: what caused the 2013 Alberta floods? The weather network. Retrieved from <https://www.theweathernetwork.com/news/articles/why-was-southern-alberta-so-vulnerable-to-flooding-in-2013/29800>. Accessed 26 May 2018
- Sutton J, Palen L, Shklovski I (2008) Backchannels on the front lines: emergent use of social media in the 2007 Southern California Fires. In: The proceedings of the 5th international ISCRAM conference—Washington, DC. Retrieved from <http://jeannettesutton.com/uploads/BackchannelsISCRAM08.pdf>. Accessed 31 May 2018
- The Canadian Press (2017) All alerts, evacuation orders lifted as worst wildfire season eases in B.C. Vancouver Sun. Retrieved from <http://vancouversun.com/news/local-news/all-alerts-evacuation-orders-lifted-as-worst-wildfire-season-eases-in-b-c>. Accessed 31 May 2018
- Thurton D (2016) Council considers compensation for homes sacrificed to save others in Fort McMurray wildfire. Canadian Broadcasting Corporation News. Retrieved from <http://www.cbc.ca/news/canada/edmonton/council-considers-compensation-for-homes-bulldozed-to-save-others-in-fort-mcmurray-wildfire-1.3769980>. Accessed 31 May 2018
- Thurton D (2017a) Fort McMurray seeing big spike in water-treatment costs. Canadian Broadcasting Corporation News. Retrieved from <https://www.cbc.ca/news/canada/edmonton/fort-mcmurray-wildfire-water-treatment-costs-contaminants-1.3973249>. Accessed 31 May 2018

- Thurton D (2017b) Fort McMurray wildfire committee outlines recovery's failures and successes. Canadian Broadcasting Corporation News. Retrieved from <https://www.cbc.ca/news/canada/edmonton/fort-mcmurray-wildfire-committee-recovery-wood-buffalo-1.4149037>. Accessed 31 May 2018
- Thurton D (2017c) Fort McMurray prepares for the next wildfire by strengthening its defences. Canadian Broadcasting Corporation News. Retrieved from <http://www.cbc.ca/news/canada/edmonton/fort-mcmurray-wildfire-fire-smart-fire-guard-1.4272973>. Accessed 31 May 2018
- Thurton D (2018) Fort McMurray rebuild lagging 2 years after the wildfire. Canadian Broadcasting Corporation News. Retrieved from <http://www.cbc.ca/news/canada/edmonton/fort-mcmurray-rebuild-lagging-2-years-after-the-wildfire-1.4642533>. Accessed 31 May 2018
- Tierney KJ, Lindell MK, Perry RW (2001) Facing the unexpected: disaster preparedness and response in the United States. Joseph Henry Press, Washington D.C.
- U.S. Department of Homeland Security (2011) National preparedness goal. Retrieved from <https://www.fema.gov/pdf/prepared/npg.pdf>. Accessed 31 May 2018
- Walkinshaw S (2017) Regional municipality of wood buffalo wildfire mitigation strategy. Montane Forest Management Ltd., Canmore, Alberta. Retrieved from <https://www.rmwb.ca/Assets/Recovery/2017+Wildfire+Mitigation+Strategy.pdf>. Accessed 31 May 2018
- Walsh M (2017) Recovery task force teams up with McMurray Métis and Athabasca tribal council. My McMurray. Retrieved from <http://www.mymcmurray.com/2017/03/20/recovery-task-force-teams-mcmurray-metis-athabasca-tribal-council/>. Accessed 31 May 2018
- Water Services (2017) The flood of 2013. City of Calgary. Retrieved from <http://www.calgary.ca/UEP/Water/Pages/Flood-Info/Flooding-History-Calgary.aspx>. Accessed 26 May 2018
- Weinman J (2016) What were Canada's biggest mass evacuations? MacLean's. Retrieved from <https://www.macleans.ca/news/canada/what-were-canadas-biggest-mass-evacuations/>. Accessed 31 May 2018
- Woo M, Hui KTY, Ren K, Gan KE, Kim A (2017) Reconstructing an emergency evacuation by ground and air: the wildfire in fort McMurray, Alberta, Canada. Transp Res Rec JTransp Res Board 2604:63–70