

# Fires in the Rough: A Close Examination of the Fire Hazards in the Rural-Urban Fringe in Kelowna, B.C.

*Allison Hughes & Mike Simak*

**Geography and Environmental Studies**

**Supervisor:** Dr. Tom Waldichuk

## **Abstract:**

*Fire hazards in the rural-urban fringe have been a cause of concern for several decades. During the hot, dry summer months, risks for fires increase dramatically. This is due in part to the low level of maintenance in these areas when compared to their urban counterparts, as well as the issues of weather, lack of adherence to policy regarding environmental management, and the emergency response of the region. These issues have been thoroughly investigated using a deep literature review using peer reviewed articles, newspaper articles, regional data from statistics Canada, and this paper includes an examination of wildfire events in the Kelowna area, exploring the potential improvements from the perspectives of management, policy, and individual responsibility. We found that the probability of fires occurring is greater in the rural-urban fringe, the response time by regional district is slower, and there is a greater susceptibility of the landscape to hazardous weather conditions. In conclusion, the social and*

*physical characteristics of the rural-urban fringe in Kelowna promote an environment that is particularly vulnerable to wildfires, and the city is continuing to improve land-use patterns in the area to ensure a decrease risk of fire hazards.*

## **Introduction**

Forest fires in the rural-urban fringe are an unexpected occurrence. Every summer, there is worry surrounding hundreds of communities nationwide wondering if a massive fire would break on the outskirts of their city. It can lead to panic and distress when dealing with evacuation and thousands of people without homes. This is where people question what causes fire hazards when living in the rural-urban fringe, and whether they can stop it from occurring in the future. In this paper, we will define what the rural-urban fringe is, and examine in depth the fire hazards in the rural-urban fringe located in Kelowna, British Columbia. Specifically, we examine the possible fire hazards, the public's perceptions on living in this area, and the policy changes needed to make this area safer towards fire hazards.

The purpose of this paper is first to determine if fire hazards are a greater risk in the rural-urban fringe. Second, this paper will examine two forest fires that have occurred in the rural-urban fringe of Kelowna, British Columbia, determining what were the hazards that caused these fires, the policy changes that have occurred since then, and the public's perception towards these policies. Lastly, this paper will explore potential improvements for the community that can decrease the risk for forest fires.

## **Argument**

Firstly, we would like to argue that Kelowna's rural-urban fringe is susceptible to fire hazards due to rapid land use patterns. Secondly, we will argue that forest fires in Kelowna are more human caused than environmental. Thirdly, we will argue that Kelowna has continued to improve on emergency regulations, land use policies, and predicting future forest fires in the community.

## **Methodology**

The research for this paper was conducted using several different sources. The literature review was done by researching peer reviewed articles, books, refereed journal articles, and case studies that discussed fire hazards in general terms. We also used city planning strategies from neighboring communities for researching examples for future policy suggestions. In addition, we used several additional case studies to look into the fire hazards surrounding the rural-urban fringe in Kelowna, BC, using Statistic Canada for population size of the city and online newspaper articles for researching the 2017 East Kelowna fire.

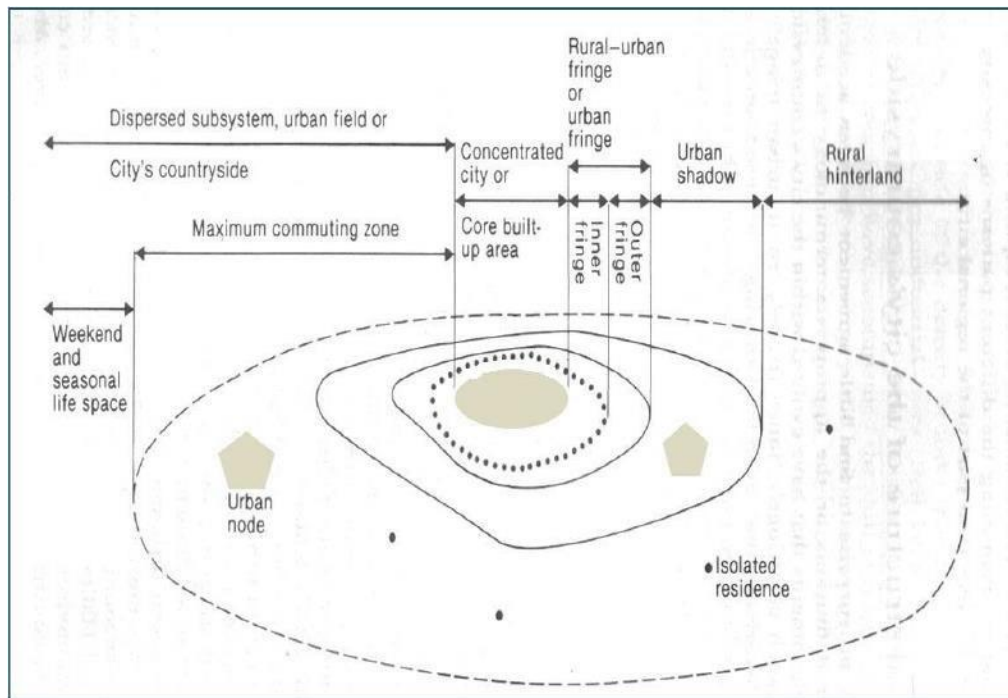
## **Literature Review**

### **Defining the Rural-Urban Fringe**

The first official definition of the rural-urban fringe occurred in 1942 by Wehrwein as being "...the area of transition, between well recognized urban land uses and the area devoted to agriculture" (p. 218). Richard Pryor would later expand on this definition in 1968 by defining it as: "...the zone transition in land use, social and demographic characteristics, lying between (a) the continuously

built-up urban and suburban areas of the central city, and (b) the rural hinterland, characterized by the almost complete absence of non-farm dwellings, occupations and land use...” (p. 206).

The rural-urban fringe has many different synonyms including the fringe, urban shadow, exurban zone, rurban fringe, and the term rural-urban fringe is seldom used outside of North America. Another commonly used alternative to rural-urban fringe that comes up in a vast amount of literature is the wildland-urban interface (WUI) which Radeloff et al. define as “...the area where houses meet or intermingle with undeveloped wildland vegetation” (2005, p. 799). The first and most basic representation of this area was modeled by Bryant et al. in 1982 (Figure 1).



**Figure 1:** Diagram of the Rural-Urban Fringe. Source: Bryant et al. (1982)

As urban sprawl continues and more land becomes part of the urban core, the boundaries of the rural-urban fringe continue to expand outwards exemplifying its' nature as a zone of transition. Donna Senese explains that the accelerated urban consumption of agricultural land is due in part to urban population growth and urban households consuming more land per dwelling (as cited in Beesley, 2010 p. 164).

### **Wildfires in Canada**

Wildfires in Canada are a large problem, accounting for two million hectares of forest burned each year (Beverly & Bothwell n.d, p. 572). Radeloff et al. (2005) consider the rural-urban fringe to be the area where the most structures are lost to wildfires (p. 803). Unfortunately the risk of these incidents has been steadily increasing due to urban sprawl, amenity migration and climate change (Anton & Lawrence, 2016, p. 148). Nitschke and Innes recognize that wildfire is a source of economic loss and as an ecological process that is susceptible to change with shifts in climate (2008, p. 841). They determine that the mean fire season length will increase by 17 days by 2039, and by 28 days in 2070 with 25 of the additional days to occur during the spring (p. 851). Research by Beverly and Bothwell (n.d.) estimated that “between 1970 and 2007, 209,121 people have been evacuated due to wildfire events” (p. 580). They also calculate that of the 43% of events with which a cause can be determined, 45% of the fires were human caused (p. 583). On a Canada-wide basis, the majority of fires are still caused by lightning strikes hitting areas where there is plenty of fuel (vegetation, shrubs, etc.) on the surface (Jiang & Zhuang, 2011, p. 1850). With regard to natural forest fires, Goldammer and Price (1998) state that the biggest factors affecting occurrence are weather conditions, ignition sources, and availability of fuels (cited in Nitschke & Innes, 2008, p. 842). In 2003 alone, the summer season facilitated 2500 forest fire events in British Columbia (Hystad & Keller, 2006, p. 48). During the wildfires, the

number of visits to physicians by residents of Kelowna were 78% above the ten-year average for that same time period due to respiratory diseases (Moore et al. 2006, p. 107). This reinforces the idea that the danger of wildfires in the fringe is not just about issues of land loss.

### **Attitudes and Perceptions**

With wildfires being so prevalent in Canada and being responsible for the destruction of land, evacuation, and even health concerns, the residents of the rural-urban fringe have a responsibility to be aware of the risks that their land use entails. They must be prepared to take preventative measures to decrease the risk of these events occurring. Cohen (2000) asserts that homeowners who live next to wildfire-prone areas must take responsibility to ensure their homes are not a fire hazard (p. 21), and that property losses can be mitigated and prevented by homeowners deciding to focus on their immediate surroundings (p. 20). This is backed up by Kauffman's (2004) report that wildland fuel characteristics beyond the home and its surroundings have little if any significance in regards to home loss (p. 881).

Proper mitigation cannot happen without the proper attitude towards, and perception of, wildfires. The attitudes of people in the fringe can be uniquely dangerous when compared to true rural people because they are straddling the line between rural and urban causing them to want the best of both worlds. Fringe residents are less likely to realize the threat of wildfires among other hazards due to their proximity to the urban core and emergency services (Anton & Lawrence, 2016, p. 151) while at the same time priding themselves on their self-sufficiency, making them less likely to be receptive to one-way educational methods (Cole & Murphy, 2014, p. 301).

The lack of willingness to reduce wildfire risk often comes from a selfish

place. A survey done by Cortner, Gardner, and Taylor (1990) survey found that many people who choose to live in a hazard-prone area have the idea that the risk is theirs alone (p.60), which is simply not true. Because of this mindset homeowners can be resistant to performing best practices such as tree thinning or removal as it can reduce aesthetic value and privacy, without realizing that many people and a great deal of land will be affected if a fire breaks loose (Labossière & McGee, 2017, p. 209). Resistant residents who have the reasoning behind the clearing or thinning explained to them retort with claims as extreme as “Well I don’t care if my house burns down, that’s what insurance is for...” (Goemans & Ballamingie, 2013, p. 60). However, since the fire events in Kelowna, many residents have been in support of at least removing excess vegetation from their properties to reduce fire risk in the future (p. 64). Unfortunately, homeowners who have experienced a fire are more likely to convince themselves that it will not happen again despite the recurring nature of fires (Cortner, Gardner & Taylor, 1990, p. 59).

### **Prevention and Mitigation**

There are many different levels of prevention and mitigation that can be improved upon to reduce overall risk. These include improving the education and practices of rural-urban fringe residents, refining policy, and direct contribution from the government. Berkes (2007) explains that resilience to hazard risks can be built through decreasing vulnerability via political, ecological, and social planning (p. 292). On an individual level, people can either modify their personal environments or vocalize support for public policies designed to mitigate fire hazards. This is especially important because the majority of urban forests are on private land (Goemans & Ballamingie, 2013, p. 57). Positive actions include things like using fire resistant vegetation in landscaping and installing roof sprinkler systems and shuttered windows (Cortner, Gardner, & Taylor 1990, p.

59). However, people will not take these steps unless they are properly educated about risk and have the means to enact these measures. Anton and Lawrence (2016) note that greater education and higher income have been linked to greater disaster mitigation and preparedness (p. 150). They also found that people were not likely to make changes to their homes such as roof-mounted sprinklers (159). This is likely an issue with the cost associated with making these changes. Labossière and McGee (2017) support this notion with an example in Logan Lake (a rural-urban fringe community), where the government provided rooftop sprinkler systems and hazard risk assessment of properties for only \$40 (p. 205). As of 2012, one third of all homeowners owned a sprinkler system purchased through this program (p. 205).

Forest thinning, logging, and prescribed burning are conventional methods that can help reduce instances of wildfires, and municipalities play a large role in promoting best practices in regards to fire hazards (p. 205). For example, the city of Kamloops works hard at promoting xeriscaping (arid landscaping) and has offered fire-resistant tree species to replace trees killed by the mountain pine beetle (p. 206). Even taking small steps like Logan Lake has by providing dumpsters free of charge in which dead trees and other fire fuel can be disposed of by residents goes a long way (p. 206). Cole and Murphy (2014) recognize that communities across Canada are from rural to urban, small to large, with a variety of different geographical features and no universal strategy that can be applied in regards to mitigation and prevention (p. 293). A wide range of platforms needs to be employed in order to educate people, especially in the more rural communities where internet accessibility may not be widely available (p. 300). Due to rural and fringe communities being unique in the sense that they exhibit an increased amount of social cohesion (p. 301), partnerships with local organizations and neighbouring communities are of extreme importance (p. 302). Because of these



aspects, top-down approaches that work on generalities are far inferior to those that are started on the community level (p. 293).

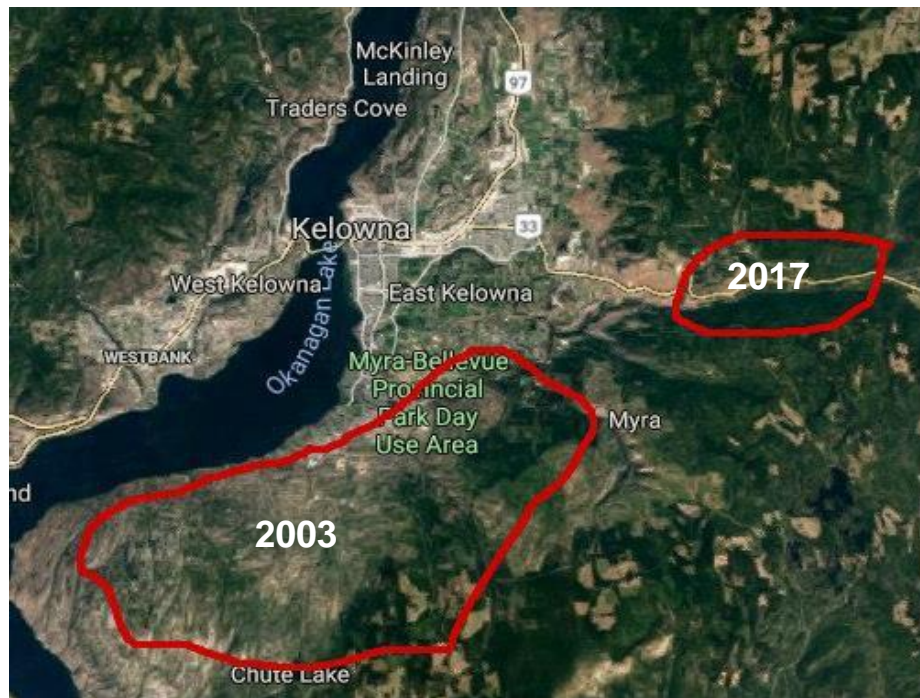
## **Kelowna, B.C. Discussion and Results**

### **Introduction to Kelowna, B.C.**

The city of Kelowna is located in the central part of the Okanagan Valley region, situated in the southern interior of British Columbia (see Map 1 & 2). This region is settled in a semi-arid climate (Ballamingie & Goemans 2013), with relatively dry humidity in the summer months. The city is surrounded by the popular Okanagan Lake, vast grassland areas and large forests, and an abundance of recreational activities, making it a perfect destination for tourists and retirees who want to experience the outdoors and the peaceful surroundings. The current population stands at 151,957 people (Statistics Canada, 2016) with a population increase during the summer months due to the tourist season. The percent of the population that currently lives in the rural-urban fringe of Kelowna is unknown; however, there are major land use developments and agricultural farmland that are located in these heavily populated areas. These areas are considered to be a high risk for forest fires. This study explores two forest fires, 2003 Okanagan Mountain Park Fire and 2017 East Kelowna fire (see Map 2) that have occurred almost fifteen years apart in the rural-urban fringe of this region. This study examines the fire hazards that could have caused these disasters, the changes Kelowna has made in land policies surrounding and predicting fire hazards, and the population's perception on the events.



**Map 1:** BC Provincial Map. Source: Victoria BC Guide (2012)



**Map 2:** Kelowna, B.C. Forest Fires Source: Google Maps

### **2003 Okanagan Mountain Park Fire**

In mid-August 2003, one of the Okanagan's most damaging forest fires occurred in Okanagan Mountain Park (see Map 3). Located on the rural-urban fringe of south Kelowna, this park is used for recreational purposes for the tourist season. However, this area frequently has unexpected weather changes such as lightning storms, heat waves, and high wind gusts during the summer. The fire in 2003 was caused by a lightning strike. According to Goemans and Ballamingie (2013), the rapid movement of the fire was "spurred by strong winds and dry forest vegetation, the blaze eventually grew into a Rank 6 crown fire, which according to the British Columbia Ministry of Forests and Range Fire Intensity Rank System, is the most damaging of this type of disturbance" (p. 58). The 33,000 residents in the rural-urban fringe of the surrounding area were evacuated, which can account for 20% of the city's population. The emergency crews struggled to reach the main hotspot of the fire because of the location where it started. In this area, the wind gusts can increase at any time and, therefore, the city would have to act in the first hour to gain control. Because the fire occurred in the middle of the night, the fire spread rapidly, and within four days 13,000 hectares were engulfed (Goemans & Ballamingie, 2013). The result of the fire was \$200 million dollars in damage, 238 homes lost, and 26,000 hectares burned. Therefore, any land use policies in Kelowna during this time showed the city's unpreparedness for a major disaster. If Kelowna had been prepared and planned better land use patterns,

it could have saved homes and millions of dollars in damage.



**Map 3:** 2003 Okanagan Mountain Park Fire. Source:

[https://eoimages.gsfc.nasa.gov/images/imagerecords/3000/3766/okanagan\\_ast\\_2003245.jpg](https://eoimages.gsfc.nasa.gov/images/imagerecords/3000/3766/okanagan_ast_2003245.jpg)

There is major evidence through Kelowna's land use patterns that the city was not prepared for the 2003 Okanagan Mountain Park fire. Goemans & Ballamingie (2013) examined two areas that were most vulnerable to the fire and found them "comprised of high value residential properties that had steadily encroached into the forested periphery" (p. 58). These at-risk areas in the rural-urban fringe of Kelowna are heavily populated with residents who knew nothing about the dangers of a possible outbreak of fire. In fact, that summer the province

itself experienced extremely dry and hot weather conditions, leading to 2500 forest fire events, 15 of which were located in the rural-urban fringe area (Hystad & Keller, 2006). Although there was a province-wide campfire ban and a restriction ban for entering the back country, this did not include residential areas in the rural-urban fringe that can be at a much higher risk where residents may not know the limitations of fire usage in their own backyard. There is also the major growth the city is constantly experiencing with urban sprawl that can increase the risk. In the book, *The Rural-Urban Fringe in Canada: Conflict & Controversy*, Senese (2010) examines the land-use patterns of Kelowna sprawling out into the rural-urban interface, explaining “urban pressures are most significant in Kelowna with 49% of its municipal land based within the Agricultural Land Reserve” (p. 165). Another risk explored was the tourism that exists in the rural-urban fringe where most of Kelowna’s tourism is located. An example of this is the Okanagan Mountain Provincial Park where dozens of wineries are located around the park. These large agricultural areas can be a hazard risk and can be ignition fuels for these fires. Luckily none were damaged or destroyed in the 2003 fire; however, according to Hystad and Keller (2006), “Tourism Kelowna did not have any disaster management strategies in place prior to the fire” (p. 49). Due to the unpreparedness Kelowna had to face from this disaster, the city began to implement new policy practices to reduce the risk of future forest fires in the rural-urban fringe.

The major impact the Okanagan Mountain Park fire had on the city of Kelowna awakened new policy practices to decrease the risk for another disaster. For Tourism Kelowna, this led them into responding to prepare better in case of another fire to occur. In addition, the tourism industry also volunteered its time to respond towards the negativity from the community and tourists after the fire by setting up toll-free call centres, contacting local business, and creating new

campaigns for the market to increase positivity in the community (Hystad & Keller, 2006). At the same time, the city itself had begun to set up strategies through the Ministry of Forests to decrease the impact of fires occurring in adjacent forest areas. This included prescribed burns set and controlled by forestry officials, mechanical tree removals, and replacement of flammable vegetation such as “conifers with less flammable species such as deciduous trees or shrubs (Goemans & Ballamingie, 2013, p. 60). Another change Kelowna has set for decreasing risks in the rural-urban fringe was predicting the occurrence of these fires via weather stations, and measuring the climate change that could occur over the next century. This would give them enough information and time to follow through a proper procedure and set strict rules to decrease the fire risks surrounding these hazardous areas. In Nitschke and Innes’ (2008) study on climate change in the southern interior, they used five local weather stations to predict temperature, precipitations, wind speed, and relative humidity levels to predict possible weather patterns during the summer months. They explain that “the occurrence and impact of forest fires are closely connected to climate and weather” (Nitschke & Innes, 2008, p. 842) and because the 2003 fire was caused by a lightning strike and pushed by massive wind gusts, weather is possibly the most likely fire hazard in this region. Using the local weather stations and predicting future summer weather patterns, Kelowna has been able to counteract the massive fires that devastate the community.

The local residents of Kelowna were the most affected by the 2003 fire, and because of this devastation, their perceptions on the rural-urban fringe changed. Several interviews after the fire were conducted to gain perception and ideas for change surrounding fire hazards and possible land use policies. Goemans and Ballamingie (2013) found that many residents supported the idea surrounding the removal of excess vegetation in and around their properties to decrease the fire

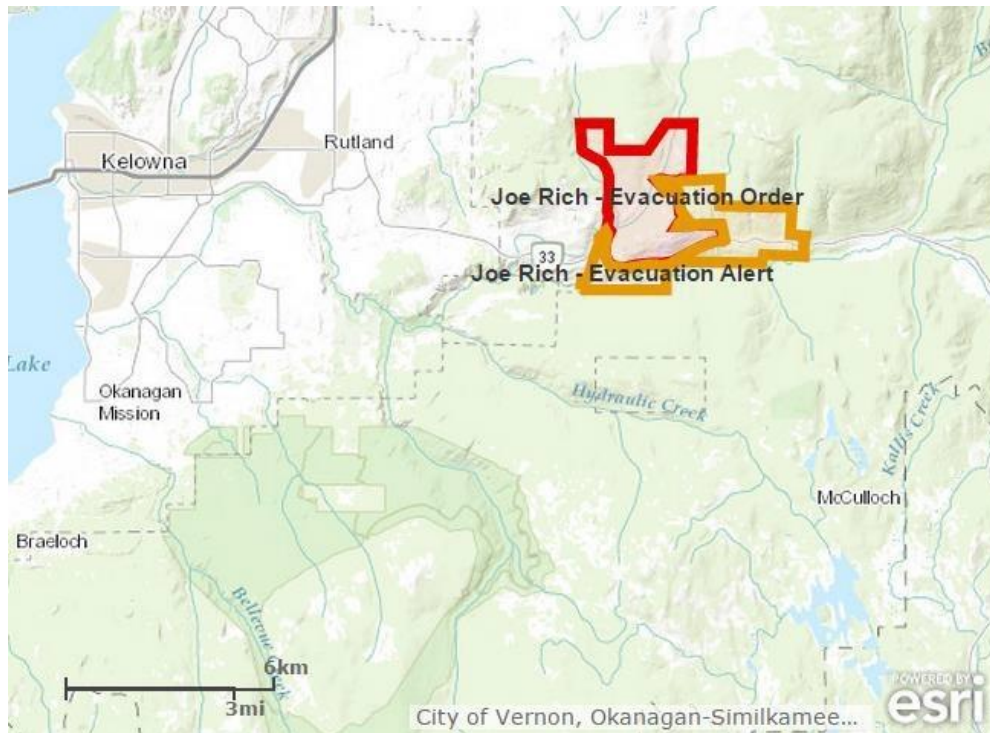
hazard. However there were those who instead accepted that there was a potential hazard living in the rural-urban fringe. They didn't approve of vegetation removal or forest thinning, claiming that they wanted to "maintain the natural surroundings on private properties according to visual priorities such as ensuring privacy or accessibility to views" (p. 65). Furthermore, residents who were against the removal cared more about privacy than their own homes, and therefore they further explain in their study that "residents who hold this perspective often resist disaster mitigation policies that do not correspond with familiar perceptions of local forested areas" (Goemans & Ballamingie, 2013, p. 65). Through this reaction, many of the residents were not informed enough about the hazards and therefore did not know the significance around the high risks of forest fires.

The 2003 Okanagan Mountain Park fire was an eye opener for Kelowna's community. It was a devastating event that placed the city and many residents with a negative attitude towards the rural-urban fringe. However, it had also taught them the risk involved in this hazardous area. Therefore, because of this event and knowing the fire hazards, Kelowna began to use better land use policies and coordinate weather predictions for future forest fire occurrences.

### **2017 East Kelowna Fire**

Although the 2003 fire was the worst the city of Kelowna experienced in terms of forest fires, in 2017 the province of British Columbia saw one of the worst fire seasons in the last twenty years. One of these fires occurred at the end of August in the rural-urban fringe area of East Kelowna known as Joe Rich (see Map 4). This area is home to fewer than 2,000 residents and 20km outside the city. The fire was suggested to have started in the early afternoon with emergency crew on scene hours later after a 911 call. Around 1,100 people were evacuated and 474 properties left empty as the fire grew to 400 hectares, only 3 km away from the

nearest home (CBC News, 2017). The cause of the fire is currently unknown; however, it is highly possible it was started by a discarded cigarette. Because the city was quick to action, it resulted in zero loss of property (Kelowna Capital News, 2017).



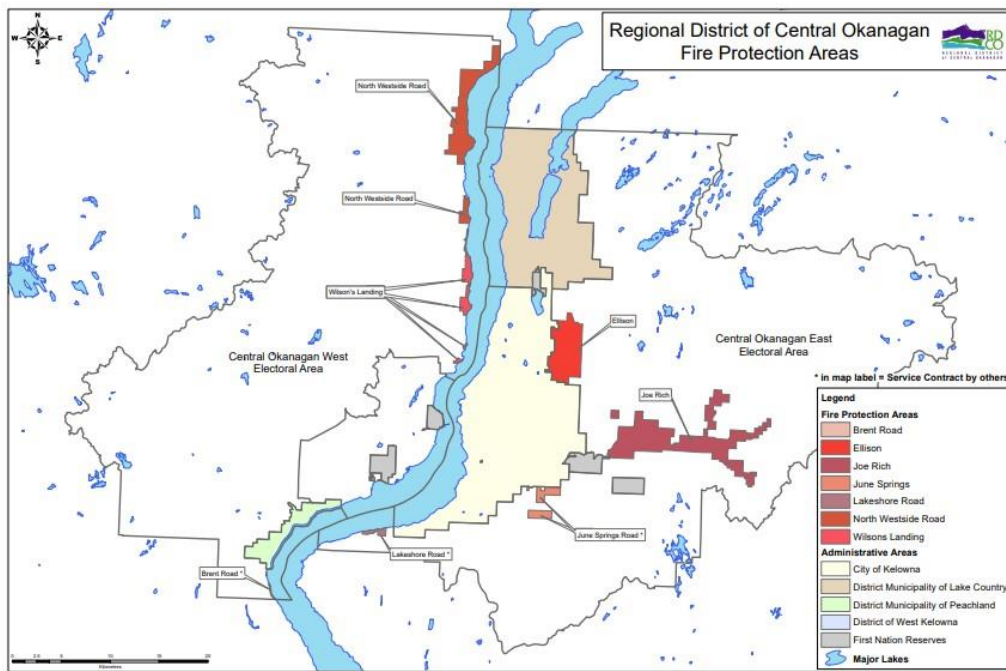
**Map 4:** East Kelowna Fire evacuation area. Source:

<https://shawglobalnews.files.wordpress.com/2015/07/capture3.png>

This rural-urban fringe fire is an example that Kelowna has acted through land-use policy changes, and predicting weather and climate change. One major change the city made was placing sprinklers on homes, which in the Joe Rich area eighteen homes had implemented (Kelly, 2017). Another is having areas designated under a fire protection policy (see Map 5). However, Kelowna has yet to improve the quality of education of fire hazards towards the residents: “Homeowners who have experienced a fire are more likely to convince themselves that it could not



happen again, illustrating a lack of knowledge about the recurring nature of fire (Cortner, Gardner & Taylor, 1990, p. 59). Due to the fact Kelowna is in a semi-arid climate, no precipitation can become a major factor during the summer months, as residents saw in 2017. The fire ban that was placed on, more strictly than in 2003, wasn't seen as serious than past summers. People need to realize that they themselves can cause forest fires as easily as a lightning strike.



**Map 5:** Fire Protection Areas Source:

[https://www.regionaldistrict.com/media/228559/RDCO\\_Fire\\_Protection\\_Areas.pdf](https://www.regionaldistrict.com/media/228559/RDCO_Fire_Protection_Areas.pdf)

### **Future Policy Recommendations**

Since the 2003 and 2017 wildfires in the Kelowna area, the municipality has taken several steps towards prevention and mitigation. They have set up five weather monitoring stations specifically to track conditions that may promote a fire hazard. In East Kelowna, a fringe community, they have set up emergency

services to decrease response time to fire hazards. After reviewing the literature, we have several suggestions to make for Kelowna to help decrease risk in the fringe. An inexpensive and effective start would be to add more signage on roads and paths towards and in the fringe. These signs would tell people about camp-fire bans, the dangers of throwing cigarettes out of car windows and the threat of fines and community risk. A slightly more but also effective method the municipality could use is to subsidize the cost of rooftop sprinklers, as well as offer free risk assessments of properties in the fringe to help make homeowners aware of their responsibility to manage potential hazards on their property. Both governmental agencies and non-governmental agencies should be more active in using social media platforms during spring and summer to spread awareness about fire hazards, as well as sharing more personal stories of the consequences to help get people attached to the idea. There should also be an effort to make use of the increased social cohesion in rural-urban fringe communities by promoting and empowering them to form their own educational and hazard

## **Conclusion**

When living in the rural-urban fringe, many residents must be aware of the dangers that can occur, especially dealing with fire hazards in a dry, hot summer. There can be many reasons why a fire may break out in these areas, and it is mostly due to human-caused activity. Kelowna, B.C. is an active tourist place during the summer. The increasing population and sprawl into the rural-urban fringe area can create worry and stress on the community as a whole when the possibility of a fire occurring is common. Over the years, Kelowna has built a fire-resistant boundary to protect their city from another massive fire from happening. From 2003 to 2017, many policy changes have been implemented to give the public a sigh of relief; however, the problem still lies within the public

itself. Kelowna must deal with educating its public's awareness regarding the importance of fire hazards in the rural-urban fringe. Although the city cannot stop weather from starting a fire, it can stop one from spreading too fast. Through fast acting emergency services and locals working as a team, Kelowna can become a better community when creating a safer environment and decreasing the risk of fire hazards indefinitely.

## References

- Anton, C., & Lawrence, C. (2016). Does Place Attachment Predict Wildfire Mitigation and Preparedness? A Comparison of Wildland-Urban Interface and Rural Communities. *Environmental Management*, 57(1), 148-162. doi: 10.1007/s00267-015-0597-7
- Berkes, F. (2007). Understanding uncertainty and reducing vulnerability: lessons from resilience thinking. *Natural Hazards*, 41(2), 283-295. doi: 10.1007/s11069-006-9036-7
- Beverly, J. L., & Bothwell, P. (n.d). Wildfire evacuations in Canada 1980-2007. *Natural Hazards*, 59(1), 571-596. doi: 10.1007/s11069-011-9777-9
- Bryant, C. R., Russwurm, L. J., & McLellan, A. G. (1982). *The City's Countryside. Land and Its Management in the Rural-urban Fringe*. Longman.
- Cohen, J. D. (2000). Preventing disaster: home ignitability in the wildland-urban interface. *Journal of Forestry*, 98(3), 15-21. doi: 10.1093/jof/98.3.15
- Cole, J. M., & Murphy, B. L. (2014). Rural hazard risk communication and public education: Strategic and tactical best practices. *International Journal of Disaster Risk Reduction*, 10(Part A), 292-304. doi: 10.1016/j.ijdr.2014.10.001

- Cortner, H. J., Gardner, P. D., & Taylor, J. G. (1990). Fire hazards at the urban-wildland interface: What the public expects. *Environmental Management*, *14*(1), 57-62. doi: 10.1007/BF02394019
- Goemans, M., & Ballamingie, P. (2013). Forest as hazard, forest as victim: Community perspectives and disaster mitigation in the aftermath of Kelowna's 2003 wildfires. *Canadian Geographer*, *57*(1), 56-71. doi: 10.1111/j.1541-0064.2012.00447.x
- Goldammer, J. G., & Price, C. (1998). Potential impacts of climate change on fire regimes in the tropics based on MAGICC and a GISS GCM-derived lightning model. *Climatic Change*, *39*(2-3), 273-296. <https://doi.org/10.1023/A:1005371923658>
- Hystad, P., & Keller, P. (2006). Disaster management: Kelowna tourism industry's preparedness, impact and response to a 2003 major forest fire. *Journal of Hospitality and Tourism Management*, *13*(1), 44-58. doi: 10.1375/jhtm.13.1.44
- Jiang, Y., & Zhuang, Q. (2011). Extreme value analysis of wildfires in Canadian boreal forest ecosystems. *Canadian Journal of Forest Research*, *41*(9), 1836. Doi:10.1139/x11-102
- Kauffman, J. B. (2004). Death rides the forest: perceptions of fire, land use, and ecological restoration of western forests. *Conservation Biology*, *18*(4), 878-882. doi: 10.1111/j.1523-1739.2004.545\_1.x
- Kelly, A. (2017, August 31). Aftermath of Joe Rich fire. *Castanet*. Retrieved from <https://www.castanet.net/news/Kelowna/205480/Aftermath-of-Joe-Rich-fire>
- Labossière, L. M., & McGee, T. K. (2017). Innovative wildfire mitigation by municipal governments: Two case studies in Western Canada.

*International Journal of Disaster Risk Reduction*, 22,204-210. doi:  
10.1016/j.ijdr.2017.03.009

- Moore, D., Copes, R., Fisk, R., Joy, R., Chan, K., & Brauer, M. (2006). Population health effects of air quality changes due to forest fires in British Columbia in 2003: estimates from physician-visit billing data. *Canadian Journal of Public Health/Revue Canadienne de Sante'e Publique*, 105-108. Retrieved from <http://www.jstor.org/stable/41994694>
- Nitschke, C. R., & Innes, J. L. (2008). Climatic change and fire potential in South-Central British Columbia, Canada. *Global Change Biology*, 14(4), 841-855. 10.1111/j.1365-2486.2007.01517.x
- Pryor, R. J. (1968). Defining the rural-urban fringe. *Social Forces*, 47(2), 202-215. <https://doi.org/10.1093/sf/47.2.202>
- Radeloff, V. C., Hammer, R. B., Stewart, S. I., Fried, J. S., Holcomb, S. S., & McKeefry, J. F. (2005). The wildland–urban interface in the United States. *Ecological applications*, 15(3), 799-805. doi: 10.1890/04-1413
- Senese, D. (2010). Amenity resources and rural change in the Okanagan Valley of British Columbia. Beesley, K. B. (Ed.), *The Rural-Urban Fringe in Canada: Conflict and Controversy* 158-175. Rural Development Institute.
- Statistics Canada. 2017. *Kelowna [Population centre], British Columbia and Alberta [Province] (Table)*. *Census Profile*. 2016 Census. Statistics Canada Catalogue no. 98-316-X2016001. Ottawa. Released November 29, 2017. <http://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/index.cfm?Lang=E> (accessed April 2, 2018).
- Wehrwein, G. S. (1942). The rural-urban fringe. *Economic Geography*, 18(3), 217-228. doi: 10.2307/141123