

Case studies of large outdoor fires involving evacuations

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Large Outdoor Fires & the Built Environment
(LOF&BE) Working Group

Emergency Management & Evacuation (EME)
Subgroup

Enrico Ronchi <i>Lund University, Sweden</i>	Guillermo Rein <i>Imperial College London, UK</i>
Stephen Wong <i>University of California Institute of Transportation Studies, USA Transportation Sustainability Research Center, USA</i>	Martin Kristoffersen <i>COWI, Norway</i>
Sayaka Suzuki <i>National Research Institute of Fire and Disaster, Japan</i>	Ruggiero Lovreglio <i>Massey University, New Zealand</i>
Maria Theodori <i>Reax Engineering Inc., USA University of California, Berkeley, USA</i>	Ido Marom <i>Technion- Israel Institute of Technology, Israel</i>
Rahul Wadhvani <i>Dept. of Wildlife Protection, Leh, India Imperial College London, UK Victoria University, Australia</i>	Chunyun Ma <i>NRC Canada, Canada</i>
Sandra Vaiciulyte <i>Arup, UK</i>	Danielle Antonellis <i>Kindling, USA</i>
Steve Gwynne <i>Lund University, Sweden Movement Strategies, UK</i>	Xiaoning Zhang <i>The Hong Kong Polytech University, China</i>
	Zilong Wang <i>The Hong Kong Polytech University, China</i>
	Nima Masoudvaziri <i>University at Buffalo, USA</i>

*Current affiliation

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Corresponding author: Sayaka Suzuki (sayakas@fri.go.jp)

Cover Photo

The cover photo is taken at the Estreito de Calheta during the fires affecting the community of Madeira (Portugal) in 2016. The photo clearly show an example of a wildland-urban interface fire, in which an urbanized area is threatened by an approaching wildfire. Three deaths were eventually attributed to the fire as well as a thousand people needed to be evacuated. Photo taken by Michael Held.

Case studies of large outdoor fires involving evacuation

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Abstract. This report presents a list of case studies concerning large outdoor fires involving evacuation. The report has been developed within the activities of the Emergency Management & Evacuation (EME) Subgroup of the Large Outdoor Fires & the Built Environment (LOF&BE) group of the International Association for Fire Safety Science (IAFSS). This work is deemed to be a useful starting point to build a large database of case studies and identify common trends and differences across such type of incidents.

The case studies presented are useful for the identification of critical issues related to evacuation scenarios due to large outdoor fires and could be used to identify lessons learnt based on the events. Spatial and temporal scales of past events can be reviewed and an analysis of their consequences could inform policy makers in further developing safety guidance and recommendations for emergency management and evacuation planning.

Emergency Management & Evacuation
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About the International Association for Fire Safety Science (IAFSS)

IAFSS was founded with the primary objective of encouraging research into the science of preventing and mitigating the adverse effects of fires and of providing a forum for presenting the results of such research. The International Association for Fire Safety Science perceives its role to lie in the scientific bases for achieving progress in unsolved fire problems. It will seek cooperation with other organizations, be they concerned with application or with the sciences that are fundamental to our interests in fire. It will seek to promote high standards, to encourage and stimulate scientists to address fire problems, to provide the necessary scientific foundations and means to facilitate applications aimed at reducing life and property loss.

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1. Introduction

Large outdoor fires around the world are a growing and critical issue, requiring mass evacuations to protect people and ensure safety [1]. The term large outdoor fires here includes a range of incidents, such as wildland fires, wildland-urban interface (WUI) fires, urban fires and informal settlement fires¹. When people are required to leave the hazard area, evacuations can be carried out using a variety of transport modes, including the use of private vehicles, public transport, walking on foot, and being rescued by fire rescue vehicles via land, air or water [2]. Depending on the scale of the incident and the population at risk, evacuations may range from small (a few houses) to large (hundreds of thousands of houses) [3]. Similarly, the short-term and long-term effects of the fire event on the population will vary depending on the capacity to recover available within the community and the government agencies involved [4]. Examples across scientific literature show that large outdoor fires are likely to continue to affect people, calling for urgent action to mitigate the risks with the help of evidence-based research [1].

The understanding of the evacuation process in large outdoor fires can be informed by the evaluation of past incidents [2]. In particular, it allows expanding our understanding of the critical factors affecting evacuation dynamics, considering both spatial and temporal variables to formulate policies and recommendations/guidelines for future similar incidents. Increased population densities in the proximity of vegetation or the rising number of informal settlements [5] have shown to affect the risk for fire-related incident which require evacuation. To fully understand this subject domain, it is necessary to investigate the interplay between the actors involved (e.g., general public and first responders), and the information exchange between them in relation to the spatial and temporal evolution of the incident.

Considering the example of WUI fires, in the US alone, an increasing trend of wildfire effects is observed for housing structures built in the WUI areas and populations residing in the WUI area during 1990-2010 [6]. A similar trend for risks to the built environment exist in other countries (e.g. Canada [7]), which means that wildland fires would threaten more communities in the near future. For example, an overall increase in wildfire risk has been identified by Jolly et al. [8], who have already observed such a pattern due to changing climate across the globe. Similarly, Zhang et al [9] also observed an increased frequency of urban fires in the last decade for the Nanjing area of China. Though limited research is available for urban fires, it has been found that in China from 2000 to 2009 there were on average 500 accidental fires daily in urban settlements [10]. Such types of fires have been occurring historically all around the world, as reported by Brode and Small [11], who have documented 25 major large outdoor fires that occurred in the urban settlement from 1666-1985. Such cases include very well-known fires such as the London Fire (UK, 1666) the New York City Fire, (USA, 1835), the San Francisco Fire (USA, 1906), the Hakodate Fire (Japan, 1934). Despite the rather large number of disastrous urban fires, limited technical data is openly available from an evacuation standpoint [11]. Observations by survivors, in most cases, rarely provide sufficient information to reconstruct the details of the event. Considering the issues linked to biases and memory [12], [13], it is even more difficult to collect reliable data on human response if they are not collected right after the event occurs. Large fires have also been documented in

¹ In the present report, all fire phenomena that can lead to evacuations are in general named as large outdoor fires. An operationalization of the definition of large outdoor fires in this context include: 1) an uncontrolled fire event, 2) a fire that is not contained within a single building, 3) capable of affecting a group of urban infrastructures, 4) requiring coordination of more than one stakeholder, e.g. civil protection, fire and rescue services, police or military forces, 5) with long-term psychological, financial and social effects, and 6) requiring support for recovery at local, national or international level. Given this definition, not all urban fires qualify as large outdoor fires as they may refer to small events. Generally speaking, outdoor fires which are capable of causing major damage or mass evacuation qualify here as large outdoor fires.

informal settlements [14], for which obtaining reliable information concerning evacuation has been challenging [15].

In this context, while the analysis of a single incident could provide useful information, the generalizability of the findings is potentially undermined by the unique features that each fire evacuation may have. For instance, population characteristics may be different from both a physical perspective (i.e. physical ability to perform protective actions [16]) as well as from a behavioural perspective (i.e. factors influencing human response [17]–[20] for both the first responders and the evacuees. Similarly, a whole range of environmental factors may greatly vary [21], potentially affecting the evacuation process.

Starting from this premise, a database of large outdoor fire case studies around the world involving evacuation is currently being built within the Emergency Management and Evacuation (EME) subgroup within the Large Outdoor Fires and the Built Environment group of the International Association for Fire Safety Science (IAFSS). This database will allow the identification of a wide range of issues that might be encountered during an evacuation due to a large outdoor fire and the main variables affecting their outcome. Variables include event size, the timeline of the event, actions of first responders, impact of different notification strategies, and response strategies.

The development of such database is associated with several benefits. A common issue in case study reporting is the formatting inconsistencies. For this reason, the data in this report are based on a standardized template developed to scrutinize case studies in a project concerning WUI fire evacuation [2] which has been modified to address a wider variety of types of fires (e.g. informal settlement fires, city fires). The template was first developed with a small sub-set of case studies, and it was then expanded and refined to cover the key features related to the varying conditions of large outdoor fires involving evacuation. This methodology helps facilitate the identification and analysis of similarities and differences across case studies. In addition, a better understanding of fire evacuation events would help mitigate the risks and prevent loss of life in future events [20]. This report aims to obtain a global picture of large-outdoor fire that required evacuations. Lessons learned and best practices can be derived from the cast studies in this report, aiding governments in preparing for and responding to these devastating events.

2. Aim and objectives

This report presents a set of cases studies of large outdoor fires that required evacuations. The case studies were reported with a consistent template to identify trends, similarities, and differences across a variety of scenarios.

The specific objectives of this report include to:

- Identify case studies where an evacuation of people took place following a large outdoor fire event;
- Adopt a common reporting format for large-outdoor fire case studies involving evacuations;
- Enhance the knowledge of the fire safety science community on case studies involving evacuations by providing information in a central location;
- Provide detailed information from case studies concerning the impact of large-outdoor fires and the evacuation process;
- Present a database to be used and analysed by researchers and governments in future research and policymaking.

3. Methods

To gather consistent information across large outdoor fire cases, a template was developed (Appendix A). The template was originally developed in [2], focusing on collecting case studies on wildland fire evacuations. A new template was expanded to include evacuation case studies for all large outdoor fires (see Appendix A). Sections 1 to 16 of the template collect information on fire characteristics (e.g., location, cause, acreage burned, structured impacted). Sections 17 to 27 collect information on evacuation circumstances, and section 28 and 29 collect information on references and members who filled in the template. Member(s) gathered information from news outlets (e.g., [3-7]), online searches (e.g., [8-13]), academic publications (e.g., [2, 14-19]), and official reports (e.g., [20-25]). A detailed timeline for each fire is included (section 16 of each template) along with a general summary.

The collection of case studies is essential to better understand which critical features affect the severity of large outdoor fires. However, due to the sheer number of fire incidents and variability in their reporting, it is often challenging to comprehensively describe each of these incidents. Therefore, the present work represents only a small set of such large-outdoor fire incidents for which most of the key information was available. The criteria for the selection of these incidents were:

- Availability of data and information needed to comprehensively discuss an incident;
- Inclusion of fire evacuation incidents from different geographical areas and climates;
- Inclusion of fire evacuation incidents related to different types of large outdoor fires;
- Recency of the incidents – all occurred within the last 20 years (except for Sakata fire, Japan, 1976 which is included for its comprehensive information and damage severity).

4. Case studies

This section presents the set of case studies of large outdoor fires involving evacuation which have been reviewed.

1. Atlas fire (USA), 2017

The Atlas Fire in October 2017 was a large wildfire that severely impacted Napa and Solano counties in Northern California. The Atlas Fire coincided with multiple other wildfires – particularly the Nuns, Tubbs, and Pocket Fires – which are collectively known as the 2017 October Northern California Wildfires. The Atlas Fire ignited near the Atlas Peak area due to trees falling on power lines owned by PG&E in two different locations. The Atlas spread rapidly down the dry and hilly terrain into the area surrounding the city of Napa. Gusts in the region were reported up to 70 mph. Evacuation orders were given within several hours of ignition across rural Napa County and some developed neighbourhoods in the city of Napa. Helicopters assisted the evacuation process by airlifting trapped evacuees off Atlas Peak after downed trees blocked the road. Additional evacuation orders were given for Napa and Solano counties for the next several days with continued fire growth. After several days, firefighters began to gain against the fire, and containment was achieved in late October.

During the 2017 October Northern California Wildfires, about 100,000 people were ordered to evacuate. The Atlas Fire impacted less communities than the Nuns and Tubbs Fire so it is estimated that at most 20,000 people were ordered to evacuate from the Atlas Fire. The Atlas Fire destroyed 120 structures and damaged 783. With multiple fires across the Northern California area, firefighting resources were spread extremely thin, leading to slow response against the Atlas Fire. Throughout the fire, evacuations were challenging in the mountain terrain. Additional details are provided below.

1	Where?	Napa County, Solano County, California, USA
2	When?	10/8/2017 – 10/28/2017
3	How was the fire started?	Trees striking power lines owned by Pacific Gas and Electric in two separate locations
4	Initial fire size	200 acres
5	Area affected (burned area)	51,624 acres
6	Fuels involved in the fire	Hardwood woodland and shrub land vegetation with grassland, some coniferous forest, and agriculture land (mostly viticulture), structures
7	WUI, urban, wildland or informal settlement fires?	WUI fire, Napa, Vichy Springs
8	Average weather conditions	Warm temperatures, low humidity, high winds especially along ridge lines; Red Flag Warning; gusts in the region reaching 70 mph in some locations
9	Geographical highlights	Mountain range with steep drainages and canyons; heavily wooded area surrounded by viticulture; multiple roads with only one exit for evacuations
10	Was there any fire break? (natural or artificial)	Silverado Trail to the west, Highway 121 to the east, Highway 128 and Lake Berryessa to the north; Napa Valley to the west

11	Did the Fire Service report extreme fire behaviour?	Red Flag Warning, rapid fire development moving downhill and south along the mountain range
12	Number of structures and infrastructures affected (damaged)	120 structures destroyed, 783 damaged
13	Estimated direct and indirect economic damage	\$15 billion in direct damages across all 2017 October Northern California Wildfires
14	Did it occur in conjunction with multiple fires in the country?	Five large fires burning simultaneously in Northern California in October (Atlas, Partrick, Nuns, Tubbs, Pocket) with multiple smaller fires, which are collectively known as the 2017 October Northern California Wildfires. The Atlas, Partrick, and Nuns are collectively known as the Southern LNU Complex. Later, the Noorbom, Adobe, and Pressley Fire would merge with the Nuns Fire and were included in the Southern LNU Complex. The Tubbs and Nuns Fires most directly impacted residences and were the most destructive of the fires. With all fires igniting within a few hours, firefighting was severely hampered and communication with residents and across agencies was challenging.
15	Countries involved	United States
16	Brief timeline of the key events	<p>October 8 - 9:52 pm: Atlas Fire starts in Napa County near Atlas Peak in two different places due to downed trees on power lines</p> <p>October 8 - 11:45 pm: Evacuation orders are issued for multiple areas in Napa County</p> <p>October 9 - 12:00 am: Fire reaches Silverado Country Club, fuelled by high winds</p> <p>October 9 - 2:00 am: Additional evacuation orders are issued through the night for areas near the city of Napa; evacuation centres begin to fill by 4:00 am</p> <p>October 9 - 6:00 am: Throughout the night, helicopters rescue 42 people from Atlas Peak who were trapped from advancing flames</p> <p>October 9 - 10:00 am: Atlas Fire continues to expand rapidly, growing to 12,000 acres</p> <p>October 9 - 2:20 pm: Solano County begins issuing advisory evacuation orders as the fire spreads south</p>

		<p>October 9 - 7:53 pm: Mandatory evacuation orders are issued for multiple areas in rural Solano County</p> <p>October 9 - 8:30 pm: High winds and dry vegetation fuel the fire, causing it to explode to 25,000 acres; evacuation orders are in place for large sections of Napa</p> <p>October 10 - Evacuation orders continue to be issued in Napa County due to both the Atlas Fire and the Partrick Fire; Atlas Fire is reclassified with the Nuns and Partrick Fire as the Southern LNU Complex under a single unified command from Cal Fire</p> <p>October 10 - 7:00 pm: Growth slows to 26,000 acres but with only 3% containment</p> <p>October 11 - 7:30 am: Overnight, fire rapidly expands to 42,000 acres</p> <p>October 11: Advisory evacuation orders are expanded across Napa County and Solano County; heavy winds lead to additional fires to be added to the Southern LNU Complex including Norrbom, Adobe, and Pressley Fires impacting Napa, Solano, and Sonoma counties</p> <p>October 12: Growth of the Atlas Fire slows to 43,000 acres; Red Flag Warning remains in place; repopulation begins in Napa County</p> <p>October 13: Favourable conditions allow firefighters to slow growth to 48,000 acres with 27% containment; Nuns, Norrbom, Adobe, and Pressley Fires are transitioned into the Central LNU Complex</p> <p>October 14: Additional repopulation notices are given for Napa and most of Solano County</p> <p>October 15 - October 27: Improving conditions allow firefighters to gain a foothold against the fire</p> <p>October 28: The Atlas Fire is contained, burning 51,624 acres and destroyed 120 structures.</p>
17	Time of initial order to evacuate and locations	Begin: 10/8/17 - In the late evening, mandatory evacuation orders are issued for multiple areas in

		<p>Napa County by 11:45 pm (note: likely evacuation orders issued between 9:52 pm and 11:45 pm)</p> <p>Additional: 10/9/17- 10/11/17 - Mandatory evacuation orders and advisory evacuation orders are given across Napa and Solano counties</p>
18	Time when evacuation was considered completed	End: 10/20/17 - Mandatory evacuation orders are lifted for residents (most roads open 10/23/17)
19	Deaths/Injuries	6 deaths
20	The number of people evacuated	100,000 people ordered to evacuate across all 2017 October Northern California Wildfires (note: required the least number of evacuations of the wildfires, 20,000 at most)
21	The location people initially evacuated	Additional data required
22	Reasons why people decided to evacuate	Additional data required
23	Evacuation type	Predominately ground transport by private vehicles
24	Any drill/education/instructions on large outdoor fires provided beforehand?	No information available
25	Personnel involved in rescue operations	<p>Unified Command: Cal Fire Incident Management Team 3; Cal Fire Sonoma-Lake-Napa Unit</p> <p>Cooperating Agencies: California Highway Patrol, Napa County OES, Sonoma County OES, Solano County OES, California State Parks, PG&E and CDCR.</p> <p>Total fire personnel: +3,000 (may include personnel from other fires)</p> <p>Total fire engines: +300 (may include engines from other fires)</p>
26	Did the smoke hindered significantly the evacuation because of low visibility or health problems	Significant smoke in the area that caused severe health issues; smoke from the 2017 Northern California Wildfire severely impacted the San Francisco Bay Area, leading to extremely unhealthy air quality for weeks; AQI over 400 in Napa, rising to just below 200 in San Francisco and Oakland, and hitting 150 in Gilroy (over 100 miles away)
27	Possible causes of issues in management operations	Evacuations: Due to the rapid spread of the fire (moving at least 10 miles in 2 hours), many residents were caught off-guard and evacuated without mandatory orders. Erratic fire also cut off some residences along Atlas Peak Road (one exit road) from evacuating. Helicopters were able to ferry people to safety from Atlas Peak.

		<p>Firefighting: The Atlas Fire sparked in a rugged mountain area with dry vegetation. PG&E electrical equipment caused the fire after two tree fell on equipment in two separate locations. Due to the terrain, the fire expanded quickly. However, resources were being diverted to other fires including the Tubbs and Nuns Fire, which more quickly entered urban neighbourhoods. The outbreak of multiple fires in the region made firefighting difficult and spread resources thin.</p>
28	References	<p>Academic:</p> <p>Nauslar, N. J., Abatzoglou, J. T., & Marsh, P. T. (2018). The 2017 North Bay and Southern California Fires: A Case Study. <i>Fire</i>, 1(1), 18. https://doi.org/10.3390/fire1010018</p> <p>Wong, S., Broader, J., Shaheen, S. (2020). Review of California Wildfire Evacuations from 2017 to 2019. Retrieved from https://escholarship.org/uc/item/5w85z07g.</p> <p>Other: Cal Fire. (2019, November). Southern LNU Incident Information. Retrieved May 23, 2019, from http://cdfdata.fire.ca.gov/incidents/incidents_details_newsreleases?incident_id=1866</p> <p>John, P. S. (2017, October 12). Overnight winds were milder than expected, keeping Atlas fire's growth to a minimum. Retrieved June 3, 2019, from latimes.com website: https://www.latimes.com/local/california/la-northern-california-fires-live-overnight-winds-were-milder-than-1507819015-htmllstory.html</p> <p>Lewis, S. (2018, March 6). Inside the CHP Helicopter That Rescued 26 People From the Atlas Peak Fire The California Report KQED News. Retrieved September 20, 2018, from https://www.kqed.org/news/11653959/inside-the-chp-helicopter-that-rescued-dozens-from-the-atlas-peak-fire</p> <p>Lyons, J., Fimrite, P., Tucker, J., Cabanatuan, M., & Lang, M. (2017, October 11). Live updates: 15 dead in Wine Country fires as team searches for more bodies. Retrieved October 20, 2018, from SFGate website: https://www.sfgate.com/bayarea/article/Latest-on-North-Bay-fires-A-really-rough-12263721.php</p>

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		<p>http://www.latimes.com/local/lanow/la-me-fire-mystery-santa-rosa-20180912-story.html</p> <p>Solano County Sheriff's Office. (2017, October 9). Evacuation Orders for Atlas Fire. Retrieved from Facebook website: https://m.facebook.com/story.php?story_fbid=1067572653380130&id=348438128626923</p>
29	Name/Surname/Email/Date of who filled in this template	Stephen Wong/stephen.wong@berkeley.edu 6/2/19

2. British Columbia fires (Canada), 2017

On July 6th 2017, a fire started in British Columbia (BC), Canada. On the next day, 56 more fires started in BC, which prompted evacuation alerts, orders and declaration of a provincial state emergency. At the end of this fire season, it was recorded as having the largest total area burnt to that date.

1	Where?	Four distinct parts of British Columbia: The Cariboo Fire Centre Kamloops Fire Centre Southeast Fire Centre Coastal Fire Centre
2	When?	July 6, 2017 – Sep 15, 2017
3	How was the fire started?	Dry lightning + human-caused fires
4	Initial fire size	Two-hectare, about the size of two playing fields.
5	Area affected (burned area)	1.2 million hectares (12,1611 square kilometres), the largest total area burnt in a fire season in recorded history (1.3% of British Columbia's total area).
6	Fuels involved in the fire	Pine, structures
7	WUI, urban, wildland or informal settlement fires?	WUI fire, the wildfires reportedly destroyed over 300 buildings ranging from homes and barns to commercial structures.
8	Average weather conditions	The summer was one of the driest on record. Heat waves, minimal rainfall, and strong winds (in some regions up to 70 km/h). The Cariboo region saw unseasonably hot and dry conditions, as well as record-high Build Up Index (BUI) ratings in several areas.
9	Geographical highlights	Pine forests contained a large amount of dead pine trees.
10	Was there any fire break? (natural or artificial)	Lakes
11	Did the Fire Service report extreme fire behaviour?	On July 7, more than 160 fires began on the same day; some fires merged together as one.
12	Number of structures and infrastructures affected (damaged)	Closure of Highway 97 Closure of Bella Coola Highway westbound traffic Fires are blamed for destroying 509 structures, including 229 homes, and causing financial loss to ranchers, farmers, forestry and tourism operations.
13	Estimated direct and indirect economic damage	the total cost of fire suppression: over \$568 million Prevention expenditure: \$3 million Emergency support for evacuees: \$200 million
14	Did it occur in conjunction with multiple fires in the country?	Yes. Multiple fires merged into one
15	Countries involved	Firefighters from Australia, New Zealand, Mexico, and United States

16	Brief timeline of the key events	<p>July 6, a two-hectare wildfire began west of 100 Mile House, British Columbia; an evacuation alert was issued.</p> <p>July 7, 56 new fires started throughout British Columbia. Several evac alerts issued. The British Columbia government declared a provincial state of emergency, which ended on September 15 midnight.</p> <p>July 10, campfires were banned province wide.</p> <p>July 11, a total of 200 fires were active.</p> <p>July 15, an evacuation order was issued for the city of Williams Lake (population 12,400). It was lifted on July 27.</p> <p>August 2, to help prevent human-caused wildfires, off-road vehicles (ORVs) were banned in the Kamloops, Southeast and Coastal Fire Centre areas.</p> <p>August 11, in the Cariboo Fire Centre area, a full backcountry closure was implemented. It was lifted on August 23, and downgraded to fire-specific area restrictions.</p> <p>August 20, fire reached its largest size of 227,000 hectares.</p> <p>Sep 2, a backcountry closure was implemented for the Rocky Mountain Natural Resource District. It was lifted on September 15.</p> <p>Sep 12, 158 fires were burning throughout the province.</p> <p>Sep 15, the provincial state of emergency was lifted.</p> <p>Sep 20, ORV bans were lifted province wide</p> <p>Sep 22, Campfire bans were lifted province wide.</p>
17	Time of initial order to evacuate and locations	July 6, 2019
18	Time when evacuation was considered completed	Many evacuations happened during the season and they often overlapped in time/space; not clear when the evacuation was considered complete
19	Deaths/Injuries	No reported death. A fire helicopter crashed during firefighting duties; the pilot suffered non-life-threatening injuries.
20	The number of people evacuated	65,000 (largest number of total evacuees in a fire season)
21	The location people initially evacuated	Unknown. Evacuation centres and group lodging were set up across the province.
22	Reasons why people decided to evacuate	Evacuation orders, alerts
23	Evacuation type	A combination of cars, buses, motor homes, pulling trailers and military helicopters. Search and rescue team delivered notices to residents in the 100 Mile House town.

24	Any drill/education/instructions on large outdoor fires provided beforehand?	Unknown
25	Personnel involved in rescue operations	At its peak activity, over 4,700 personnel were engaged in fighting wildfires across BC, including over 2,000 contract personnel from the forest industry and over 1,200 personnel from outside the province. This support came from across Canada, as well as from Australia, New Zealand, Mexico, and the United States. Ground personnel from the Canadian Armed Forces were also brought in to fight fires for the first time since 2003.
26	Did the smoke hindered significantly the evacuation because of low visibility or health problems	Yes. A 20% to 50% increase in hospital visits related to the smoke and heat in the southern half of British Columbia. Multiple air quality advisories issued; people were urged to avoid strenuous outdoor activities. By the start of August, Metro Vancouver had already seen the longest air quality advisory in the region's history – for 10 days.
27	Possible causes of issues in management operations	Many recommendations were published ^{4,5} , including “Reduce wildfire extent and severity through pro-active fuel management”
28	References	<p>https://en.wikipedia.org/wiki/2017_British_Columbia_wildfires</p> <p>https://www2.gov.bc.ca/gov/content/safety/wildfire-status/about-bcws/wildfire-history/wildfire-season-summary</p> <p>https://www2.gov.bc.ca/assets/gov/public-safety-and-emergency-services/emergency-preparedness-response-recovery/embc/bc-flood-and-wildfire-review-addressing-the-new-normal-21st-century-disaster-management-in-bc-web.pdf</p> <p>https://www.cariboord.ca/uploads/3735/CRD_EOC_After_Action_Report_on_2017_Wildfires.pdf</p> <p>http://treering.forestry.ubc.ca/files/2018/05/2017-Wildfires-and-Resilience.pdf</p> <p>http://www.princegeorgecitizen.com/news/local-news/a-timeline-of-b-c-wildfires-1.21164609</p> <p>https://globalnews.ca/news/3921710/b-c-year-in-review-2017-wildfires/</p>
29	Name/Surname/Email/Date of who filled in this template	Chunyun Ma/Chunyun.Ma@nrc-cnrc.gc.ca/2019-06-17

3. Cadiz fire (Spain), 2016

A fire started near La Linea in Cadiz, started on July 12th 2016. The fire forced people (tourists) in hotels to evacuate.

1	Where?	La Línea de la Concepción (Cádiz) - Spain
2	When?	From 12/07/2016 (12:53 pm) to 15/07/2016 (12:10 pm)(71 hours)
3	How was the fire started?	Vandalism - burning garbage container of a nearby urbanization
4	Initial fire size	More than 100 square meters at the moment of seeing it by our watchman
5	Area affected (burned area)	435 hectares
6	Fuels involved in the fire	Scrub
7	WUI, urban, wildland or informal settlement fires?	WUI fire, only touched the border of urbanisation and a restaurant on the beach
8	Average weather conditions	Conditions at the time of ignition: Temperature: 30,5 °C RH: 37% Wind speed: 8 km/h Direction of the wind: 260° (W) Dead fuel moisture: 5%
9	Geographical highlights	Undulating topography
10	Was there any fire break? (natural or artificial)	No
11	Did the Fire Service report extreme fire behaviour?	Yes
12	Number of structures and infrastructures affected (damaged)	One restaurant on the beach and vegetation on the border of the urbanization (palm trees)
13	Estimated direct and indirect economic damage	90000 euros (wooden restaurant and trees burnt within the urbanization)
14	Did it occur in conjunction with multiple fires in the country?	This fire is typical in this place every several years in the same conditions.
15	Countries involved	Spain
16	Brief timeline of the key events	The fire started in the urban area but quickly affected the forest area that was next to it. The fire began to spread rapidly due to the large amount of existing fuel and climatic conditions very favourable for its development (wind and high temperatures). Initially affected to urbanizations in the southern part, next to the area where the fire started, where protection work was not necessary for the urbanizations. The main problem was in the northern part, where the fire arrived hours later and affected the urbanization "Alcaidesa", where a hotel had to be evacuated and the rest of the inhabitants of the urbanization confined in their houses. In this

		urbanization burned a wooden restaurant that was on the beach.
17	Time of initial order to evacuate and locations	Unknown
18	Time when evacuation was considered completed	Unknown
19	Deaths/Injuries	Not reported
20	The number of people evacuated	420 (from hotel), (180 from hostel) 620 censuses that live in houses (besides the hotel). Maybe at the time of the fire there would be many more (the population multiplies in summer)
21	The location people initially evacuated	nearby sports centre
22	Reasons why people decided to evacuate	Unknown
23	Evacuation type	Private cars and buses
24	Any drill/education/instructions on large outdoor fires provided beforehand?	Unknown
25	Personnel involved in rescue operations	Unknown
26	Did the smoke hindered significantly the evacuation because of low visibility or health problems	No
27	Possible causes of issues in management operations	The fire acquired a lot of strength and there was no time to evacuate the whole urbanization with total security, only the hotel, where the fire would first arrive, was evacuated. Having planned before, the whole urbanization could have been evacuated.
28	References	Plan Infoca and 112
29	Name/Surname/Email/Date of who filled in this template	Sandra Vaiciulyte - 17/06/2019 (Note: a co-author of this case study is known to Sandra but is left out due to confidentiality reasons – please get in touch if you have any further questions)

4. Camp fire (USA), 2018

The Camp Fire in November 2018 was a fast-moving wildfire that severely impacted Butte County and the town of Paradise in California, burning over 150,000 acres. Igniting in the Sierra Nevada foothills, the Camp Fire was fuelled by dry vegetation, high winds, and low humidity. The fire was caused by a Pacific Gas & Electric transmission line that became detached from a supporting tower. Beginning near the town of Pulga, the fire spread rapidly, upwards of an acre per second. Soon after the start of the fire, the town of Paradise (with population of 26,000) was evacuated. However, severe congestion along major arterials and minor streets hampered the evacuation process. Moreover, several key evacuation routes were overcome by fire. Some evacuees were able to escape by foot while others became trapped in their vehicles. Evacuations were also challenging for the significant number of older adults, individuals with disabilities, and low-income households living in Paradise and surrounding towns. Despite a high level of preparedness related to communications and a future evacuation, Paradise experienced significant setbacks as the speed and magnitude of the Camp Fire overwhelmed response capabilities.

About 52,000 people were ordered to evacuate from the Camp Fire and 85 people were killed, making it the deadliest wildfire in California and one of the deadliest wildfires in United States history. The fire was also one of the most expensive wildfires, leading to approximately \$16.5 billion in damages with 13,972 residences, 528 businesses, 4,293 minor structures destroyed. Impacts of the wildfire were far-reaching as the entire town of Paradise was devastated by the wildfire. Smoke from the fire drifted as far as San Francisco, approximately 150 miles away. The fire also led to a housing crisis, public health challenges, and major environmental damages in Paradise and the surrounding Butte County area. The recovery process is anticipated to last multiple years. A more detailed description can be found below.

1	Where?	Butte County, California, USA
2	When?	11/8/18 – 11/25/18
3	How was the fire started?	Pacific Gas & Electric transmission line unhooking from tower
4	Initial fire size	10 acres
5	Area affected (burned area)	153,335 acres
6	Fuels involved in the fire	Predominately Ponderosa pines. Most ignition sources were low-lying brush, leaves, needles, and flammable structures
7	WUI, urban, wildland or informal settlement fires?	WUI fire, impacted the town of Pulga, city of Paradise, and outskirts of Chico
8	Average weather conditions	Prior to fire, received less than one inch of rain in the previous six months (despite average of 7 inches over same period). Santa Ana winds were recorded between 40 and 50 mph. Relative humidity fell as low as 11%.
9	Geographical highlights	Foothills / Rural. The terrain in the impacted area includes rolling hills and forests; Sierra Nevada foothills also includes secluded canyons and multiple drainages; canyons produced strong down winds, which pushed the fire down the foothills; area also contains narrow roads and few exits, even for larger developments.

10	Was there any fire break? (natural or artificial)	Highway 70, Highway 99, Highway 32, Lake Oroville
11	Did the Fire Service report extreme fire behaviour?	Critical fire weather conditions fuelled by high winds and low humidity; rapid fire spreading (upwards of 1.3 acres/second)
12	Number of structures and infrastructures affected (damaged)	13,972 residences, 528 businesses, 4,293 minor structures destroyed
13	Estimated direct and indirect economic damage	Approximately \$16 billion USD in damages
14	Did it occur in conjunction with multiple fires in the country?	Occurred same day as the Woolsey and Hill Fires in Southern California (some resource overlap with air tankers)
15	Countries involved	United States (with some international relief aid); assistance from western states
16	Brief timeline of the key events	<p>November 8, 6:30 am: Fire begins in the early morning near the town of Pulga from a fallen transmission line</p> <p>November 8, 7:23 am: All of Pulga is ordered to evacuate</p> <p>November 8, 8:00 am: Fire reaches the town of Paradise, first evacuation orders for the town are issued</p> <p>November 8, ~10:00 am: Fire overcomes some evacuating vehicles, leading local law enforcement to tell evacuees to run for safety (decision reversed around 12:00 pm)</p> <p>November 8, ~10:45 am: Fire grows to 20,000 acres; over next several hours, Paradise attempts to evacuate but with high smoke and fire danger; abandoned cars along roads presents challenges for those still evacuating</p> <p>November 8, ~ 2:30 pm: Evacuation orders are issued to all of Paradise and neighbouring Magalia</p> <p>November 8, ~6:00 pm: Fire grows to 55,000 acres; fire has travelled 17 miles from its origin</p> <p>November 9-15: Fire spreads but at a much slower rate. Fire crews begin to contain the fire; spread continues eastward into the Sierra Nevada Foothills.</p> <p>November 16: Fire reaches the outskirts of Chico but does not threaten major developments</p>

		<p>November 25: The Camp Fire is 100% contained, with help from wet conditions</p> <p>December 5: Evacuation orders are lifted and residents are allowed to return; prior to evacuation orders lifted, multiple first responder groups assess damage, search, and rescue as needed</p>
17	Time of initial order to evacuate and locations	<p>Begin: 11/9/18 (7:23 am) - Pulga</p> <p>Additional: 11/9/18 (8:00 am) - Part of Paradise</p> <p>Additional: 11/9/18 (2:00 pm) - All of Paradise</p>
18	Time when evacuation was considered completed	End: 12/5/18 - All evacuation orders are lifted
19	Deaths/Injuries	85 deaths
20	The number of people evacuated	Approximately 52,000 people (ordered)
21	The location people initially evacuated	Additional data required
22	Reasons why people decided to evacuate	Additional data required
23	Evacuation type	Predominately ground transport by private vehicles. Some instances of walking/running to safety along fire-impacted routes. Some use of buses for nursing homes and schools.
24	Any drill/education/instructions on large outdoor fires provided beforehand?	No additional information (note: the town of Paradise did have an evacuation plan that subdivided the town into several sections and had previously experienced wildfires in the past five years)
25	Personnel involved in rescue operations	<p>Unified Command: Cal Fire, Butte County Sheriff Department, Paradise Police Department, United States Forest Service</p> <p>Cooperating Agencies: California Department of Transportation, California Department of Corrections and Rehabilitation, California Highway Patrol, California Office of Emergency Services, National Weather Service, California Conservation Corps, Butte County, City of Chico</p> <p>Total fire personnel: +1,000</p> <p>Total fire engines: 73</p>
26	Did the smoke hindered significantly the evacuation because of low visibility or health problems	Extremely poor visibility greatly impacted evacuations and led to additional car accidents. Health problems were acute for the impacted area and air quality was severe for areas as far away as San Francisco (~150 miles away).
27	Possible causes of issues in management operations	Preparedness: The city of Paradise had developed an evacuation plan with a phased strategy along with contraflow response for major thoroughfares. The plan also contained significant

response strategies for communication with the public.

Communication: Some Paradise residents were not alerted to the mandatory evacuation. Only about 30% of residents were registered for alerts and calls could not be established to over 10,000 phones. Damaged phone lines reduced calling capabilities and lack of personnel and infrastructure hampered the local dispatch centre. Delays of up to 30 minutes for evacuation orders were observed and officials were unable to notify all neighbourhoods due to the rapid spread of the fire. The Wireless Emergency Alert System was not employed during the wildfire.

Evacuations: Of the four primary evacuation routes out of Paradise, only two were viable for the majority of the fire. Rapid fire overtook some roadways, leading some people to run to safety and trapping others in their vehicles. High congestion along both major and local roads slowed the evacuation process. Skyway, the primary road in and out of Paradise, was particularly impacted. In addition, vehicles ran out of gas and abandoned cars blocked the travel lanes. Contraflow and shoulder usage were established but severe bottlenecks persisted. In Concow, residents were unable to escape due to fallen trees, leading to the deployment of protective shelters and escape into the Concow Reservoir.

Sheltering: Local shelters in Butte County, particularly Chico, filled up quickly. Tent shelter cities were established across the area but poor weather conditions and sanitation led to an outbreak of norovirus. Hotels were fully booked and increasingly poor weather (including substantial rain and sometimes sub-freezing temperature) made shelter challenging for evacuees. Sheltering was also difficult for the largely middle- to lower-class evacuees, of which a high proportion were elderly and/or disabled.

Other: The elderly and disabled populations in the area required considerably more assistance, especially those without vehicles. While plans had noted the extra need, resources for these individuals were low throughout the evacuation process.

28	References	<p>Academic: Wong, S., Broader, J., Shaheen, S. (2020). Review of California Wildfire Evacuations from 2017 to 2019. Retrieved from https://escholarship.org/uc/item/5w85z07g.</p> <p>Other: Almukhtar, S., Griggs, T., Johnson, K., Patel, J. K., Singhvi, A., & Watkins, D. (2018, November 18). 'Hell on Earth': The First 12 Hours of California's Deadliest Wildfire. The New York Times. Retrieved from https://www.nytimes.com/interactive/2018/11/18/us/california-camp-fire-paradise.html, https://www.nytimes.com/interactive/2018/11/18/us/california-camp-fire-paradise.html</p> <p>Belles, J. (2018, November 9). How The Deadly Camp Fire Exploded In Size Overnight. Retrieved May 23, 2019, from The Weather Channel website: https://weather.com/news/weather/news/2018-11-09-camp-fire-exploded-size-explainer</p> <p>Bizjak, T., Bollag, S., & Sabalow, R. (2019, May 15). PG&E caused Camp Fire that destroyed Paradise and killed 85, Cal Fire says. The Sacramento Bee. Retrieved from https://www.sacbee.com/news/local/article23044554.html</p> <p>Bizjak, T., Yoon-Hendricks, A., Reese, P., & Sullivan, M. (2018, December 4). Many of the dead in Camp Fire were disabled, elderly. Could they have been saved? The Sacramento Bee. Retrieved from https://www.sacbee.com/news/state/california/fires/article222044970.html</p> <p>Cal Fire. (2019, November). 2018 Statewide Incidents Map. Retrieved May 23, 2019, from Google My Maps website: https://www.google.com/maps/d/viewer?mid=1HacmM5E2ueL-FT2c6QMVzoAmE5M19GAf&hl=en</p> <p>Cappucci, M., & Samenow, J. (2018, November 12). The weather and climate behind the California infernos that wrecked Paradise and torched Malibu. Washington Post. Retrieved from</p>
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29	Name/Surname/Email/Date of who filled in this template	Stephen Wong / stephen.wong@berkeley.edu / 5/23/19

5. Carr fire (USA), 2018

The Carr Fire in July through August 2018 was a destructive wildfire that severely impacted Shasta and Trinity Counties in Northern California and the City of Redding. The Carr Fire ignited in the Whiskeytown Recreation Area due to sparks from a flat tire from a passing vehicle. Expanding slowly at first, the fire was soon fuelled by low humidity (under 10%), high temperatures (100+ degrees Fahrenheit), and dry vegetation. With the fire moving eastward, multiple communities including French Gulch, Old Shasta, and Keswick were evacuated. Conditions worsened significantly, leading officials to evacuate multiple urban neighbourhoods in Redding. The fire jumped the Sacramento River, partially due to observed fire whirls and fire tornados with winds upwards of 140 mph. The intensity of flames also created a localized weather system. With considerable effort and favourable conditions, fire progression slowed in Redding but instead expanded quickly north and west into additional rural communities. At the height of the Carr Fire, over 4,500 personnel were battling the fires. Containment slowly grew through August, but all evacuees were allowed to return by mid-August. The Carr Fire was contained by the end of August.

About 39,000 people were ordered to evacuate from the Carr Fire and 8 people were killed. Destroying over 1,600 structures, the Carr Fire caused damages of over \$1.5 billion. During the evacuation, roads were heavily congested with evacuees attempting to escape through Redding. Inconsistent messaging and wide variations in distribution times gave some evacuees little time to leave. Along with poor communication, the erratic behaviour of the fire also contributed to the confusion on the ground for officials and firefighting efforts. While the fire severely impacted multiple neighbourhoods of Redding, the majority of the city, including downtown, was saved. Additional details are provided below.

1	Where?	Shasta County, Trinity County California, USA
2	When?	7/23/18 - 8/30/18
3	How was the fire started?	Sparks from a vehicle with a flat tire
4	Initial fire size	50 acres
5	Area affected (burned area)	229,651 acres
6	Fuels involved in the fire	Mixed including woodlands, Ponderosa and Knobcone pine, evergreen forests, grassland, interior chaparral
7	WUI, urban, wildland or informal settlement fires?	WUI fire, Redding, Lewiston, French Gulch, Whiskeytown, Shasta, Old Shasta, Keswick, Douglas City
8	Average weather conditions	Prior to fire, dry conditions including dry vegetation. During fire, temperatures upwards of 110 degrees Fahrenheit, humidity levels below 10%, and winds up to 25 mph; worsening conditions led to a fire tornado with winds up to 143 mph (only second known instance of fire tornado); fire whirls also observed; local weather system surrounding fire
9	Geographical highlights	Wooded mountain ranges with small rural communities; some major roads with small rural roads; canyons and relatively rugged terrain; near Shasta-Trinity National Forest, Whiskeytown Recreation Area

10	Was there any fire break? (natural or artificial)	Shasta Lake to the east, Trinity Lake to the west, Sacramento River to the east (but was compromised)
11	Did the Fire Service report extreme fire behaviour?	Red flag warning; critical fire weather conditions fuelled by very high temperatures and low humidity; rapid fire spreading in irregular patterns; worsening conditions led to a fire tornado with winds up to 143 mph (only second known instance of fire tornado); fire whirls also observed
12	Number of structures and infrastructures affected (damaged)	1,079 residences destroyed, 22 commercial structures destroyed, 503 additional buildings destroyed
13	Estimated direct and indirect economic damage	Approximately \$1.5 billion in damages
14	Did it occur in conjunction with multiple fires in the country?	Three fire burning simultaneously in Northern California in late July (Carr, River, and Ranch), spreading resources thin
15	Countries involved	United States
16	Brief timeline of the key events	<p>July 23 - 1:15 pm: Carr Fire begins along Highway 299 due to sparks from a vehicle with a flat tire</p> <p>July 23 - 3:30 pm: Discussions are made to begin evacuating residents in the Whiskeytown area with the help of the Redding Area Bus Authority</p> <p>July 23 - 4:30 pm: The fire grows rapidly to 1,000 acres with no containment; mandatory evacuation orders are issued for the French Gulch community</p> <p>July 24 - 9:00 am: With extremely hot and dry conditions and difficult terrain, firefighters struggle to contain the fire which grows to 3,000 acres; multiple areas around Whiskeytown are under mandatory evacuation orders and Highway 299 is closed</p> <p>July 25: Carr Fire continues to grow due to dry conditions to 6,700 acres</p> <p>July 26 - 4:03 am: Mandatory evacuation orders are issued for the communities of Old Shasta and Keswick; all roads coming off Rock Creek Rd. and Iron Mountain Rd. are also issued mandatory orders; additional orders are given to homes in the area of Swasey, Lower Springs, and Victoria Dr. one hour later</p> <p>July 26 -7:00 am: Overnight, fire rapidly expands</p>

	<p>to 20,000 acres; westbound traffic is closed starting at Buenaventura Blvd in Redding</p> <p>July 26 - Fire moves rapidly towards Redding, leading to additional evacuations in urban neighbourhoods; fire swirls and fire tornado jump across the Sacramento River into Redding city limits</p> <p>July 26 - 7:00 pm: Mandatory evacuation orders are expanded to include most areas west of Overhill Drive and multiple subdivision to the north and east of the Sacramento River</p> <p>July 26 - 9:00 pm: A primary evacuation centre, Shasta High School, is evacuated to Shasta College</p> <p>July 26 - 11:00 pm: Mandatory evacuation orders continue to expand rapidly, including additional orders at midnight to most areas west of downtown Redding as far north as Shasta Dam and south towards Happy Valley; all areas west of Buenaventura Blvd. are under mandatory evacuation orders; some areas west of Highway 273, N. Market St, and I-5 are also under mandatory evacuation orders</p> <p>July 27 - 7:00 am: Fire continues to grow with little containment to 44,000 acres; weather remains over 100 degrees</p> <p>July 28 - Evacuation orders are extended towards the west of the Carr Fire to Lewiston; fire explodes to 83,800 acres by 7:30 pm; fire progression into Redding slows</p> <p>July 29 - Evacuation orders continue to be extended west; containment rises to 17% with 95,000 acres burned</p> <p>July 30 - Northern portion of fires remains highly active; repopulation begins for multiple neighbourhoods in Redding</p> <p>July 31 - Containment slowly grows to 30% as firefighters stop progression into Redding</p> <p>August 1 - Carr Fire expands to 121,000 acres but most evacuation orders in Redding are lifted</p>
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17	Time of initial order to evacuate and locations	<p>Begin: 7/23/18 - Evacuation orders issued for French Gulch at 4:30 pm</p> <p>Additional: 7/24/18 - Whiskeytown and multiple rural areas</p> <p>Additional: 7/26/18 - Most of western Redding</p> <p>Additional: 7/27/18 - Additional areas in Redding</p> <p>Additional: 7/28/18 - Additional areas west of the fire</p> <p>Additional: 7/29/18 - Additional areas west of the fire</p>
18	Time when evacuation was considered completed	End: 8/15/18 - All evacuation orders related to the Carr Fire are lifted
19	Deaths/Injuries	8 deaths
20	The number of people evacuated	39,000 people (ordered)
21	The location people initially evacuated	About 66% evacuated within their county of origin(Wong et al., 2021, based on Carr Wildfire survey data)
22	Reasons why people decided to evacuate	Mandatory evacuation orders; strong belief of utility loss and strong belief of structural damage (risk perceptions); living in a high fire risk zone as defined by Cal Fire; higher income (annual household income \$100K or above); female; young adult (under 35) (Wong et al., 2021, based on a discrete choice model for the decision to evacuate or stay/defend using survey data)
23	Evacuation type	Predominately ground transport by private vehicles
24	Any drill/education/instructions on large outdoor fires provided beforehand?	No information available
25	Personnel involved in rescue operations	<p>Unified Command: Cal Fire Shasta-Trinity Unit</p> <p>Cooperating Agencies: PG&E, CAL TRANS, Shasta County Sheriff, CHP, Redding Police Department, Shasta County Fire Department, Shasta County Public Works, CAL OES, Bureau of Land Management, CCC, State Parks, CDCR, Red Cross, Redding Electric, WAPA, California</p>

		<p>National Guard, Trinity OES, Trinity County Sheriff's Office, Sierra Pacific Industries</p> <p>Total fire personnel: +4,500</p> <p>Total fire engines: +360</p>
26	Did the smoke hindered significantly the evacuation because of low visibility or health problems	Significant smoke impact in the Redding area along with high impacts in other areas in Southern Oregon and Northern California including Sacramento.
27	Possible causes of issues in management operations	<p>Evacuations: As the Carr Fire spread to Redding, multiple major arterial and minor streets experienced heavy congestion. This congestion was attributed to the rapid loading of streets with evacuees and difficulty issuing evacuation orders without complete information of fire behaviour. Shasta High School was evacuated, despite being used as a preliminary evacuation centre.</p> <p>Information: Due to erratic behaviour from the Carr Fire, officials struggled with issuing appropriate evacuation orders. One key issue was that the time period between notification receipt and evacuation departure was highly varied by geography and message description. In some cases, residents were ordered to evacuate too late, giving them little to no time to leave. Reports also indicated that communication gaps arose from a lack of consistent messaging. Moreover, delays in the delivery of the message occurred due to poor standardization. Officials often had to conduct door-to-door notifications to evacuate citizens.</p>
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29	Name/Surname/Email/Date of who filled in this template	Stephen Wong/stephen.wong@berkeley.edu 6/2/19

6. Creek fire (USA), 2017

The Creek Fire in December 2017 was a wildfire that severely impacted Los Angeles County in Southern California. The fire broke out around the same time as other fires in the area including the Thomas, Rye, Skirball, and Lilac fires, which are collectively known as the 2017 December Southern California Wildfires. The Creek Fire ignited near Little Tujunga Canyon Road and Kagel Canyon Road just outside of Los Angeles city limits. The cause of the fire is still under investigation. Fuelled by high winds and dry vegetation, the Creek Fire spread rapidly into the community of Kagel Canyon. Evacuations were ordered for multiple neighbourhoods in Los Angeles, with approximately 150,000 people issued mandatory evacuation orders. The Creek Fire impacted several neighbourhoods and jumped Interstate 210. Dry conditions and steep terrain in the canyon areas slowed firefighting efforts. However, improving conditions and strong containment lines allowed firefighters to reach containment just one week after ignition.

Despite the large evacuation, the Creek Fire destroyed only 123 structures due to quick response and a more isolated ignition point. However, firefighting resources were still spread thin across the region, due to the outbreak of multiple fires. Firefighters were unable to save multiple homes in the Kagel Canyon neighbourhood. No one was killed from the Creek Fire. Additional details are provided below.

1	Where?	Los Angeles County, California, USA
2	When?	12/5/2017 – 12/11/2017
3	How was the fire started?	Under investigation
4	Initial fire size	Unknown
5	Area affected (burned area)	15,619 acres
6	Fuels involved in the fire	Shrub land vegetation with grassland, chaparral environment with oak woodlands
7	WUI, urban, wildland or informal settlement fires?	WUI fire, Los Angeles (Kagel Canyon, Lakeview Terrace, Sylmar, Pacoima, Sun Valley, Shadow Hills, Sunland-Tujunga), San Fernando
8	Average weather conditions	Single digit humidity, Santa Ana winds with gusts upwards of 50 to 70 mph
9	Geographical highlights	Mountain range with steep drainages and canyons; suburban density in nearby neighbourhoods; Angeles National Forest to the north
10	Was there any fire break? (natural or artificial)	Interstate 210
11	Did the Fire Service report extreme fire behaviour?	Red Flag Warning; fire behaviour is extreme, wind driven, with long-range spotting and uphill runs.
12	Number of structures and infrastructures affected (damaged)	123 destroyed, 81 damaged
13	Estimated direct and indirect economic damage	At least \$3.2 billion in economic loss of which \$2.2 billion were insured loss across all fires in the 2017 December Southern California Wildfires
14	Did it occur in conjunction with multiple fires in the country?	Creek Fire coincided with an outbreak of other major fires including the Rye, Skirball, Thomas, and Lilac Fires. These fires are collectively known as the 2017 December Southern California Wildfires. Los Angeles was most impacted by the Creek and Skirball fires. With all active fires,

		firefighting resources were spread thin throughout the region.
15	Countries involved	United States
16	Brief timeline of the key events	<p>December 5 - 3:44 am: The Creek Fire breaks out near Little Tujunga Canyon Rd. and Kagel Canyon Rd.</p> <p>December 5 - 4:00 am: Fire rapidly spreads into the community of Kagel Canyon, driven by Santa Ana winds</p> <p>December 5 - 5:37 am: Mandatory evacuation orders are issued for all areas between Sayre Rd and Little Tujunga Canyon Road north of I-210</p> <p>December 5 - 7:06 am: Creek Fire grows to 2,500 acres</p> <p>December 5 - 8:19 am: Patients are evacuated from Mountain View Convalescent Centre</p> <p>December 5 - 9:31 am: I-210 is closed in both directions from Sunland to I-5</p> <p>December 5 - 10:38 am: Mandatory evacuation orders issued for all areas north of I-210 from Sunland-Tujunga to Sylmar including Lake View Terrace, Paicoma, and Kagel Canyon</p> <p>December 5 - 6:00 pm: Fire jumps Interstate 210 and reaches 11,000 acres; additional evacuation orders are issued for Shadow Hill</p> <p>December 6 - 6:00 pm: Containment reaches just 5% with single digit humidity persisting; multiple exits to I-210 remain closed</p> <p>December 7 - 6:00 am: Fire grows slowly to 12,600 acres but firefighters remain challenged in steep rugged terrain; gusts remain between 50 and 70 mph</p> <p>December 7 - 4:00 pm: All evacuation orders are lifted except Limekiln Canyon; re-entry for residents only</p> <p>December 7 - 6:00 pm: Fire grows to 15,300 acres with 20%; weather conditions improve with less winds</p>

		<p>December 8 - 6:00 am: Containment grows to 40%</p> <p>December 8 - 6:00 pm: Containment continues to grow to 70% and all evacuation orders are lifted</p> <p>December 9 - December 10: With improving weather conditions, firefighters continue to make rapid gains against the fire</p> <p>December 11: The Creek Fire is 100% contained.</p>
17	Time of initial order to evacuate and locations	<p>Begin: 12/5/17 - Evacuation orders are issued for multiple areas north of I-210 between Sylmar and Sunland-Tujunga at 5:37 am</p> <p>Additional: 12/5/17 - Additional orders are expanded west and east as well as to Shadow Hills</p>
18	Time when evacuation was considered completed	End: 12/8/17 - All evacuation orders are lifted for residences by 6:00 pm
19	Deaths/Injuries	0 deaths
20	The number of people evacuated	Approximately 150,000 people (ordered)
21	The location people initially evacuated	About 66% evacuated within their county of origin(Wong et al., 2021, based on a 2017 Southern California Wildfire survey data; note: not wildfire specific
22	Reasons why people decided to evacuate	Mandatory evacuation orders; strong belief of utility loss and strong belief of fast fire spread (i.e., risk perceptions); long-term residents (more than 10 years in residence); children in the household; higher level degree (e.g., Master's or higher) (Wong et al., 2021, based on a 2017 Southern California Wildfire discrete choice model using survey data; note: not wildfire specific)
23	Evacuation type	Predominately ground transport by private vehicles
24	Any drill/education/instructions on large outdoor fires provided beforehand?	No information available
25	Personnel involved in rescue operations	<p>Unified Command: Los Angeles Fire, Los Angeles County Fire, Angeles National Forest</p> <p>Cooperating Agencies: Los Angeles School Police, Cal OES, Glendale Fire Department, California Department of Corrections, City of Los Angeles, California Conversation Corps, California Highway Patrol, Los Angeles Department of Transportation, Cal Trans, Los Angeles County Public Health, Los Angeles County Public Works, Southern California Edison, Southern California Gas, Los Angeles City Park Rangers, Los Angeles Department of Water, Power, and Security, Mountains Recreation Conservation Authority,</p>

		<p>Los Angeles County Animal Control, Los Angeles City Animal Services, Red Cross, CARE</p> <p>Total fire personnel: +2000 Total fire engines: +200</p>
26	Did the smoke hindered significantly the evacuation because of low visibility or health problems	Smoke conditions cause some health problems in the area for responders and citizens; unhealthy air quality is declared for parts of Los Angeles County
27	Possible causes of issues in management operations	<p>Firefighting: With multiple fires breaking out across Southern California, firefighting resources were stretched thin. Some Los Angeles County Fire Department personnel were sent to the Thomas Fire, only to be reassigned to the Creek Fire. Firefighters also battled flames with extremely poor weather conditions in steep, rugged terrain. Despite the natural fire break of I-210, flames jumped the highway and impacted the Shadow Hill neighbourhood.</p> <p>Evacuations: Evacuations during the Creek Fire were hurried and often chaotic. The community of Kagel Canyon had little to no warning about the impending danger, leading to congestion along the only main road through the neighbourhood. Other neighbourhoods were unable to use I-210, which was closed to all traffic in the morning of the fire outbreak. Evacuees also had difficulty transporting animals, particularly horses, away from the fire.</p>
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29	Name/Surname/Email/Date of who filled in this template	Stephen Wong/stephen.wong@berkeley.edu 6/13/19

7. Haifa fire (Israel), 2016

Between November 22nd to 29th, 2016, after a long period of drought, a series of fires raged across Israel. The most severe fire started on Thursday, November 24th, 2016, at 10:05 am in an WUI zone in the city of Haifa, Israel. Strong eastern, dry, winds and a long drought allowed for the fire to spread quickly across the urban area. Lower wind speeds during the evening, along with foreign aid given, allowed for the extinguishing of the fire by the next day.

1	Where?	Haifa, Israel
2	When?	24/11/2016 10:00 – 25/11/2016
3	How was the fire started?	Unknown/Suspected arson
4	Initial fire size	
5	Area affected (burned area)	0.28 km ²
6	Fuels involved in the fire	Mediterranean forests, woodlands, and scrub; structures, roads
7	WUI, urban, wildland or informal settlement fires?	WUI, urban
8	Average weather conditions	High heat, low relative humidity and high, gusty and dry winds. During a period of drought.
9	Geographical highlights	Mountain slopes and wadies
10	Was there any fire break? (natural or artificial)	The fire passed across roads and urban blocks as wide as 30 m' or more and did not stop at any barriers.
11	Did the Fire Service report extreme fire behaviour?	Spots fire jumping with the wind direction
12	Number of structures and infrastructures affected (damaged)	1784 buildings
13	Estimated direct and indirect economic damage	~650 million NIS For the entire fires in Israel during 22-29/11/2016.
14	Did it occur in conjunction with multiple fires in the country?	Part of a series of fires in Israel at that time period 22-29/11/2016. The Haifa fire was the major off
15	Countries involved	Fir extinguishing aid given for all fires in Israel at that period by: Ukraine; Azerbaijan; Italy; USA; UK; Palestinian National Authority; Turkey; Greece; Jordan; Egypt; Spain; France; Cyprus; Croatia; Russia.
16	Brief timeline of the key events	22/12/2016 10:05 first call arrives alerting about a fire in wild area inside the city. 10:30 fire order to evacuate to houses near the fire area 11:38 all residences at the affected area are ordered to evacuate 12:40 chief fire fighter reports the fire as out of control 13:40 additional residences are ordered to evacuate

		20:30 fire reported to be under control, but not yet out 24/11/2016 00:30 all routs reopened to traffic 13:15 all residences are permitted to return home
17	Time of initial order to evacuate and locations	22/12/2016 10:40 nearby schools
18	Time when evacuation was considered completed	N/A
19	Deaths/Injuries	No death. About 150 injured.
20	The number of people evacuated	About 60,000
21	The location people initially evacuated	Mostly to relatives. Shelters were offered
22	Reasons why people decided to evacuate	Fire arrival; order to evacuate
23	Evacuation type	Mostly by car
24	Any drill/education/instructions on large outdoor fires provided beforehand?	Previous experience with crises, for some with fires. Haifa municipality issues yearly pamphlet regarding disaster mitigation.
25	Personnel involved in rescue operations	Firefighters, police, municipality.
26	Did the smoke hindered significantly the evacuation because of low visibility or health problems	N/A
27	Possible causes of issues in management operations	State Comptroller identified several factors. Among which: <ul style="list-style-type: none"> ● No fire protection plan ● Only one escape route from most neighbourhoods ● Insufficient water supply systems ● Emergency state wasn't declared ● Key management personals were not given pass through the area ● Ineffective management at central command centres ● Inadequate civilian evacuation ● Inadequate schools evacuation
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29	Name/Surname/Email/Date of who filled in this template	Ido Marom Ido.marom@gmail.com 08/08/2020

8. Flatanger Fire (Norway) 2014

January 2014 was a particularly dry and windy month in large parts of Norway. This led to several large outdoor fires in sub-zero temperatures, most notably the urban conflagration in Lærdal. However, a large grass and heather fire in Flatanger also led to the evacuation of 26 people and 63 buildings were lost.

1	Where?	Flatanger, Norway
2	When?	<ul style="list-style-type: none"> ● Fire reported 22:18 27. January 2014. ● Evacuation process started at 23:10 27. January 2014. Last fires extinguished during 1. February.
3	How was the fire started?	Eyewitnesses confirmed that the fire started when a live, uninsulated high voltage line fell down. This caused a short circuit, and sparks ignited the vegetation.
4	Initial fire size	Unknown.
5	Area affected (burned area)	15 000 000 m ²
6	Fuels involved in the fire	Heather and Shrublands.
7	WUI, urban, wildland or informal settlement fires?	WUI, Started in Shrublands and spread to nearby village.
8	Average weather conditions	<p>The weather had for weeks been characterized by a strong high pressure system from the east. This blocked the normal low-pressure passage from the west.</p> <p>This brought eastern to south-eastern winds over most of Norway.</p> <p>Thus, the area was without precipitation and in many places, January was the driest month recorded. Measuring stations in the region measured relative humidity on 26 January to 33%. Flatanger received only 2 mm of precipitation in the last three weeks before the fire. In addition, the ground was without snow after an unusual mild weather period early in the month.</p> <p>In many places the dry wind became very strong, with gales and periodically small storms in exposed places. This is not unusual for the region. During the fire, the temperature was between minus 5 and minus 1 degrees Celsius. Humidity between 50 and 60%. The wind in the first phase of the fire was around 20 m / s with strong gusts.</p>
9	Geographical highlights	Peninsula of coastal landscape characterized by hilly terrain with a number of crags and coastal rocks as well as bogs and small ponds and fjords. Vegetation consists mostly of scrub, grass and heather

10	Was there any fire break? (natural or artificial)	Rocks, bogs, fjords and frozen ponds.
11	Did the Fire Service report extreme fire behaviour?	Extreme weather made the operation challenging. Firefighters reported they had to lie down because of strong wind gusts and sub-zero temperatures made water supply difficult. Turbulent and shifting winds made the fire change direction in several instances.
12	Number of structures and infrastructures affected (damaged)	64 structures burned down including 4 residential houses and 22 cottages (holiday homes).
13	Estimated direct and indirect economic damage	14 million euros in direct insurance refunds. Indirect costs unknown.
14	Did it occur in conjunction with multiple fires in the country?	Yes
15	Countries involved	Norway (help from several municipalities)
16	Brief timeline of the key events	<p>27. January</p> <p>22:00: Fire starts some time right after 22.</p> <p>22.18: Fire reported</p> <p>22.30: First firefighters in action</p> <p>22.30: Neighbouring fire department assembles.</p> <p>Kl. 22.57: Fire chief decides to evacuate nearby houses.</p> <p>2310: Reinforcements arrive, and command post is set up.</p> <p>2310: Fire chief drives to nearby village to start evacuation door to door.</p> <p>2310-2350: (Exact time unknown): Road mail is created and staffed by ambulance personnel who register evacuees leaving the peninsula.</p> <p>23.30: Helicopters are requested but are unable to fly at night.</p> <p>28. January</p> <p>00.30: All houses evacuated to assembly point at a nearby camp school.</p> <p>01.30: The municipal crisis team mobilized and in operation at the assembly point.</p> <p>01.00: further reinforcements arrive</p> <p>01:00-08:00 (Exact time unknown) Farm animals are evacuated during the night.</p> <p>02:02: The civil defence was asked by the police to assist.</p> <p>04.00-06.00: Most houses burn down during this time.</p> <p>04.20: The nearest hospital increases emergency preparedness and ambulances are in rotating standby in case of personal injuries during the operation.</p> <p>05.47: Rescue boat assists with extinguishing via water cannon from the sea.</p>

		<p>08:30: First helicopter arrives but is grounded due to strong wind.</p> <p>19.40: Coast guard ship assists with extinguishing via water cannon from the sea</p> <p>- An extensive firefighting effort was carried out throughout the first day, both from land and from the sea. This effort stopped the spread of the fire in the outer part of the Sørnes Peninsula and prevented the fire from spreading Inland</p> <p>29.-31. January</p> <p>On Wednesday 29 January, the wind died down and helicopters could therefore assist in the extinguishing. helicopters operated from early morning until 16.04. After this they were redirected to a different fire.</p> <p>There were several minor flares of the fire which were extinguished continuously until the morning of 30 January.</p> <p>From 31 January, the operation was gradually phased out, and crews were gradually sent home as the fire went into a post-extinguishing phase. Heat-seeking cameras were used from both aircraft and ground crews to detect residual heat and places where the fire could flare up. The civil defence ended the operation in the afternoon.</p> <p>There were no signs of heat and the fire chief decided to pull out the task forces at 18:00. Guards were organized and patrolled along the roads to look for new flares.</p> <p>1-17. February</p> <p>On the evening of February 1, the fire flared up again, and a full alarm was sounded at. 19:12. The extinguishing operation included several fire departments as well as the Civil Defence. The fire threatened four residential houses and people were again evacuated. The fire was extinguished the following day with helicopter support.</p> <p>A new post-extinguishing phase was organized throughout the fire area. There had still been no significant rainfall, and it was decided to deploy a fire truck on 24-hourstand-by in the area. This contingency lasted until 17 February.</p>
17	Time of initial order to evacuate and locations	22.57 (27. January)

18	Time when evacuation was considered completed	00.30 (28. January).
19	Deaths/Injuries	0 Deaths.
20	The number of people evacuated	26
21	The location people initially evacuated	Assembly point - At a nearby camp school
22	Reasons why people decided to evacuate	Fire chief's decision
23	Evacuation type	By private cars
24	Any drill/education/instructions on large outdoor fires provided beforehand?	
25	Personnel involved in rescue operations	About. 250 fire crews from 13 different fire departments. 170 crews from the Civil Defence. In addition personnel from Police, military, coast guard, paramedics and Norway's volunteer marine rescue team. A pre-planned municipal crisis team took care of evacuees.
26	Did the smoke hindered significantly the evacuation because of low visibility or health problems	Investigations does not mention this.
27	Possible causes of issues in management operations	<ul style="list-style-type: none"> ● Poor radio coverage in the operation area. ● Unclear and changing command lines as well as rotating shift changes among the operation management led to somewhat unclear communication. ● Fire chief does not have the full picture of all possible reinforcements from neighbouring regions. Some reinforcements could have been requested earlier.
28	References	<p>PwC - PricewaterhouseCoopers AS, "Evaluering av brannene: Lærdal, Flatanger og Frøya," Justis- og beredskapsdepartementet, 2014.</p> <p>T. Log, "Cold Climate Fire Risk; A Case Study of the Lærdalsøyri Fire, January 2014," Springerlink.com, 2015.</p> <p>Direktoratet for samfunnssikkerhet og beredskap (dsb), "Brannene i Lærdal, Flatanger og på Frøya vinteren 2014," 2014.</p>
29	Name/Surname/Email/Date of who filled in this template	Martin Kristoffersen. 16th August 2020.

9. Fort McMurray fire (Canada), 2016

On May 1, 2016, at approximately 16:00, agriculture and forestry crews spotted a two-hectare (0.02 km²) wildfire in the Wood Buffalo area, burning deep in the forest - 15-20km southwest of the urban service area of Fort McMurray. Wood Buffalo is home to both rural and urban communities, with a population of more than 125,000 people (approximately 35 % are temporary residents, and 10 % are First Nation communities). Strong winds and elevated temperatures promoted the development of the fire. Water bombers were quickly deployed, followed by warnings issued to campgrounds in Gregorie and Prairie Creek of the possibility of an upcoming evacuation. An evacuation centre was opened on MacDonald Island, and a local state of emergency declared – within six hours of the fire initially being spotted. Late the following day, warning levels were reduced given that wind conditions appeared favourable - blowing the fire away from the city. On May 3rd, conditions changed again, and the fire entered Fort McMurray leading to 12 neighbourhoods and tens of thousands of people evacuating to evacuation centres. Some centres were affected by changing conditions requiring them to be subsequently evacuated. During this, two people were killed in a car accident. By the end of the day, over 60,000 residents had evacuated, including all 105 patients at the Northern Lights Regional Health Centre. During this evacuation, highways were quickly overloaded with traffic. To cope with this, convoys were formed.

By the 4th of May 1600 structures had been destroyed with 10,000 ha (100 km²) of wildland involved in the fire. A provincial state of emergency was declared with 80,000 people instructed to leave. By the 5th of May, there were 49 separate fires burning and 4000 people had to be airlifted from work camps north of Fort McMurray. On the 6th of May, 8,000 workers were evacuated from 19 oil sites as the fire spread north.

Most people who fled the region did not have short-term contingency plans in place other than getting out of immediate danger. Local industry and residents, communities, post-secondary institutions, and parks offered to lodge. Reception centres were put up across Alberta in Anzac, Athabasca, Bonnyville, Calgary, Drayton Valley, Edmonton, Fort Chipewyan, Fort McKay, Grassland, Janvier, Lac La Biche, Smoky Lake, and St. Paul.

On May 6, Alberta premier Notley announced emergency funds for evacuees, with the Canadian Red Cross providing additional funding. The use of firefighting resources peaked on June 3 with approximately 2,197 firefighters engaged. The Government informed Albertans of the situation with news conferences, information bulletins, social media, websites, call centres, emails, telephone town halls, etc. Eventually, more than 88,000 people were evacuated with two fatalities due to a car crash.

1	Where?	Fort McMurray, Alberta, Canada
2	When?	01/05/2016 – 07/2016
3	How was the fire started?	Suspect arson
4	Initial fire size	0.02 km ²
5	Area affected (burned area)	5895 km ²
6	Fuels involved in the fire	Boreal forest primarily Jack Pine. Structures.
7	WUI, urban, wildland or informal settlement fires?	WUI, fire consumed portions of the city.
8	Average weather conditions	Hot start of fire season after unusual dry fall and winter. Daily highs above 30°C, high winds with gusts over 70 km/h. Relative humidity down to 12%.

9	Geographical highlights	Multiple river valleys.
10	Was there any fire break? (natural or artificial)	No.
11	Did the Fire Service report extreme fire behaviour?	Yes. Four days build up until firestorm created. Spot fires ignite over 1km from source fire.
12	Number of structures and infrastructures affected (damaged)	+2400 Structures destroyed, +540 homes damaged. +660 work camp structures. Gas, electricity, water supply disrupted. Local airport closed, main road connection severed.
13	Estimated direct and indirect economic damage	589552 ha (5895.52 km ²) burned. CD\$3.6 billion (or US\$2.9 billion) insured loss. CD\$9.5 billion (or US\$7.6 billion) as direct and indirect loss including the firefighting costs.
14	Did it occur in conjunction with multiple fires in the country?	Yes. Fire later merges with another.
15	Countries involved	Canada, South Africa, United States of America
16	Brief timeline of the key events	<ul style="list-style-type: none"> - 16:00 MDT, May 1, 2016, Fire detected South West of Fort McMurray. - 21:57 MDT, May 1, 2016, Local state of emergency, mandatory evacuation in limited areas. - 15:00 MDT, May 3, 2016, Inversion layer dissipated, fire jumps 1 km into Fort McMurray. - 18:00 MDT, May 3, 2016, Mandatory evacuation. - May 4, 2016, Provincial state of emergency, winds 72km/h, firestorm and flame spread of 40 metres per minute. - May 6, 2016, Police convoys to evacuate area. - May 7, 2016, Evacuation of Fort McMurray and surrounding area complete. - May 13, 2016, Main fire exits Fort McMurray. - May 18, 2016, Fire crosses into next province, Saskatchewan. - July 4, 2016, Fire considered contained.
17	Time of initial order to evacuate and locations	19:00 MDT, May 1, 2016, Warning to prepare for evacuation.
18	Time when evacuation was considered completed	May 7, 2016, 25000 People evacuated. Many animals, pets, livestock, left behind.
19	Deaths/Injuries	2 Fatalities, traffic collision during evacuation.
20	The number of people evacuated	~88000. Fire threatens city refuge sites.
21	The location people initially evacuated	
22	Reasons why people decided to evacuate	Mandatory order by local authorities
23	Evacuation type	Primarily ground transport by private vehicles. Additional use of buses for oil camp operations. Minor use of aircraft.

24	Any drill/education/instructions on large outdoor fires provided beforehand?	Canadian fire services are trained for it.
25	Personnel involved in rescue operations	Royal Canadian Mounted Police, Alberta Fish and Wildlife, Alberta Sheriffs Branch.
26	Did the smoke hindered significantly the evacuation because of low visibility or health problems	Yes – during vehicle evacuation.
27	Possible causes of issues in management operations	16:00 MDT, May 4, 2016, Regional Emergency Operations Centre evacuated and relocated. Some evacuees required further evacuations as refuge sites were threatened or consumed.
28	References	<p>Scientific literature:</p> <ol style="list-style-type: none"> 1) Westhaver, A. (2017). Why some homes survived: Learning from the Fort McMurray wildland/urban interface fire disaster. 2) McKenney, D. W., Pedlar, J. H., Lawrence, K., Papadopol, P., Campbell, K., & Hutchinson, M. F. (2014). Change and Evolution in the Plant Hardiness Zones of Canada. <i>BioScience</i>, 64(4), 341–350. https://doi.org/10.1093/biosci/biu016 <p>Websites:</p> <ol style="list-style-type: none"> 3) https://www.alberta.ca/release.cfm?xID=41701E7ECBE35-AD48-5793-1642C499FF0DE4CF 4) http://cwfis.cfs.nrcan.gc.ca/interactive-map?zoom=9&lon=-902990.75370526&lat=931229.14058237&month=05&day=18&year=2016 5) Daily Data Report for May 2016, Fort McMurray Alberta at climate.weather.gc.ca 6) www.plantmaps.com/interactive-alberta-plant-zone-hardiness-map.php 7) www.planthardiness.gc.ca/images/PHZ_2014_CFS_Map.pdf 8) www.agr.gc.ca/atlas/agpv?webmap-en=78529700717d4cab81c13e9f9404ef10&webmap-fr=c1b454842d3748b0bb0807d7817d34c2 9) http://www.cbc.ca/interactives/longform/news/battling-the-beast-fort-mcmurray-wildfire <p>http://globalnews.ca/news/2681249/fort-mcmurray-wildfire-timeline-of-events/</p>
29	Name/Surname/Email/Date of who filled in this template	Ronchi, E., Rein, G., Gwynne, S., Wadhvani, R., Intini, P., & Bergstedt, A. (2017). e-Sanctuary: Open Multi-Physics Framework for Modelling Wildfire Urban Evacuation. Quincy, MA (USA)

10. Hill fire (USA), 2018

The Hill Fire in November 2018 was a small wildfire that impacted Ventura County in Southern California. The Hill Fire coincided with the nearby Woolsey Fire and ignited near Newbury Park and Camarillo Springs. Within 15 minutes of starting, the fire reached Highway 101 and began spreading south of the highway. Since the fire was threatening a significant number of people and structures, evacuations were ordered and fire resources were mostly assigned to the Hill Fire. The decision to focus on the Hill Fire would have devastating impacts for the Woolsey Fire, which soon grew rapidly and caused significant damage. A perimeter around the Hill Fire was developed quickly and the fire was contained a little over a week after starting. A burn scar from the 2013 Springs Fire helped slow the growth of the Hill Fire.

The Hill Fire led about 17,000 people to be ordered to evacuate and burned 4,531 acres. The fire destroyed four residences, but damage estimates for the fire could not be found. With the much larger and devastating Woolsey Fire nearby, the Hill Fire received only minimal media attention. Additional details are provided in below.

1	Where?	Ventura County, California, USA
2	When?	11/8/18 - 11/16/18
3	How was the fire started?	Human caused (under investigation)
4	Initial fire size	100 acres
5	Area affected (burned area)	4,531 acres
6	Fuels involved in the fire	Mixed including chaparral shrub-land, grassland, and oak woodlands
7	WUI, urban, wildland or informal settlement fires?	WUI fire, impacted the communities of Newbury Park, Camarillo Springs, Dos Vientos, South Coast
8	Average weather conditions	Prior to fire, dry conditions in the area along with Santa Ana winds. During the wildfire, winds up between 29 and 34 mph. Gusts of wind up to 70 mph.
9	Geographical highlights	Chaparral mountain range and foothills with nearby valleys and coastal range. Impacted Hill Canyon area is characterized by rolling hills along with narrower canyons and multiple drainages.
10	Was there any fire break? (natural or artificial)	Highway 101; Springs Fire (2013) burn scar
11	Did the Fire Service report extreme fire behaviour?	Red flag warning; critical fire weather conditions fuelled by high Santa Ana winds; rapid fire spreading
12	Number of structures and infrastructures affected (damaged)	4 structures destroyed, 2 structure damaged
13	Estimated direct and indirect economic damage	Unknown - most estimates are calculated together with the Woolsey Fire, which was significantly more damaging
14	Did it occur in conjunction with multiple fires in the country?	Occurred the same day as the Camp Fire in Butte County. Resource overlap with state air tankers. Occurred at the same time as the nearby Woolsey Fire. With the Hill Fire threatening more people, significant firefighting resources were diverted

		<p>away from the Woolsey Fire for the Hill Fire. Reports indicate that even as the Woolsey Fire grew, the number of personnel remained high at the Hill Fire. A lack of unified command and jurisdictional differences contributed to the confusion on the ground, allowing the Woolsey Fire to grow rapidly. Hill Fire was contained rapidly, allowing resources to be diverted to the Woolsey Fire.</p>
15	Countries involved	United States
16	Brief timeline of the key events	<p>November 8, 2:00 pm: Hill Fire begins near Eastern Camarillo/Newbury Park with winds reported around 30 mph</p> <p>November 8, 2:15 pm: Fire reaches Highway 101</p> <p>November 8, 2:27 pm: Evacuations are ordered for the local water treatment plant and hiking trails in the area</p> <p>November 8, 2:44 pm: Camarillo Springs area is issued a mandatory evacuation order</p> <p>November 8, 3:03 pm: Highway 101 is closed in both directions; mandatory evacuation orders are issued for the Vicieto Trailer Park and later Dos Vientos and California State University Channel Islands</p> <p>November 8, 6:00 pm: Approximately 1,200 homes are evacuated as firefighters gain an upper hand against the Hill Fire</p> <p>November 8, 7:49 pm: Areas in the South Coast area are issued mandatory evacuation orders with fire spread likely to the south further beyond Highway 101</p> <p>November 9, 7:00 am: Fire behaviour moderates overnight with sparse fuel from a previous fire; resources reassigned to the Woolsey Fire</p> <p>November 10, 7:00 am - Hill Fire remains at 4,531 acres with 25% containment with very slow growth; focus on firefighting remains on the Woolsey Fire</p> <p>November 10, 5:28 pm - Repopulation begins for the Hill Fire, but the South Coast area remains under mandatory evacuation orders</p>

		<p>November 11 - November 15 - Fire perimeter for the Hill Fire holds and containment grows quickly</p> <p>November 16 - Hill Fire is 100% contained</p>
17	Time of initial order to evacuate and locations	<p>Begin: 11/8/18 (2:44 pm) - Camarillo Springs</p> <p>Additional: 11/8/18 - Vicieto Trailer Park, Dos Vientos, Cal State Channel Islands, South Coast</p>
18	Time when evacuation was considered completed	<p>End: 11/10/18 - Most areas impacted by the Hill Fire are repopulated; South Coast area still under evacuation orders due to the Woolsey Fire</p>
19	Deaths/Injuries	0 deaths
20	The number of people evacuated	Approximately 17,000 people (ordered)
21	The location people initially evacuated	Additional data required
22	Reasons why people decided to evacuate	Additional data required
23	Evacuation type	Predominately ground transport by private vehicles.
24	Any drill/education/instructions on large outdoor fires provided beforehand?	No information available
25	Personnel involved in rescue operations	<p>Unified Command: CAL FIRE (additional agencies: Ventura County Fire, Ventura Sheriff Dept, LA County Fire, LA City Fire, LA Sherriff Dept, LA Police Dept)</p> <p>Cooperating Agencies: Southern California Edison, Southern California Gas Company, California Department of Corrections and Rehabilitation (CDCR), California Department of Fish & Game, California Highway Patrol, Public Health Department, National Park Service, Caltrans, Ventura County Animal Control, LA County Animal Control, Office of Emergency Management, American Red Cross</p> <p>Total fire personnel: +450</p> <p>Total fire engines: +15</p>
26	Did the smoke hindered significantly the evacuation because of low visibility or health problems	Extremely poor visibility greatly impacted evacuations. Air quality was poor during the fire but did not drift far.
27	Possible causes of issues in management operations	<p>Firefighting Resources: The Hill Fire threatened more homes and people compared to the more devastating Woolsey Fire. Consequently, Ventura County sent most of its resources to combat the Hill Fire. Los Angeles County, through mutual aid, arrived at the Woolsey Fire but a unified command structure remained lacking during the early hours of the fire. With the Woolsey Fire</p>

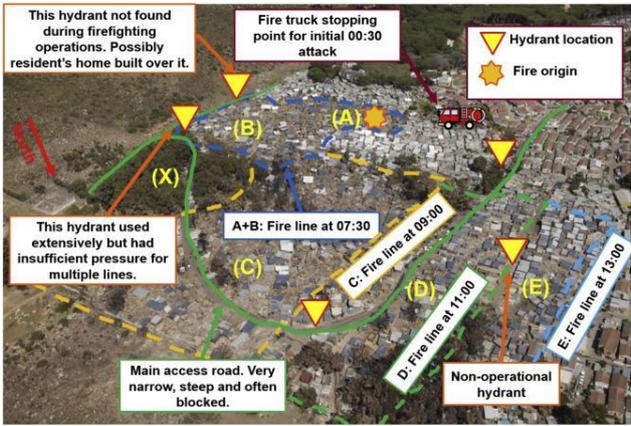
		<p>growing rapidly, resources were not enough to contain the fire. The Woolsey Fire quickly overran neighbourhoods, jumped the 101 Highway, and spread to the Pacific Ocean and Malibu. The Hill Fire did not spread rapidly due to entering an area with sparse vegetation.</p> <p>Evacuation: Congestion during the evacuation was heavy, especially near Highway 101 as the Hill Fire reached the highway within 15 minutes of starting. The closure of Highway 101 led to significant congestion for regular traffic and evacuees attempting to escape the Hill Fire.</p>
28	References	<p>Academic: Wong, S., Broader, J., Shaheen, S. (2020). Review of California Wildfire Evacuations from 2017 to 2019. Retrieved from https://escholarship.org/uc/item/5w85z07g.</p> <p>Other: Cal Fire. (2018). Hill Fire Incident Information. Retrieved June 7, 2019, from http://cdfdata.fire.ca.gov/incidents/incidents_details_info?incident_id=2281</p> <p>Campos, E. (2018, November 17). Hill Fire was Caused by Human Activity. Retrieved June 3, 2019, from NBC Southern California website: http://www.nbclosangeles.com/news/local/Hill-Fire-Caused-by-Human-Activity-500745102.html</p> <p>Childs, J. (2018, November 10). How the wildfires are affecting air quality in Ventura County. Retrieved May 31, 2019, from Ventura County Star website: https://www.vcstar.com/story/news/2018/11/10/local-ventura-county-air-quality-impacted-smoke-hill-and-woolsey-fire/1948281002/</p> <p>Cosgrove, J. (2018, January 6). Firefighters' fateful choices: How the Woolsey fire became an unstoppable monster. Los Angeles Times. Retrieved from https://www.latimes.com/local/lanow/la-me-woolsey-resources-20190106-htmllstory.html</p> <p>Hersko, T. (2018, November 16). Investigators point to human activity as cause of Hill Fire; containment at 100 percent. Ventura County Star. Retrieved from https://www.vcstar.com/story/news/2018/11/16</p>

		<p>6/hill-fire-update-fully-contained-california-wildfire/2024113002/</p> <p>Jackson, A., & Hamasaki, S. (2018, November 8). Down the road from the Thousand Oaks shooting, people are being evacuated because of a wildfire. Retrieved June 3, 2019, from CNN website: https://www.cnn.com/2018/11/08/us/hill-fire-ventura-county-trnd/index.html</p> <p>Licas, E., & Gundran, R. (2018, November 9). Hill and Woolsey fires force evacuations in Ventura, LA counties - structures burn in Oak Park. Los Angeles Daily News. Retrieved from https://www.dailynews.com/2018/11/08/fast-moving-brush-fire-scorches-at-least-3000-acres-near-highway-101-ventura-county-officials-say/</p> <p>Lloyd, J. (2018, November 15). What to Know About the Hill Fire: Evacuation Information. Retrieved June 3, 2019, from NBC Southern California website: https://www.nbclosangeles.com/news/local/Hill-Fire-Evacuations-Road-Closure-500124611.html</p> <p>Martinez, C., Carlson, C., & Diskin, M. (2018, November 12). Smaller fires amid Hill, Woolsey a reminder: "We are still in significant fire weather." Retrieved May 24, 2019, from Ventura County Star website: https://www.vcstar.com/story/news/2018/11/12/thousand-oaks-lynn-fire-rocky-live-updates-california-wildfires/1976430002/</p> <p>Ventura County Fire Department PIO. (2018). Ventura County Fire Department PIO via Twitter [Twitter]. Retrieved May 31, 2019, from https://twitter.com/VCFD_PIO</p>
29	Name/Surname/Email/Date of who filled in this template	Stephen Wong/stephen.wong@berkeley.edu 6/7/19

11. Imizamo Yethu fire (South Africa) 2017

A fire started around 23:00 – 24:00 March 11 2017, in Imizamo Yethu settlement in Cape Town, South Africa. The fire spread quickly within communities, which resulted in quick fire spreads. The fire was initially thought to be becoming under control around 0:40 March 12th until a hose was cut by a resident. The water loss and time loss are thought to be the reason why the fire became out of control again. Residents evacuated with their belongings as well as help others, and firefighting. The fire was extinguished 13:00 March 12th, almost 13 hours later the fire started.

1	Where?	Imizamo Yethu, Cape Town, South Africa
2	When?	2017/Mar/11 between 23:00-24:00 to Mar/12 13:00
3	How was the fire started?	No information
4	Initial fire size	No information
5	Area affected (burned area)	76600 m ²
6	Fuels involved in the fire	Structures (informal settlements)
7	WUI, urban, wildland or informal settlement fires?	informal settlement fires
8	Average weather conditions	Wind speed 28 to 44 km/h at nearby weather station but wind around the fire may be different due to mountain. Wind direction shifted. Temperature between 19 to 24 C, with humidity 44 to 78 %.
9	Geographical highlights	Informal settlement area, narrow roads, history of fires, some steep hills
10	Was there any fire break? (natural or artificial)	No
11	Did the Fire Service report extreme fire behaviour?	Quick fire spread
12	Number of structures and infrastructures affected (damaged)	2194
13	Estimated direct and indirect economic damage	No information
14	Did it occur in conjunction with multiple fires in the country?	No
15	Countries involved	South Africa
16	Brief timeline of the key events	<p>March 11th 23:00-24:00 A fire started</p> <p>March 12th 0:26 Fire was reported to the Public Emergency Communications Center</p> <p>0:28 A team at local fire station was dispatched to the fire</p> <p>0:40 A fire was becoming under control</p>

		<p>Around this time, a hose was cut by a resident (thus, fire again becoming out of control).</p> <p>2:00 A fire reached at the end of informal settlements (possible spreading into wildlands).</p> <p>1:00-3:00 Wind shifted. A fire spread into another part of community</p> <p>7:00 A fire reached forest (Eucalyptus trees)</p> <p>9:00-13:00 Aerial fire-fighting</p>  <p>(Taken from Kahanji C et al 2019)</p> <p>13:00 The fire was extinguished</p>
17	Time of initial order to evacuate and locations	No information
18	Time when evacuation was considered completed	No information as some of residents stayed the site
19	Deaths/Injuries	4 deaths 2 injuries (firefighter)
20	The number of people evacuated	Around 9700 displaced
21	The location people initially evacuated	Near site, observing a fire, shelter (at nearby community halls)
22	Reasons why people decided to evacuate	Fire approaching their dwellings
23	Evacuation type	Not issued
24	Any drill/education/instructions on large outdoor fires provided beforehand?	No
25	Personnel involved in rescue operations	22 fire engines, 6 water tenders, 1 skid, 6 support vehicles, 1 fixed wing aircraft, 2 helicopters

26	Did the smoke hindered significantly the evacuation because of low visibility or health problems	Black then grey smoke was seen
27	Possible causes of issues in management operations	Narrow roads, flammable dwellings, fire hose was cut by a resident (lost water, additional time to bring a hose) Inadequate water supply
28	References	<p>https://www.groundup.org.za/article/photos-fire-destroys-numerous-homes-hout-bay/</p> <p>Kahanji, C et al. Fire spread analysis for the 2017 Imizamo Yethu informal settlement conflagration in South Africa, International Journal of Disaster Risk Reduction, 39:101146 (2019). https://doi.org/10.1016/j.ijdrr.2019.101146</p>
29	Name/Surname/Email/Date of who filled in this template	Sayaka Suzuki, sayakas@fri.go.jp July October

12. La Gomera Island fire (Spain), 2012

The La Gomera island fire is suspected to have started due to arson. It damaged a quarter of Garajonay National park, considered by UNESCO as a world heritage site since 1986. Approximately 11% of the island burnt and threatened ~8000-9000 people. It was unusual in that one of the chosen evacuation routes was via sea (i.e. using boats), although river evacuation has been seen previously. This has not been observed in other wildfire cases discussed in this document. This method of evacuation was due to other evacuation routes being obstructed by fire. A similar situation happened recently in a wildfire at San Vito Lo Capo in Sicily, Italy in July 2017.

1	Where?	La Gomera, Canary Island, Spain
2	When?	04/08/2012 -17/08/2012
3	How was the fire started?	Suspected arson
4	Initial fire size	It had two focal points three km apart that began burning vigorously within a short space of time from each other
5	Area affected (burned area)	4 000 ha (40 km ²) of land which is equivalent to 11 % of the islands total surface area. Of these, 900 ha (9 km ²) (or 25% of the UNESCO conserved site) belong to the Garajonay National Park
6	Fuels involved in the fire	Lauri Silva rain forest which is a Canarian pine woodland (covering 606.78 km ²), thermophilous forest (64.32 km ²), Canarian palm community (18.45 km ²), Canarian willow community (4.29 km ²) and Monteverde forest (101.81 km ²). Structures
7	WUI, urban, wildland or informal settlement fires?	WUI
8	Average weather conditions	Heat waves coming from Saharan coastline, temperature in high 30°C (reaching 40°C), relative humidity in 10-20% with strong winds, driest winter in past 70 years
9	Geographical highlights	Mountainous terrain with uphill and downhill slope
10	Was there any fire break? (natural or artificial)	Roads, rivers, lakes were present as natural fire breaks
11	Did the Fire Service report extreme fire behaviour?	The fire reported to be of high severity and classified by local authority as level 2 fire
12	Number of structures and infrastructures affected (damaged)	More than 63 structures were damaged in Valle Gran Rey and most of the evacuees did not have a home to return
13	Estimated direct and indirect economic damage	Damage to homes, infrastructure and forest areas has been valued at over € 71 million (US\$ 92.3million)
14	Did it occur in conjunction with multiple fires in the country?	Yes, in La Gomera and Tenerife; both in Canary Islands.
15	Countries involved	Spain

16	Brief timeline of the key events	<p>The wildfires and forest fires in the Canary island began on the 4th of August, spread later in the month and fanned by hot winds, spread to a large area of the island. About 11% of the whole island was severely affected and 18% of the national park was damaged or destroyed. Over 100 houses were partially or totally burned down, most of them in the upper part of the Valle Gran Rey district. Thousands of people were evacuated and spent time in shelters.</p> <p>While the investigation into the cause of the fires is still ongoing, it is accepted that arson was behind the first three fires that erupted in different locations within a very short time span (a local history of arson was also noted). The extreme weather conditions with hot, dry and strong winds after an almost rainless previous year aided the development of the fire. This culminated in a most dangerous 'thermal inversion' in the upper part of Valle Gran Rey that trapped the hot, smoky air from the forest fires with a hot, dry wind. The wind also blew sparks in the deep and narrow part of the valley devastating some places in a very short time. Delayed access from the Spanish mainland in conjunction with eight wildfires on mainland Spain at the time of the request from the Canary island (three days after the ignition of fire) contributed to the delayed arrival of resources. About half of the people were evacuated via ships and boats as roads and highways were cut-off.</p>
17	Time of initial order to evacuate and locations	People hurriedly evacuated as authorities had underestimated the potential of fire on August 8 th and change the severity of fire to level 2 on August 10 th
18	Time when evacuation was considered completed	Few hours before fire the arrived at the WUI, and a few minutes when the severity of fire changed on August 10 th
19	Deaths/Injuries	0 deaths and no serious injuries, no information available on other injuries
20	The number of people evacuated	~5000 (~2500 people were evacuated via boat as roads were cut off by fires)
21	The location people initially evacuated	No information available
22	Reasons why people decided to evacuate	Informed by emergency and police personnel by cars, radio
23	Evacuation type	Evacuated via boats, and roads
24	Any drill/education/instructions on large outdoor fires provided beforehand?	No information available

25	Personnel involved in rescue operations	<p>Police and emergency services</p> <p>Firefighters-</p> <ul style="list-style-type: none"> ● 6 planes ● 7 helicopters ● 1 BRIF (military) ● 2 ships <p>Unknown no. of firefighters and fire brigades</p>
26	Did the smoke hindered significantly the evacuation because of low visibility or health problems	No information available but dense smoke visible is seen in the video and images affecting the fire personnel
27	Possible causes of issues in management operations	Delay in sending firefighters from the Spanish mainland (three days after the start of fire and request) while there were eight other wildfires in the Spanish mainland at the same time
28	References	<p>Scientific literature:</p> <p>1) del Arco Aguilar, M.-J., González-González, R., Garzón-Machado, V., & Pizarro-Hernández, B. (2010). Actual and potential natural vegetation on the Canary Islands and its conservation status. <i>Biodiversity and Conservation</i>, 19(11), 3089–3140.</p> <p>Websites:</p> <p>2) http://www.itv.com/news/2012-08-13/fierce-wildfires-force-evacuations-across-canary-islands-of-la-gomera-and-tenerife/</p> <p>3) Fiona Govan, Canary Islands wildfires lead to evacuation of 5,000 people, <i>The Telegraph</i>, August 12, 2012 at http://www.telegraph.co.uk</p> <p>4) Fiona Govan, Canary Islands fire threatens UNESCO heritage site, <i>The Telegraph</i>, August 6, 2012 at http://www.telegraph.co.uk</p>
29	Name/Surname/Email/Date of who filled in this template	Ronchi, E., Rein, G., Gwynne, S., Wadhvani, R., Intini, P., & Bergstedt, A. (2017). e-Sanctuary: Open Multi-Physics Framework for Modelling Wildfire Urban Evacuation. Quincy, MA (USA)

13. Laerdalsoyri fire (Norway), 2014

Norway has a rich tradition with respect to wooden constructions. Unlike most of Europe, Norway did not until the early 1900s change its building regulations to make stone buildings mandatory in urban areas. Thus, there is still around 180 urban areas with well-preserved dense wooden houses from the years 1700 to 1900. One of this being Lærdal, a fjord, valley and mountain community of 2200 inhabitants in Western Norway,

Saturday night, January 18th, 2014, a private villa, 80 m from the fire station, caught fire. 40 buildings, including 4 cultural heritage buildings, were lost in the fire, which was the largest fire in Norway since World War II. During the fire, assistance from 14 neighbour fire brigade units, including units from Bergen, the civil protection forces and the armed forces were mobilized to control the conflagration. This was achieved just as the fire had penetrated into the historical village [1].

The fires spread extremely quick to neighbouring houses to the east and west. The fire fighters reported massive production of glowing embers as well as airborne red glowing metal roof plates, representing a deadly threat to the fire fighters. Glowing metal plates hit fire hoses, melted through and cut their water [1].

During the fire, several smaller wild fires were ignited in the steep valley sides. As these did not possess any threat to people or structures, they were left unattended during the night in order to focus on preventing the main fire from penetrating into the dense heritage centre. The wild fires were extinguished by helicopters during daylight on the second day of the fire.

The Lærdal valley is generally a dry area. Additionally, there was much less precipitation than normal prior to the fire. It is shown by Professor Torgrim Log that air from surrounding mountains blowing into the valley prior to the fire was adiabatically heated to low levels of relative humidity. This dried out the wood and resulted in severe fire development. Strong shifting winds spread the fire to neighbouring structures and over long distances (200 m) [1]

1	Where?	Lærdal, Norway
2	When?	<ul style="list-style-type: none"> ● Fire reported 22:53 18. January 2014. ● Evacuation process started at 23:31 18. January 2014. ● Last fires extinguished during 20. January.
3	How was the fire started?	House fire
4	Initial fire size	Initially a house fire in a small residential house.
5	Area affected (burned area)	100 000 m ² urban area Total 350 000 m ²
6	Fuels involved in the fire	Heather and shrublands. Structures
7	WUI, urban, wildland or informal settlement fires?	Urban fire, started in urban area and spread within urban area and to nearby Shrublands.
8	Average weather conditions	Adiabatically heated (low humidity) air from surrounding high mountains gave outdoor wood fuel moisture content (FMC) of about 7.6%. Inside inhabited buildings, it is shown that the wooden products reached about 4.5% FMC prior

		<p>to the blaze [1]. Strong shifting winds of at least 22 m/s during the fire.</p> <p>The storm strength wind occasionally eased off and suddenly changed 180 degrees direction followed by full strength in the new direction. The horizontal flames, up to 20 m to 30 m length and shifting ± 180 degrees represented a serious threat to the fire fighters. They frequently had to reorganize according to the shifty wind seriously hampering their efforts to control the fire. Such wind shifts are common in Lærdalsøyri in strong easterly gradient winds [2].</p>
9	Geographical highlights	Town situated in a valley surrounded by steep mountains to the north and south, overlooking a fjord to the west.
10	Was there any fire break? (natural or artificial)	A large open sports ground of 190 meters was thought by the fire department to act as a fire break but firebrands skipped the field and ignited hoses on the opposite side.
11	Did the Fire Service report extreme fire behaviour?	Extreme firebrand showers, spot fires in wood, 20-meter-long horizontal flames from burning houses.
12	Number of structures and infrastructures affected (damaged)	40 structures burned down including 17 residential houses. Telecommunications station burned down leaving the fire site without cell phone coverage.
13	Estimated direct and indirect economic damage	15 million euros in loss
14	Did it occur in conjunction with multiple fires in the country?	No.
15	Countries involved	Norway (help from several municipalities)
16	Brief timeline of the key events	<p>18. January 2014</p> <p>22.53: Fire reported</p> <p>22.54: Fire service dispatched. Subsequent notification to police, emergency medical and local power company.</p> <p>22.59: Fire service on scene.</p> <p>23.00: Fire starting to spread to adjacent house.</p> <p>23.00: The municipal crisis team is established.</p> <p>23.08: Neighbouring fire service notified.</p> <p>23.13: first police patrol on scene and takes the task as operation leader.</p> <p>23.15-23.21: Neighbouring fire service sends 3 trucks and 9 firefighters.</p> <p>23.12: Neighbouring fire service dispatched.</p> <p>23.29: The Civil Defence is notified and is given the task of establishing alternative water supply.</p> <p>23.30: The Red Cross and Norwegian People's Aid assists is notified.</p>

	<p>23.31: Police starts notification of residents in the centre with audio and light signals</p> <p>23.37: Another Neighbouring fire service notified and dispatched. At the same time helicopters are requested.</p> <p>23.39 The Red Cross and Norwegian People's Aid assists (volunteer organisations) starts assisting the police with the evaluation work.</p> <p>23.40: The municipality established crisis management staff.</p> <p>00.01: Local farmers starts assisting the fire service by using manure spreaders filled with water.</p> <p>23.53: Full alert is sent to neighbouring fire service.</p> <p>19. January 2014</p> <p>00.05: A third nearby fire service is notified and dispatched (full alert/all available firefighters)</p> <p>00.29: The Civil Defence arrives.</p> <p>00.30: fire spreading between multiple houses. It is discovered that the fire has spread across the local sports ground, 190 meters.</p> <p>00.32: A power out occurred. It turned out afterwards that the secondary power station was burnt out inside and that it would take a long time for this to be replaced.</p> <p>00.40-01.10: The Civil Defence establishes alternative water supply.</p> <p>00.50: Bergen fire department (nearest big city) is requested to help. Its located 4 hours' drive away.</p> <p>01.17: Bergen fire department asked to clarify how many people to send.</p> <p>01.47: The regional alarm centre notes that the situation in Lærdal is chaotic and that they are requesting managerial support. They also reported problems with the communication connection and that there was a great need for a water tanker.</p> <p>01.50: alternative water supply is reinforced.</p> <p>02.08: it is discovered that a mobile base station had burned down and that the mobile connection was out of operation.</p> <p>02.13: A fire truck from the nearest airport was sent to larval.</p> <p>04.00: Bergen fire department sends satellite phones to Lærdal.</p> <p>04.20-04.40: Two more fire services are dispatched.</p> <p>05.00-06.00: The wind decreases allowing the multiple fire services to gain some control of the fire. A building ignited at 05.30 is the last to burn down.</p> <p>08.40: some firefighters are sent home.</p>
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		<p>10.03: 2 Helicopters arrives to assist in the firefighting.</p> <p>13.03: Some fires are burning in the surrounding vegetation.</p> <p>15.47: The situation is under control.</p> <p>20. January 2014</p> <p>During the night to the 20. January small fires in the surrounding vegetation are being put out and the area is being watered to mitigate new fires.</p>
17	Time of initial order to evacuate and locations	23.31 (18. January 2014)
18	Time when evacuation was considered completed	Unknown.
19	Deaths/Injuries	0 Deaths.
20	The number of people evacuated	680
21	The location people initially evacuated	
22	Reasons why people decided to evacuate	At least 1 nursing home was threatened to be evacuated. A warm bus was standing by in case evacuation became necessary.
23	Evacuation type	Mode of transport and procedure employed.
24	Any drill/education/instructions on large outdoor fires provided beforehand?	Unknown
25	Personnel involved in rescue operations	<p>Police, red cross volunteers, fire department.</p> <p>In taking care of the evacuated the following was involved: A pre-planned crisis team consisting of the municipal head doctor, nurse, psychiatric nurse, priest, environmental therapist in the school, police and child welfare officer</p>
26	Did the smoke hindered significantly the evacuation because of low visibility or health problems	Investigations does not mention this.
27	Possible causes of issues in management operations	<ul style="list-style-type: none"> ● Police understaffed to take care of evacuation. Received support from volunteers. The registration of evacuated people was conducted by hospital employees and not the police. This led to different systems being used and the number of evacuated people was unclear at times. ● Several people refused to evacuate and contributed significantly to the firefighting. ● During the fires, the emergency management was taken care of by both fire and police, and there are examples of it, at times, being unclear who actually led the operation. <p>Many learning point following the fire</p>
28	References	

		<p>T. Log, "Cold Climate Fire Risk; A Case Study of the Lærdalsøyri Fire, January 2014," Springerlink.com, 2015.</p> <p>"Johnsgård G (2014) What can we learn from Lærdal, Brannfaglig Fellesorganisasjon (BFO), Spring Seminar 3–4 April 2014, Qality Airport Hotel, Gardermoen".</p> <p>PwC - PricewaterhouseCoopers AS, "Evaluering av brannene: Lærdal, Flatanger og Frøya," Justis- og beredskapsdepartementet, 2014.</p> <p>Direktoratet for samfunnssikkerhet og beredskap (dsb), "Brannene i Lærdal, Flatanger og på Frøya vinteren 2014," 2014.</p>
29	Name/Surname/Email/Date of who filled in this template	Martin Kristoffersen. 28th may 2019.

14. Madeira Island fire (Portugal), 2016

The Madeira island fire occurred on 8th August 2016 in a vegetation which consists of maritime pines, acacia, eucalyptus, softwoods/broadleaved, bushes, and herbaceous plants, laurel forest. The severe weather condition of strong wind, high temperature and very low humidity supported the propagation of fire causing losses equal to €61million (or US\$70million) just in Funchal.

1	Where?	Madeira island (Portugal): Câmara de Lobos, Ribeira Brava, Ponta do Sol, Calheta, and the regional capital of Funchal
2	When?	08/08/2016-13/08/2016
3	How was the fire started?	Suspected Arson
4	Initial fire size	Multiple fires detected in the forest areas. First started at Alegria in Sao Roque (highlands of Funchal) in the border with the semi-urban part of the city. In Calheta there were two fronts starting on 09/08 both in the forest and threatening WUI areas. Fire fronts started also in Ponta do Sol and Ribeira Brava on the 08/08.
5	Area affected (burned area)	79.40 km ² (based on Copernicus European Programme)
6	Fuels involved in the fire	Maritime pines, acacia, eucalyptus, softwoods/broadleaved, bushes, and herbaceous plants, laurel forest.
7	WUI, urban, wildland or informal settlement fires?	WUI fire
8	Average weather conditions	Winds reaching 90 km/h, air humidity of 10%, Max temperature approximately of 38 °C (avg. 30 °C)
9	Geographical highlights	Madeira island has an area of 741 km ² , a length of 57 km and a coastline of 150 km. A mountain ridge is present that extends along the centre of the island up to 1862 m of height. The mountainous terrain goes from 520 m to 1818 m in elevation over a short distance creating challenges to fire-fighting activities.
10	Was there any fire break? (natural or artificial)	River Fundoa
11	Did the Fire Service report extreme fire behaviour?	Burning embers were swept along by strong winds. Multiple fronts where occurring, one in Calheta and another in Paul da Serra.
12	Number of structures and infrastructures affected (damaged)	300+ homes destroyed – 1 hotel, 1 restaurant in Ponta do Sol, blocked motorways, 2 hospitals.
13	Estimated direct and indirect economic damage	Estimated €61million damage just in Funchal (US\$70million), of which €36 million are for 300 private buildings, €25 million are for damages in municipal infrastructure.
14	Did it occur in conjunction with multiple fires in the country?	Yes

15	Countries involved	National, EU Civil Protection mechanism alerted
16	Brief timeline of the key events	On Monday, 08/08, 2016, at 15:30, a fire was detected in a bush area and forest at an altitude of 600 meters. Temperature was 37° C, winds up to 70 km/h and low humidity. During the night between 08/08 and 09/08, strong winds spread the fire to the area of Sao Roque to the edges of Fundoa River, to the Park of Funchal and the area of Monte On the morning of 09/08 234 people were evacuated from the Hospital of Marmoles along with 200 people. On the 09/08 the fire approaches Funchal.
17	Time of initial order to evacuate and locations	At the end of the night of the 08/08, 600 people were evacuated from Santo Antonio following 36 burnt houses and 2 serious injuries and 1 death in addition to the evacuated Hospital.
18	Time when evacuation was considered completed	At the end of the night of the 08/08, 600 people were evacuated from Santo Antonio following 36 burnt houses and 2 serious injuries and 1 death in addition to the evacuated Hospital.
19	Deaths/Injuries	3 (elderly people whose homes caught fire)/372
20	The number of people evacuated	1000+ of which 234 patients were evacuated from the small hospital of Marmeleiros. 200+ people evacuated from the Regimento de Guarnição
21	The location people initially evacuated	No information available
22	Reasons why people decided to evacuate	Ordered by local authorities
23	Evacuation type	Ordered and spontaneous.
24	Any drill/education/instructions on large outdoor fires provided beforehand?	No information available but firefighters involved would have been trained in combating fires as 110 emergency personnel included 36 special force professionals
25	Personnel involved in rescue operations	110 emergency service personnel (of which special force of 36 professionals)
26	Did the smoke hindered significantly the evacuation because of low visibility or health problems	Yes
27	Possible causes of issues in management operations	Underestimation of the situation (statement of situation under control at 16:00 of the 09/08 was false and contradicted in the evening of the same day)
28	References	Scientific literature: Navarro, G., Caballero, I., Silva, G., Parra, P.-C., Vázquez, Á., & Caldeira, R. (2017). Evaluation of forest fire on Madeira Island using Sentinel-2A MSI imagery. International Journal of Applied

		<p>Earth Observation and Geoinformation, 58, 97–106. https://doi.org/10.1016/j.jag.2017.02.003</p> <p>Websites:</p> <p>Lusa, Mil deslocados e pelo menos três mortos nos incêndios da Madeira, Diário de Notícias, August 10, 2016 at www.dn.pt</p> <p>Jorge Freitas Souse, Rubina Leal lembra condições meteorológicas de "catástrofe" e "mão criminosa" nos incêndios, Diário de Notícias Madeira, August 10, 2016, at http://www.dnoticias.pt</p> <p>Catherine Hardy, Wildfires lay waste to mainland Portugal and Madeira, Euro news, August 9, 2016 at http://euronews.com</p> <p>Madeira wildfires: Three dead as flames reach Funchal, BBC news at bbc.com</p> <p>Laura Connor, what caused the Madeira fire? Portugal authorities blame high temperatures but man arrested for arson, August 10, 2016, at http://www.mirror.co.uk</p> <p>Andrei Khalip and Silvio Castellanos, Forest fires ravage mainland Portugal, Madeira calmer after deaths, August 11, 2016 at www.reuters.com</p>
29	Name/Surname/Email/Date of who filled in this template	<p>Ronchi, E., Rein, G., Gwynne, S., Wadhvani, R., Intini, P., & Bergstedt, A. (2017). e-Sanctuary: Open Multi-Physics Framework for Modelling Wildfire Urban Evacuation. Quincy, MA (USA)</p>

15. Pigeon Valley fire (New Zealand), 2019

The Pigeon Valley wildfire was the latest wildfire in New Zealand since 1955. This wildfire coincided with multiple other wildfires known as “2019 Nelson fires”. The Pigeon Valley wildfire forced three thousand residents of Wakefield to evacuate.

1	Where?	Pigeon Valley Wildfire, Nelson, New Zealand
2	When?	5 February 2019 – 6 March 2019
3	How was the fire started?	Arson
4	Initial fire size	Farm paddock
5	Area affected (burned area)	More than 2,400 ha
6	Fuels involved in the fire	Pine forest
7	WUI, urban, wildland or informal settlement fires?	Wildland fire
8	Average weather conditions	Temperature between 12C and 22C and no rain.
9	Geographical highlights	Several hills shaping a valley
10	Was there any fire break? (natural or artificial)	NA
11	Did the Fire Service report extreme fire behaviour?	NA
12	Number of structures and infrastructures affected (damaged)	Several houses have been lost
13	Estimated direct and indirect economic damage	Loss of NZD 2 million a day for the timber industry. Fighting the fire costs NZD 2 million
14	Did it occur in conjunction with multiple fires in the country?	The 2019 Nelson fires were wildfires in Nelson and Tasman District, New Zealand. Two separate fires, twenty kilometres apart, started on the afternoon of 5 February 2019. Several other smaller fires started several weeks after the main fires.
15	Countries involved	New Zealand
16	Brief timeline of the key events	<p><u>Tuesday 5 February 2019</u></p> <ul style="list-style-type: none"> ○ 14.10 (approximately) - The Pigeon Valley Fire ignited in Pigeon Valley and quickly developed on farmland (see Figure 1.1). ○ 14.15 - The alarm was given by a call to the 111-emergency call. ○ 16.52 - Police were handling evacuations in the Eves Valley and the ridge of Teapot Valley as the properties located within these areas were at risk. ○ 17.15 - Residents from over 100 properties within Pigeon Valley received the mandatory order to evacuate or evacuated before receiving official notice from authorities.

		<ul style="list-style-type: none"> ○ 22.09 - Redwood Valley residents were ordered to evacuate. <p><u>Friday 8 February 2019</u></p> <ul style="list-style-type: none"> ○ 13.00 - Wakefield residents were ordered to evacuate. <p><u>Monday 11 February 2019</u> - Wakefield residents were allowed to return.</p> <p><u>Thursday 14 February 2019</u></p> <ul style="list-style-type: none"> ○ 08:00 - residents in some parts of Pigeon Valley were allowed to return. <p>Phased return of other valley residents occurred over the next week.</p> <p><u>Friday 22 February 2019</u> - Conditional re-entry of the last remaining evacuated.</p> <p><u>Monday 25 February 2019</u> - All cordons were lifted.</p>
17	Time of initial order to evacuate and locations	5 th of Feb, 4pm
18	Time when evacuation was considered completed	9 th of Feb
19	Deaths/Injuries	No deaths reported. Unknown injuries data
20	The number of people evacuated	3000 residents of rural area and Wakefield
21	The location people initially evacuated	No information
22	Reasons why people decided to evacuate	Mandatory order to evacuate
23	Evacuation type	Predominately ground transport by private vehicles
24	Any drill/education/instructions on large outdoor fires provided beforehand?	Unknown
25	Personnel involved in rescue operations	Fire and Emergency NZ, NZ Civil Defence and Police
26	Did the smoke hindered significantly the evacuation because of low visibility or health problems	Unknown
27	Possible causes of issues in management operations	Unknown
28	References	AFAC. (2019). A review of the management of the Tasman fires of February 2019. Retrieved from https://fireandemergency.nz/assets/Documents/Research-and-reports/Tasman-Fires/Tasman-Fires-Review-2019.pdf

		MCDEM. (2019). Tasman District Fire Response 5 – 27 February 2019 Post-Event Report. Retrieved from https://www.civildefence.govt.nz/assets/Uploads/publications/post-event-report-Tasman-District-Fire-Response.pdf
29	Name/Surname/Email/Date of who filled in this template	Rino Lovreglio r.lovreglio@massey.ac.nz 17/11/2020

16. Nuns fire (USA), 2017

The Nuns Fire in October 2017 was a destructive wildfire that severely impacted Sonoma and Napa counties in Northern California. The Nuns Fire ignited in the community of Glen Ellen due to a downed tree on a powerline conductor. With poor weather conditions and challenging terrain, the fire spread quickly into the wildland-urban interface. Following the original outbreak, multiple additional fires ignited in the area surrounding the Nuns Fire. These fires would eventually merge into the Nuns Fire. The Nuns Fire also coincided with multiple other wildfires – particularly the Atlas, Tubbs, and Pocket Fires – which are collectively known as the 2017 October Northern California Wildfires. Evacuation orders were issued across Sonoma County including the communities of Glen Ellen, Kenwood, Oakmont, Sonoma, Rohnert Park, and Santa Rosa. Evacuations caused severe congestion along multiple two-lane roads in the area. However, the slower spread of the fire allowed officials to proactively issue evacuation orders. After a week of growth and gradual containment, the Nuns Fire was fully contained in late October.

Over 100,000 people were ordered to evacuate from the 2017 October Northern California Wildfires. The Nuns Fire impacted multiple communities and it is estimated that around 30,000 people were ordered to evacuate from the Nuns Fire. The Nuns Fire destroyed 1,355 structures and killed three people. With multiple fires across the Northern California area, firefighting resources were spread extremely thin, leading to slow response against all fires in the region. Additional details are provided below.

1	Where?	Sonoma County, Napa County, California, USA
2	When?	10/8/2017 – 10/31/2017
3	How was the fire started?	Strong winds knocked a tree into a powerline conductor
4	Initial fire size	Unknown
5	Area affected (burned area)	56,556 acres
6	Fuels involved in the fire	Hardwood woodland and shrub land vegetation with grassland, some coniferous forest, and agriculture land (mostly viticulture), structures
7	WUI, urban, wildland or informal settlement fires?	WUI fire, Glen Ellen, Kenwood, Oakmont, Sonoma, Rohnert Park, Santa Rosa
8	Average weather conditions	Warm temperatures, low humidity, high winds especially along ridge lines; Red Flag Warning; gusts in the region reaching 70 mph in some locations
9	Geographical highlights	Mountain range with steep drainages and canyons; heavily wooded area surrounded by viticulture; multiple roads with only one exit for evacuations
10	Was there any fire break? (natural or artificial)	Highway 12, Pressley Rd, Crane Canyon Rd., Bennett Valley Rd., Highway 138
11	Did the Fire Service report extreme fire behaviour?	Red Flag Warning, rapid fire development spreading erratically, multiple fires in the Nuns Fire area merged
12	Number of structures and infrastructures affected (damaged)	1,355 destroyed, 172 damaged
13	Estimated direct and indirect economic damage	\$15 billion in direct damages across all 2017 October Northern California Wildfires

14	Did it occur in conjunction with multiple fires in the country?	<p>Five large fires burning simultaneously in Northern California in October (Atlas, Partrick, Nuns, Tubbs, Pocket) with multiple smaller fires, which are collectively known as the 2017 October Northern California Wildfires. The Atlas, Partrick, and Nuns are collectively known as the Southern LNU Complex. Later, the Noorbom, Adobe, and Pressley Fire would merge with the Nuns Fire and were included in the Southern LNU Complex. The Nuns Fire and associated fires would be reclassified again as the Central LNU Complex. The Tubbs and Nuns Fires most directly impacted residences and were the most destructive of the fires. With all fires igniting within a few hours, firefighting was severely hampered and communication with residents and across agencies was challenging.</p>
15	Countries involved	United States
16	Brief timeline of the key events	<p>October 8 - 10:00 pm: Nuns Fire ignites from a downed tree on a powerline conductor near the Glen Ellen area</p> <p>October 9 - 12:00 am: Officials consider evacuating nearby Kenwood</p> <p>October 9 - 3:15 am: A mandatory evacuation order is issued for Kenwood</p> <p>October 9: Nuns Fire spreads rapidly in multiple directions, leading to additional evacuation orders for Kenwood and Glen Ellen; officials institute contraflow on Highway 12 to handle evacuation congestion</p> <p>October 10: Fire reaches 5,000 acres and with no containment; mandatory evacuation orders are given for multiple roads in Sonoma County extending into the city of Sonoma; advisory evacuation orders are issued for parts of Sonoma; evacuation orders are issued for Oakmont</p> <p>October 11 - 7:00 am: Fire grows to 7,600 acres; nearby fires including the Partrick, Norrbom, Adobe, and Pressley account for an additional 20,000 acres</p> <p>October 11: Additional evacuation advisories are issued for the city of Sonoma; fire surrounds Oakmont, prompting evacuations</p>

		<p>October 12: Fire continues to spread including some growth toward Napa County</p> <p>October 13: Most fires surrounding the Nuns Fire (Partrick, Norrbom, Adobe, Pythian) combine to form a single large fire; fire forces additional evacuations from Oakmont as well as the edges of Santa Rosa</p> <p>October 14 - 4:30 am: Mandatory evacuation orders are issued for parts of downtown Sonoma with fire threatening to overtake the town</p> <p>October 14 - 7:00 am: Nuns fire (with combined fires) reaches 46,000 acres with just 10% containment; overnight winds push the fire towards Santa Rosa and Oakmont to the northwest and Sonoma to the southeast</p> <p>October 15 - 7:00 am: Nuns fire holds at 47,000 acres with 25% containment</p> <p>October 16 - October 19: Nuns fire grows minimally and containment grows; repopulation begins and road closures are lifted</p> <p>October 20: Limited re-entry is allowed in destroyed areas</p> <p>October 21 - October 30: Containment grows with improving conditions</p> <p>October 31: The Nuns Fire is 100% contained</p>
17	Time of initial order to evacuate and locations	<p>Begin: 10/8/17 - Orders are issued for Glen Ellen and Kenwood at 3:15 am</p> <p>Additional: 10/9/17 to 10/14/17 - Orders are issued across the WUI including Sonoma, Oakmont, and Santa Rosa</p>
18	Time when evacuation was considered completed	End: 10/23/17 - Most mandatory evacuation orders are lifted for residents and re-entry is allowed in damaged areas
19	Deaths/Injuries	3 deaths
20	The number of people evacuated	100,000 people ordered to evacuate across all 2017 October Northern California Wildfires (note: required moderate number of evacuations, approximately 30,000)
	The location people initially evacuated	Additional data required

21	Reasons why people decided to evacuate	Additional data required
22	Evacuation type	Predominately ground transport by private vehicles
	Any drill/education/instructions on large outdoor fires provided beforehand?	No information available
23	Personnel involved in rescue operations	<p>Unified Command: Cal Fire</p> <p>Cooperating Agencies: Santa Rosa PD, Sonoma County OES, Sonoma County Sheriff's Office, CAL OES, CHP, Caltrans, and CA National Guard. Napa County OES, Napa County Sheriff's Office, Lake County Sheriff's Office, Lake County OES, Calistoga City Fire, California Conservation Corp.</p> <p>Total fire personnel: +3,000 (may include personnel from other fires)</p> <p>Total fire engines: +300 (may include engines from other fires)</p>
24	Did the smoke hindered significantly the evacuation because of low visibility or health problems	Significant smoke in the area that caused severe health issues; smoke from the 2017 Northern California Wildfire severely impacted the San Francisco Bay Area, leading to extremely unhealthy air quality for weeks; AQI over 400 in Napa, rising to just below 200 in San Francisco and Oakland, and hitting 150 in Gilroy (over 100 miles away)
25	Possible causes of issues in management operations	<p>Evacuations: Due to the slower spread of the Nuns Fire, officials were able to issue more deliberate evacuation orders. However, evacuation orders near the beginning were issued several hours after discussion of these orders. Significant traffic along Highway 12 led officials to institute contraflow towards Sonoma and Santa Rosa.</p> <p>Firefighting: The Nuns Fire threatened and impacted multiple developed neighbourhoods along the WUI. Multiple additional fires broke out in the area, later merging with the Nuns Fire. The fluid situation challenged firefighters regarding resource deployment. Moreover, the outbreak of multiple fires in the region made firefighting difficult and spread resources thin.</p>
26	References	<p>Academic:</p> <p>Nauslar, N. J., Abatzoglou, J. T., & Marsh, P. T. (2018). The 2017 North Bay and Southern California Fires: A Case Study. <i>Fire</i>, 1(1), 18. https://doi.org/10.3390/fire1010018</p>

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27	Name/Surname/Email/Date of who filled in this template	Stephen Wong/stephen.wong@berkeley.edu 6/8/19

17. Okanagan Mountain Park fire (Canada), 2003

The Okanagan Mountain Provincial Park wildfire began on August 16, 2003. It was ignited by overnight lightning on a steep slope within the very rugged and largely roadless 10,000 hectares Okanagan Mountain Park and spread approximately 12-15 kilometres North-West to the outskirts of Kelowna, British Columbia. It grew to 26,600 hectares (266 km²) before being extinguished nearly 30 days later. Most home losses occurred within the first seven days. In the year of 2003, many wildfires burned in British Columbia (BC) with at least 50 fires that threatened urbanised areas. Many large fires were still burning in BC at the time of the Kelowna disaster. At Kelowna, the wildfire spread through several outlying rural areas along Lakeshore Road on the outskirts of the city before directly impinging upon the recently developed subdivisions of Crawford, Mission Hills, and Mission Estates within the city limits.

Kelowna is in one of the hottest and driest areas of British Columbia. The province at the time had recently suffered from a three-year drought increasing the likelihood of fire occurrences. The terrain in the affected area was challenging (gullied, rolling hills and multiple drainages). The affected private properties were located on a 10% – 20% northwest facing slopes close by to Okanagan Lake. The affected area included mature forest underlain by dense thickets of conifers and shrubs. Maximum temperatures during the disaster period ranged from 25-30°C, while humidity varied from 17 - 38% with winds at 7 - 33 km/h.

The subdivisions of Crawford, Mission Hills, and Mission Estates are located on the outer southeast margin of Kelowna. They were new areas including pockets of underdeveloped housing, natural vegetation, parks, steep terrain, gullies with housing largely bounded by natural grassland and open forest; i.e. WUI interface and intermix conditions. The housing examined was typically single large plots or small clusters of houses representing middle to upper-class housing.

238 private homes were destroyed in the City of Kelowna and on nearby acreages during the 2003 wildfire. Within the city, the majority of these losses occurred in a few, relatively large clusters of homes as the wildfire spread to the northeast and across the slopes above Okanagan Lake.

1	Where?	Okanagan Mountain Park Fire (surrounding City of Kelowna, population 115,000)
2	When?	16/07/2003 – 16/08/2003
3	How was the fire started?	Lightning Strike on a steep slope
4	Initial fire size	0.15 km ²
5	Area affected (burned area)	270 km ²
6	Fuels involved in the fire	Vegetation near Kelowna is dominated by dry grasslands and open ponderosa pine forest. Denser Douglas-fir/pine forest occurs at upper elevations and in shaded drainages. In the area, mature forest is often underlain by dense thickets of conifers and shrubs. At the time of the fire, virtually all grass was fully cured.
7	WUI, urban, wildland or informal settlement fires?	WUI, affected new developments of Crawford, Mission Hills, and Mission Estates within the city limits.
8	Average weather conditions	Maximum temperatures during the multi-day disaster ranged from 25-30°C. while humidity varied from 17 - 38% with winds at 7 - 33 km/h.

9	Geographical highlights	Parkland / Rural. The terrain in the affected area included gullied, rolling hills and multiple drainages. The affected private properties were located on gentle to moderately steep (i.e. 10% – 20%) northwest facing slopes close by to Okanagan Lake. Homes situated within high density urban areas, as well as homes situated on outlying acreages, were destroyed.
10	Was there any fire break? (natural or artificial)	Only the lake itself.
11	Did the Fire Service report extreme fire behaviour?	Firestorm
12	Number of structures and infrastructures affected (damaged)	238 homes, lodges and B&B operations
13	Estimated direct and indirect economic damage	C\$34 million (US\$27 million) / C\$100 million (US\$79 million) (including loss of historic railway sites, trestles, tourist park). Long-term impacts included loss of tourism, reported spike in respiratory diseases
14	Did it occur in conjunction with multiple fires in the country?	At the time, a large number of wildfires burned in British Columbia with at least 50 fires that threatened urbanized areas.
15	Countries involved	Canada
16	Brief timeline of the key events	<ul style="list-style-type: none"> - August 16: 0155 Lightning strike ignited a fire 15 km SE of the City of Kelowna in the Okanagan Mountain Park. - 0158: First 911 call received. 0800: Emergency Operations Centre (EOC) activated. First evacuation alerts issued for southern most residences of Kelowna. - August 17: Fire reached 4 km to closest homes / 6 km from the City of Kelowna. - August 18: Fire fighting continued. Further evacuation orders and alerts issued. - August 19: Fire affected two communications towers. Unified Command Structure created, fire set to enter the City of Kelowna. - Further evacuation orders issued. - August 20: Fire reached 11,000 ha in size, and consumed 95% of the Okanagan Mountain Park. Province wide restrictive travel advisory declared prohibiting entrance into back-country areas. City of Kelowna informed provincial fire authorities of intention to construct a large fire guard to help protect the City. - August 21: Unified Command set up between fire and emergency authorities and the City of

		<p>Kelowna as fire approached the City. Fire reaches 13,000 ha in size.</p> <ul style="list-style-type: none"> - August 22: OMPF approached City limits, exacerbated by high winds, and pushes through Kelowna neighbourhoods. 3000 residents evacuated at this point. 21 structures lost overnight. Wildfire and structural fire fighters worked to save structures threatened by the fire. “Structural triage” considered to limit overall losses. - August 24: Prime Minister tours affected areas. Evacuated residents informed of which homes were destroyed. - August 26: Tour for residents of Crawford Estates who lost their homes. - August 28: Ramping down of EOC, further tours for residents who lost their homes. Information forum held for affected residents. Many evacuation orders were rescinded, new evacuation orders for areas at risk as the fire moved north towards the June Springs Road area. - August 30: Evacuation order lifted for Naramata. - September 3 EOC activated to handle emergency as fire moves toward another part of the city (June Springs Rd. area). Two trestles in the Kettle Valley Railway national historic site are destroyed by the fire - September 4 Fire reaches 22,840 ha. - September 5 Six more Kettle Valley Railway trestles destroyed. - September 15 Province-wide state of emergency lifted. <p>September 16 Fire contained.</p>
17	Time of initial order to evacuate and locations	August 16 th .
18	Time when evacuation was considered completed	Primary residential evacuation alerts August 19 th , evacuation of June Springs Road August 28 th , order lifted on August 30 th . State of emergency lifted September 15 th .
19	Deaths/Injuries	3 Fatalities. Responder air crashes.
20	The number of people evacuated	26000 residents
21	The location people initially evacuated	As on Aug. 16 at 01:58 - First evacuation alerts issued for southern most residences of Kelowna.
22	Reasons why people decided to evacuate	Mandatory order by local authorities
23	Evacuation type	Primarily ground transport by private vehicles. Assistance provided by emergency services (e.g.

		ambulances) and commercial entities (e.g. commercial airlines).
24	Any drill/education/instructions on large outdoor fires provided beforehand?	Canadian fire services are trained quite well for this so would have multiple training beforehand.
25	Personnel involved in rescue operations	Local, Provincial and Federal resources. 686 personnel, 176 pieces heavy equipment (industrial diggers, transport, tankers, etc.) 18 helicopters
26	Did the smoke hindered significantly the evacuation because of low visibility or health problems	High winds and dry conditions hampered crew (likely including the effect of smoke).
27	Possible causes of issues in management operations	The number of agents managing the response, differences in their preparedness and resources, lack of designated contact points within organisations, and a standardised communication protocol.
28	References	<p>Scientific literature:</p> <p>Sandink, D. (2008). The resilience of the City of Kelowna: Exploring mitigation before, during and after the Okanagan Mountain Park Fire. Institute for Catastrophic Loss Reduction.</p> <p>Cash, P, Daviss, L, Kurtz, D, van den Tilaart, S, Health, Safety and Workload Challenges of the Okanagan Mountain Fire 2003, University of British Columbia Okanagan, 2005</p> <p>Websites:</p> <p>Daily Data Report for September 2003, Kelowna, British Columbia at http://climate.weather.gc.ca</p> <p>Okanagan mountain park fire update at http://bcfireinfo.for.gov.bc.ca</p>
29	Name/Surname/Email/Date of who filled in this template	Ronchi, E., Rein, G., Gwynne, S., Wadhwani, R., Intini, P., & Bergstedt, A. (2017). e-Sanctuary: Open Multi-Physics Framework for Modelling Wildfire Urban Evacuation. Quincy, MA (USA)

18. Ranch fire (USA), 2018

The Ranch Fire in July through September 2018 was a large wildfire that severely impacted multiple counties in Northern California, particular Lake County. The Ranch Fire was the largest fire in California history at the time, burning just over 400,000 acres. Igniting in the rural area of eastern Mendocino County, the Ranch Fire grew slowly at first but with little containment due to rugged and inaccessible terrain. The nearby River Fire was battled by the same unified command as the Ranch Fire, leading the fires to be known as the Mendocino Complex Fire. The fire grew over the course of several weeks, leading to evacuations of multiple rural areas and communities north of Clear Lake. The Ranch Fire spread rapidly once reaching the Mendocino National Forest, an area without accessible roads. At the height of the Mendocino Complex Fire, over 3,500 personnel were battling the blaze as it spread into the neighbouring counties of Colusa and Glenn. Firefighters gained ground against the fire in mid-August, but the blaze was not extinguished until mid-September.

The Ranch Fire and River Fire together prompted approximately 17,000 people to be ordered to evacuate and caused the death of 1 person. While damages were much lower than other California fires, over \$200 million was spent on fire suppression for the Mendocino Complex Fires. The rural environment, while increasing the number of acres burned, limited evacuations and threats to urban structures. Additional details are provided below.

1	Where?	Mendocino County, Lake County, Colusa County, and Glenn County, California, USA
2	When?	7/27/18 - 9/18/18
3	How was the fire started?	Hammer hitting a metal stake
4	Initial fire size	30 acres
5	Area affected (burned area)	401,203 acres
6	Fuels involved in the fire	Mixed including chaparral shrub-land, grassland, and woodlands, structures
7	WUI, urban, wildland or informal settlement fires?	WUI fire, Lucerne, Nice, Upper Lake, Potter Valley, Witter Springs
8	Average weather conditions	Prior to fire, dry conditions including dry vegetation, temperatures over 100-degree Fahrenheit, and high winds
9	Geographical highlights	Chaparral and wooded mountain range and foothills with nearby Clear Lake. Very rugged terrain (steep slopes and canyons) with thick forests and brush in the Mendocino National Forest with little to no road access
10	Was there any fire break? (natural or artificial)	Clear Lake to the south; Highway 20
11	Did the Fire Service report extreme fire behaviour?	Red flag warning; critical fire weather conditions fuelled by gusty winds along ridges and high winds; rapid fire spreading in irregular patterns
12	Number of structures and infrastructures affected (damaged)	157 residences destroyed and 123 other structures destroyed
13	Estimated direct and indirect economic damage	Approximately \$56 million in damages and \$200 million in fire suppression costs for the Ranch and River Fires (i.e., Mendocino Complex Fires)

14	Did it occur in conjunction with multiple fires in the country?	Was one of two fires that comprised the Mendocino Complex Fires; resources were spread between the Ranch and River fires; Carr Fire in Redding broke out prior the Mendocino Complex Fires, further spreading firefighting resources
15	Countries involved	United States with assistance from Australia and New Zealand
16	Brief timeline of the key events	<p>July 27, 12:03 pm: Fire begins near Highway 20 in Potter Valley due to sparks from a hammer striking metal stakes</p> <p>July 27, 3:00 pm: Fire spreads to 175 acres, leading to a firefighter injury; erratic fire behaviour hampers firefighting efforts</p> <p>July 27, 7:00 pm: An evacuation advisory warning is issued for areas surrounding Potter Valley; fire expands to 1,000 acres</p> <p>July 28, 7:00 am: Evacuation advisories are extended to additional areas near Highway 20 including Witter Springs; steep rugged terrain along with low humidity increase fire size to 3,500 acres</p> <p>July 28: 8:00 pm: Mandatory evacuation orders are given for some communities surrounding Clear Lake including all areas north of Highway 20 and south of the Mendocino National Forest; advisories are issued for all Lake County</p> <p>July 29: 6:00 pm: Fire continues to spread eastward along the Mendocino National Forest, expanding to 16,000 acres; mandatory evacuation orders are given for Upper Lake, Nice, Witter Springs, Bachelor Valley, Scotts Valley, and Saratoga Springs</p> <p>July 30-August 1: Fire continues expanding to 61,000 acres</p> <p>August 2: Mandatory evacuation orders are issued for most of the communities surrounding Clear Lake</p> <p>August 3-August 4: Fire spreads further east and increases to 181,000 acres</p> <p>August 5-August 7: Fire moves rapidly south and north, threatening communities near Clear Lake and in Colusa County, and increasing to 243,000</p>

		<p>acres; significant road closures across the edge of the fire</p> <p>August 8-August 14: Additional evacuation orders are issued across Lake, Colusa, and Glenn counties for rural areas; the Ranch Fire becomes the largest wildfire in California history at over 300,000 acres burned</p> <p>August 15-September 17: Containment slowly grows as the fire consumes vast sections of the Mendocino National Forest; more favourable conditions enable firefighting to gain upper hand into Sept.</p> <p>September 18: Fire reaches 100% containment, burning a total of 410,203 acres</p>
17	Time of initial order to evacuate and locations	<p>Begin: 7/28/18 (8:00 pm) - Lake County (rural areas)</p> <p>Additional: 8/2/18 - Communities in Lake County</p> <p>Additional: Ongoing evacuations across the region including Colusa and Glenn Counties</p>
18	Time when evacuation was considered completed	End: 9/18/18 - Fire reaches 100% containment
19	Deaths/Injuries	1 death, 3 injuries
20	The number of people evacuated	About 17,000 people ordered to evacuate from both the Ranch and River Fires
21	The location people initially evacuated	Additional data required
22	Reasons why people decided to evacuate	Additional data required
23	Evacuation type	Predominately ground transport by private vehicles
24	Any drill/education/instructions on large outdoor fires provided beforehand?	No information available
25	Personnel involved in rescue operations	<p>Unified Command: Cal Fire</p> <p>Cooperating Agencies: Potter Valley Fire, Redwood Valley Fire, Ukiah Fire, California Office of Emergency Services, California Department of Corrections and Rehabilitation, Lake County Sheriff's Office, Mendocino County Sheriff's Office, Colusa County Sheriff's Office, Glenn County Sheriff's Office, California Highway Patrol, Pilsbury FPD, Australia and New Zealand Fire, Bureau of Land Management, Bureau of Indian Affairs, Department of Defence, US Fish and Wildlife, National Park Service, Hopland Fire, Lakeport Fire, PG&E, AT&T,</p>

		<p>California Conservation Corps, North Shore Fire, American Red Cross, Kelseyville Fire, California State Parks, Cal Water, Lake County Farm Bureau, Nevada Division of Forestry, Nevada Department of Corrections and additional agencies from throughout California and other States</p> <p>Total fire personnel: ~3,500 (both Ranch and River Fires)</p> <p>Total fire engines: ~290 (both Ranch and River Fires)</p>
26	Did the smoke hindered significantly the evacuation because of low visibility or health problems	Hazardous air quality throughout the region especially fire impacted counties but as far away as San Francisco
27	Possible causes of issues in management operations	<p>Evacuation (Mendocino Complex): Despite a slower spreading fire, evacuations orders were still difficult to issue and enforce. Reports indicated that a significant number of people remained behind, particularly in the communities surrounding Clear lake. Non-evacuees who stayed behind to protect their homes used water to spray down their properties, decreasing the amount of water for firefighting operations. A significant number of evacuees also left without their pets or livestock, leading local organisations to find and collect over 2,500 animals.</p> <p>Sheltering (Mendocino Complex): Shelters were opened across the region. While most shelters were adequate, some shelters faced difficulty accommodating people with health problems and mobility challenges.</p> <p>Firefighting (Ranch): With the nearby River Fire and the ongoing Carr Fire, firefighting resources were stretched thin. Most problematic, the rugged and inaccessible Mendocino National Forest posed significant challenges for firefighters attempting to build containment lines. The lack of access to the most rural areas hampered firefighting.</p>
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29	Name/Surname/Email/Date of who filled in this template	Stephen Wong/stephen.wong@berkeley.edu 5/31/19

19. River Fire (USA), 2018

The River Fire in July through August 2018 was a wildfire that severely impacted Mendocino and Lake Counties in Northern California. Igniting in the rural area near the South Cow Mountain Recreation Area, the River Fire grew moderately but with little containment due to rugged terrain and poor conditions. The nearby Ranch Fire was battled by the same unified command as the River Fire, leading the fires to be known as the Mendocino Complex Fire. The fire grew over the course of several weeks, leading to evacuations of multiple rural areas and communities west and south of Clear Lake. The River Fire threatened the city of Lakeport and the smaller communities of Kelseyville and Finley. At the height of the Mendocino Complex Fire, over 3500 personnel were battling the fires, as the Ranch Fire spread into the neighbouring counties of Colusa and Glenn. Firefighters were able to reach containment quickly on August 13 for the River Fire, but the Ranch Fire was not extinguished until mid-September.

The Ranch Fire and River Fire together prompted approximately 17,000 people to be ordered to evacuate and caused the death of 1 person. While damages were much lower than other California fires, over \$200 million was spent in fire suppression on the Mendocino Complex Fires. The rural environment, while increasing the number of acres burned, limited evacuations and threats to urban structures. Additional details are provided below.

1	Where?	Mendocino County, Lake County, California, USA
2	When?	7/27/18 - 8/13/18
3	How was the fire started?	Unknown (under investigation)
4	Initial fire size	5 acres
5	Area affected (burned area)	48,920 acres
6	Fuels involved in the fire	Mixed including chaparral shrub-land, grassland, and woodlands, structures
7	WUI, urban, wildland or informal settlement fires?	WUI fire, Hopland, Largo, Kelseyville, Lakeport, Finley, Upper Lakeport
8	Average weather conditions	Prior to fire, dry conditions including dry vegetation, temperatures over 100-degree Fahrenheit, and high winds
9	Geographical highlights	Chaparral and wooded mountain range and foothills with nearby Clear Lake. Very rugged terrain (steep slopes and canyons) with thick forests and brush in the South Cow Mountain Recreation Area with little to no road access
10	Was there any fire break? (natural or artificial)	Clear Lake to the east, Highway 101 to the west, Highway 175 to the south
11	Did the Fire Service report extreme fire behaviour?	Red flag warning; critical fire weather conditions fuelled by gusty winds along ridges and high winds; rapid fire spreading in irregular pattern
12	Number of structures and infrastructures affected (damaged)	146 residences destroyed, 118 other structures destroyed
13	Estimated direct and indirect economic damage	Approximately \$56 million in damages and \$200 million in fire suppression costs for the Ranch and River Fires (i.e., Mendocino Complex Fires)
14	Did it occur in conjunction with multiple fires in the country?	Was one of two fires that comprised the Mendocino Complex Fires; resources were spread

		between the Ranch and River fires; Carr Fire in Redding broke out prior to the Mendocino Complex Fires, further spreading firefighting resources
15	Countries involved	United States with assistance from Australia and New Zealand
16	Brief timeline of the key events	<p>July 27 - 1:01 pm: River Fire begins along Old River Road, about 6 miles north of Hopland</p> <p>July 27 - 7:00 pm: River Fire expands rapidly to 4,000 acres; aggressive fire behaviour hinders firefighting efforts despite both air and ground resources; threatens UC Berkeley Hopland Research and Extension Centre; evacuation advisories are issued for residences along Old River Road</p> <p>July 27 - 8:37 pm: Mandatory evacuation orders are ordered for the Hopland area south to Highway 175, west to Highway 101, and east to the Lake county line</p> <p>July 27 - 10:00 pm: Evacuation warnings are issued for multiple areas south of Highway 175; high winds are expected through the night</p> <p>July 28 – 7:00 am: River Fire expands to 6,000 acres and mandatory evacuation orders are issued to the north of the fire</p> <p>July 28 - 9:30 pm: River Fire slows, only growing to 9,000 acres and allowing firefighters to reach 10% containment</p> <p>July 29 - 8:00 am: Fire grows to 11,000 acres and crosses over the Lake County border line</p> <p>July 29 - 3:30 pm: Mandatory evacuation orders are issued for the city of Lakeport and unincorporated areas near Lakeport</p> <p>July 29 - 4:30 pm: Mandatory evacuation advisories are issued for Finley and the Big Valley Rancheria areas; by 6:00 pm, advisories are expanded to Kelseyville</p> <p>July 29 - 7:00 pm: Fire reaches 16,300 acres</p> <p>July 30 - 12:00 pm: Some residences in the Hopland are allowed to return</p>

		<p>July 30 - 2:30 pm: Mandatory evacuation orders are issued for areas east of Highway 29 along Clear Lake including Kelseyville and Finley</p> <p>July 31: Fire expands rapidly to 27,000 acres, jumping Highway 175</p> <p>August 1-August 2: Fire continues to threaten outskirts of Lakeport but firefighters gain a foothold and reach 50% containment</p> <p>August 3: Highway 175 reopens to traffic but containment remains at 50% with growth to 42,000 acres</p> <p>August 4-August 6: Containment grows over the next few days</p> <p>August 7: All evacuation orders for all areas of Mendocino and Lake County impacted by the River Fire are lifted by 6:00 pm</p> <p>August 8-August 12: Containment for the River Fire grows</p> <p>August 13: 100% containment is reached, burning 48,920 acres</p>
17	Time of initial order to evacuate and locations	<p>Begin: 7/27/18 - Advisories at 7:00 pm, mandatory orders for Hopland area at 8:37</p> <p>Additional: 7/28/18 - Mandatory orders north of fire</p> <p>Additional: 7/29/18: Mandatory orders for Lakeport</p> <p>Additional: 7/30/18: Mandatory orders for Finley and Kelseyville</p>
18	Time when evacuation was considered completed	End: 8/7/18: Evacuation orders are lifted for all areas of the River Fire
19	Deaths/Injuries	None
20	The number of people evacuated	About 17,000 people ordered to evacuate from both the Ranch and River Fires
21	The location people initially evacuated	Additional data required
22	Reasons why people decided to evacuate	Additional data required
23	Evacuation type	Predominately ground transport by private vehicles
24	Any drill/education/instructions on large outdoor fires provided beforehand?	No information available

25	Personnel involved in rescue operations	<p>Unified Command: Cal Fire</p> <p>Cooperating Agencies: Potter Valley Fire, Redwood Valley Fire, Ukiah Fire, California Office of Emergency Services, California Department of Corrections and Rehabilitation, California SR Patrol, Lake County Sheriff's Office, Mendocino County Sheriff's Office, Colusa County Sheriff's Office, Glenn County Sheriff's Office, California Highway Patrol, Australia and New Zealand Fire, Bureau of Land Management, Hopland Fire, Lakeport Fire, PG&E, AT&T, California Conservation Corps, and additional agencies from throughout California and other States.</p> <p>Total fire personnel: ~3,500 (both Ranch and River Fires)</p> <p>Total fire engines: ~290 (both Ranch and River Fires)</p>
26	Did the smoke hindered significantly the evacuation because of low visibility or health problems	<p>Hazardous air quality throughout the region especially fire-impacted counties but also areas as far away as San Francisco</p>
27	Possible causes of issues in management operations	<p>Evacuation (Mendocino Complex): Despite a slower spreading fire, evacuations orders were still difficult to issue and enforce. Reports indicated that a significant number of people remained behind, particularly in the communities surrounding Clear Lake. Non-evacuees who stayed behind to protect their homes used water to spray down their properties, decreasing the amount of water for firefighting operations. A significant number of evacuees also left without their pets or livestock, leading local organisations to find and collect over 2,500 animals.</p> <p>Sheltering (Mendocino Complex): Shelters were opened across the region. While most shelters were adequate, some shelters faced difficulty accommodating people with health problems and mobility challenges.</p> <p>Firefighting (River): With the nearby Ranch Fire and the ongoing Carr Fire, firefighting resources were stretched thin. Most problematic, the rugged and inaccessible South Cow Mountain Recreation Area posed significant challenges for firefighters attempting to build containment lines. The lack of access to most rural areas hampered firefighting.</p>

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29	Name/Surname/Email/Date of who filled in this template	Stephen Wong/stephen.wong@berkeley.edu 6/1/19

20. Rye fire (USA), 2017

The Rye Fire in December 2017 was a small wildfire that impacted Los Angeles County in Southern California near the city of Santa Clarita. The fire broke out around the same time as other fires in the area including the Thomas, Creek, Skirball, and Lilac fires, which are collectively known as the 2017 December Southern California Wildfires. The Rye Fire ignited near Rye Canyon Road in unincorporated Los Angeles County. Within the first several hours, the fire spread quickly, leading officials to issue mandatory evacuation orders and close Interstate 5. Significant congestion was reported in Santa Clarita, especially after multiple schools were evacuated from advancing flames. After 24 hours, firefighters were able to begin containing the Rye Fire, which reached full containment just a week after igniting.

Approximately 5,000 people were ordered to evacuate from the Rye Fire with multiple other areas kept on alert if conditions changed. Due to quick firefighting response, the fire only destroyed 6 structures and did not kill anyone. With the outbreak of fires across the region, firefighting resources were still spread thin, particularly for other fires. The Rye Fire burned approximately 6,049 acres. Additional details are provided below.

1	Where?	Los Angeles County, California, USA
2	When?	12/5/2017 – 12/12/2017
3	How was the fire started?	Under investigation
4	Initial fire size	5 acres
5	Area affected (burned area)	6,049 acres
6	Fuels involved in the fire	Shrub land vegetation with grassland, chaparral environment with oak woodlands
7	WUI, urban, wildland or informal settlement fires?	WUI fire, Santa Clarita, Valencia, Stevenson Ranch, unincorporated Los Angeles County
8	Average weather conditions	Single digit humidity, Santa Ana winds with gusts upwards of 50 to 70 mph
9	Geographical highlights	Mountain range with steep drainages and canyons; some suburban density closer to Santa Clarita; Six Flags Magic Mountain Amusement Park to the east
10	Was there any fire break? (natural or artificial)	Interstate 5, Santa Clara River, Highway 126
11	Did the Fire Service report extreme fire behaviour?	Red Flag Warning; fire behaviour is extreme, wind driven
12	Number of structures and infrastructures affected (damaged)	6 destroyed, 3 damaged
13	Estimated direct and indirect economic damage	At least \$3.2 billion in economic loss of which \$2.2 billion were insured loss across all fires in the 2017 December Southern California Wildfires
14	Did it occur in conjunction with multiple fires in the country?	Rye Fire coincided with an outbreak of other major fires including the Creek, Skirball, Lilac, and Thomas Fires. These fires are collectively known as the 2017 December Southern California Wildfires. Los Angeles was most impacted by the Creek and Skirball fires. The Rye Fire threatened Santa Clarita and Six Flags Magic Mountain. With

		all active fires, firefighting resources were spread thin throughout the region.
15	Countries involved	United States
16	Brief timeline of the key events	<p>December 5 - 9:32 am: Rye Fire breaks out near Rye Canyon Loop in Santa Clarita</p> <p>December 5 - 10:05 am: Firefighters arrive on scene to report a 5-acre fire</p> <p>December 5 - 10:59 am: Fire grows to 200 acre and Interstate 5 is closed in both directions in the area</p> <p>December 5 - 11:55 am: Mandatory evacuation orders are issued for Rye Canyon Loop; multiple roads near the fire are closed</p> <p>December 5 - 1:26 pm: Mandatory evacuation orders are issued for Westridge including schools in the area</p> <p>December 5 - 1:34 pm: Fire continues to spread rapidly to 1000 acres</p> <p>December 5 - 2:00 pm: Interstate 5 is reopened</p> <p>December 5 - 3:12 pm: Fire grows quickly to 5000 acres with only 5% containment</p> <p>December 6 - 8:42 am: Fire grows overnight; firefighters evaluate conditions to allow for some repopulation</p> <p>December 7: Evacuations are lifted for the Rye Fire, including Stevenson Ranch, Valencia Travel Village, Newhall Ranch, Castaic Junction; Simi Valley remains on alert</p> <p>December 8 - 11: Containment grows quickly</p> <p>December 12: The Rye Fire is 100% contained</p>
17	Time of initial order to evacuate and locations	<p>Begin: 12/5/17 - Evacuation orders are issued for Rye Canyon Loop in the mid-morning</p> <p>Additional: 12/5/17 - Additional orders are expanded east including Westridge and Stevenson Ranch</p>
18	Time when evacuation was considered completed	End: 12/7/17 - All evacuation orders are lifted for residences

19	Deaths/Injuries	0 deaths
20	The number of people evacuated	Approximately 5,000 people ordered to evacuate (1,200 households along with schools and assisted living facilities)
21	The location people initially evacuated	Additional data required
22	Reasons why people decided to evacuate	Additional data required
23	Evacuation type	Predominately ground transport by private vehicles; use of school buses for school evacuations and city buses for assisted living centres
24	Any drill/education/instructions on large outdoor fires provided beforehand?	
25	Personnel involved in rescue operations	<p>Unified Command: Cal Fire, Los Angeles County Fire, Ventura County Fire, Los Angeles County Sheriff's Office, and Ventura County Sheriff's Office</p> <p>Cooperating Agencies: Cal Fire, California Highway Patrol, City of Santa Clarita, Southern California Edison, California Resources Corporation, California Conservation Corps, SoCal Gas, Simi Valley PD, and LA County Public Works.</p> <p>Total fire personnel: +900</p> <p>Total fire engines: +70</p>
26	Did the smoke hindered significantly the evacuation because of low visibility or health problems	Smoke conditions cause some health problems in the area for responders and citizens; unhealthy air quality is declared for parts of Los Angeles County
27	Possible causes of issues in management operations	<p>Firefighting: With multiple fires breaking out across Southern California, firefighting resources were stretched thin. Firefighters battled flames with extremely poor weather conditions in steep, rugged terrain. Firefighters closed multiple roads, including Interstate 5, to improve manoeuvrability and reduce safety issues. The quick response for the Rye Fire helped keep it from spreading further into Santa Clarita.</p> <p>Evacuations: Evacuations were ordered for multiple surrounding areas, leading to congestion on local roads. With the closure of Interstate 5, traffic heading to and from the Central Valley was severely impacted. Congestion was also high as parents attempted to pick up their children from closed school, despite the use of school buses to</p>

		assist in the evacuation. Local Santa Clarita buses were used to facilitate evacuations from several assisted living centres.
28	References	<p>Academic:</p> <p>Nauslar, N. J., Abatzoglou, J. T., & Marsh, P. T. (2018). The 2017 North Bay and Southern California Fires: A Case Study. <i>Fire</i>, 1(1), 18. https://doi.org/10.3390/fire1010018</p> <p>Wong, S., Broader, J., Shaheen, S. (2020). Review of California Wildfire Evacuations from 2017 to 2019. Retrieved from https://escholarship.org/uc/item/5w85z07g.</p> <p>Other:</p> <p>ABC7. (2017a, December 8). Rye Fire 35 percent contained after charring 6K acres in Santa Clarita abc7.com. Retrieved November 24, 2018, from https://abc7.com/6k-acre-rye-fire-50-percent-contained-in-santa-clarita-area/2756803/</p> <p>ABC7. (2017b, December 9). Rye Fire now 65 percent contained in Santa Clarita area. Retrieved November 24, 2018, from ABC7 Los Angeles website: https://abc7.com/2761523/</p> <p>Aon Benfield. (2017). Weather, Climate & Catastrophe Insight. Retrieved from http://thoughtleadership.aonbenfield.com/Documents/20180124-ab-if-annual-report-weather-climate-2017.pdf</p> <p>Baer, S. K., Smith, K., & Yee, C. (2017, December 5). Rye fire in Santa Clarita burns 7,600 acres, 1,300 homes evacuated – Daily News. Retrieved December 1, 2018, from https://www.dailynews.com/2017/12/05/firefighters-battle-200-acre-blaze-in-santa-clarita/</p> <p>Cal Fire. (2018, January). Rye Fire Incident Information. Retrieved June 4, 2019, from https://cdfdata.fire.ca.gov/incidents/incidents_details_info?incident_id=1924</p> <p>Etehad, M. (2017, December 5). Unhealthy air quality declared in parts of Los Angeles County due to smoke from Creek Fire. <i>Los Angeles Times</i>. Retrieved from </p>

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29	Name/Surname/Email/Date of who filled in this template	Stephen Wong/stephen.wong@berkeley.edu 6/13/19

21. Sakata fire (Japan), 1976

A fire started at the boiler in a movie theatre in Sakata-city, Yamagata, Japan, Oct. 29 1976. With strong wind, fire spread quickly. Firebrands and spot fires overwhelmed firefighting activities. Rain and suppression efforts across the river stopped fires from spreading eventually Oct. 30.

1	Where?	Sakata-city, Yamagata, Japan
2	When?	1976/10/29 17:50-1976/10/30 5:00
3	How was the fire started?	A fire in movie theatre (Cause was not identified)
4	Initial fire size	Boiler
5	Area affected (burned area)	22.5 ha
6	Fuels involved in the fire	Structures
7	WUI, urban, wildland or informal settlement fires?	Urban
8	Average weather conditions	Strong wind (ave. 12.2 m/s), raining
9	Geographical highlights	Semi-fire-resistant area (defined by Japanese law),
10	Was there any fire break? (natural or artificial)	6 m wide roads (fire spread beyond), 18 m wide roads, 50 m wide river (stopped here)
11	Did the Fire Service report extreme fire behaviour?	Strong wind, 17 spot fires, firebrands
12	Number of structures and infrastructures affected (damaged)	1774
13	Estimated direct and indirect economic damage	40.5 billion YEN
14	Did it occur in conjunction with multiple fires in the country?	No
15	Countries involved	Japan
16	Brief timeline of the key events	10/29 17:40 A fire started (estimated) 17:50 reported to fire department 17:53 fire spreads to houses next to movie theatre 18:30 Ignited department store next to an initial fire 19:58 Evacuation order issued Local army was assembled and headed to Sakai-city, armies in nearby prefectures were getting ready to be deployed due to 7 o'clock news 20:20 Command centre was established and asked help for fire departments in nearby cities 22:00 fire spreads beyond large roads (fire break) 10/30 3:00 initial fire was almost extinguished 4:00 wind calmed down, and confirmed fire stopped spreading at 50 m wide river
17	Time of initial order to evacuate and locations	10/29 19:58 nearby mall
18	Time when evacuation was considered completed	N/A as Some stayed home to protect houses
19	Deaths/Injuries	1 death 1003 injured, 3270 affected

20	The number of people evacuated	No information
21	The location people initially evacuated	Shelter as well as escape from fire
22	Reasons why people decided to evacuate	mandatory order, as well as they see the news or they see actual fire coming,
23	Evacuation type	On foot
24	Any drill/education/instructions on large outdoor fires provided beforehand?	Area experienced multiple large fires in the past, so roads were intentionally wide, and people had knowledge of how to deal with fires (carrying water from nearby river in buckets) and spot fires/firebrands (removing firebrands by blooms, watering roofs).
25	Personnel involved in rescue operations	Residents, firefighters, army,
26	Did the smoke hindered significantly the evacuation because of low visibility or health problems	Smoke was black and thick and hurt eyes and nose
27	Possible causes of issues in management operations	Wind direction was changed and unpredictable fire spreads
28	References	NRIFD report (No. 11) Report on Sakata fire http://nrifd.fdma.go.jp/publication/gijutsushiryo/gijutsushiryo_01_40/files/shiryo_no11.pdf
29	Name/Surname/Email/Date of who filled in this template	Sayaka Suzuki 2020/Feb

22. San Diego fire (USA), 2007

The San Diego fire 2007 was the second largest wildfire in the California fire season 2007. The fire started in Witch Creek Canyon near Santa Ysabel and quickly spread to San Diego County Estates, Ramona, Rancho Bernardo, Poway and Escondido. Locals in the San Pasqual Valley area reported wind gusts of over 100 mph (160 km/h).

1	Where?	Rancho Bernardo Trail Community, California, USA.
2	When?	21/10/2007 (1100 - Witch Creek Fire) / 21/10/2007 (Guajito Creek Fire) – 06/09/2007
3	How was the fire started?	Electrical line arcing / energized power line
4	Initial fire size	The fire started in Witch Creek Canyon near Santa Ysabel and quickly spread to San Diego Country Estates, Ramona, Rancho Bernardo, Poway and Escondido. The Canyon fire started at 1pm and ended the first day at 8km ² . The Ranch fire started at 2pm and finished the day at 8km ² . 30 minutes after start (0130), the Guejito fire was 3.2km from point of origin. End of Day 1 – 8 km ² ; Day 2 - 587 km ² ; Day 3 - 793 km ² ; Day 4-6: 797 km ²
5	Area affected (burned area)	500,000 acres / 12,000 km ²
6	Fuels involved in the fire	Brush / Hardwood / Longpole Pine/ Grass/ Structures
7	WUI, urban, wildland or informal settlement fires?	WUI
8	Average weather conditions	Local population in the San Pasqual Valley area reported wind gusts of over 100 mph (160 km/h), with severe drought in the previous months
9	Geographical highlights	Trail community in mountainous region.
10	Was there any fire break? (natural or artificial)	Rock outcrops. Interstate highway (fire jumped)
11	Did the Fire Service report extreme fire behaviour?	Hot, dry winds. Long range spotting.
12	Number of structures and infrastructures affected (damaged)	1,125 residential structures / 509 outbuildings / 239+ vehicles
13	Estimated direct and indirect economic damage	US\$18 million (although the associated fires had an estimated impact of US\$90million)
14	Did it occur in conjunction with multiple fires in the country?	Yes. In combined fires - 1500 homes destroyed and 0.5m acres burned from Santa Barbara to US-Mexico border. Merged with Guajito fire on Day 2.
15	Countries involved	USA
16	Brief timeline of the key events	Day 1 Witch Fire is reported at 12:35 p.m. in the rural area of Witch Creek, east of Ramona in San Diego County. Aircraft diverted from the Harris Fire (64 km away) take immediate action due to structure threat /rapid spread toward Ramona. Air drops

ineffective due to the winds; air attack is cancelled. Fire spreads toward the communities of Northeast Ramona, San Diego Country Estates, and Barona Mesa (area burned by the Cedar Fire in 2003). Competition for resources anticipated given multiple fires. By evening, western fire front jumps Interstate-15 and establishes itself in the river drainage. Estimated 40 km² burn. Multiple structures are destroyed in Rancho Bernardo and Poway. The communities of Ramona, San Diego Country Estates, Barona Mesa, Barona Indian Reservation, Poway and San Pasqual are all threatened.

Day 2

4:00 am - New fire reported in the San Pasqual River drainage (Guajito Fire). 4:30am - This fire burns west to Interstate- 15 leading to California Highway Patrol to close it - disrupting community evacuations. The Guajito and the Witch Creek Fires merge later that day. The Witch Creek Fire threatens many communities in the San Diego area and jumps Interstate-15 as it heads west. The fire is well established in the river drainage burning downhill, down canyon. Driven by 50 km/h winds, with gusts up to 75 mph, spotting occurs up to 0.8 km. Fire reaches the community of Ramona and evacuations take place. Highway 78 from Ramona to Santa Ysabel, Wildcat Canyon and Highway 67 from Poway Road to Ramona are closed. Widespread spotting and numerous new starts occur in the surrounding areas due to falling electrical wires. The Witch Creek Fire is reported at over 587 km². The fire exhibits extreme behaviour with long-range spotting in excess of 0.4 km and rapid spread rates over 4 km/h. The high winds with high temperature and low humidity expected to continue - Wednesday, October 24. An estimated 500 homes have been destroyed and 250 damaged; 100 commercial buildings have been destroyed and 75 damaged. More than 5,000 homes and 1,500 commercial buildings remain threatened. There are reports of civilian injuries.

Day 3

Fire continues to spread west and southwest passing through many communities. Multiple evacuations are ordered. In early hours, increase in wind and fire activity. Long-range spotting over 0.4 km. Mandatory evacuations take effect for

		<p>Scripps Ranch, Rancho Bernardo, Poway, Valley Centre, San Marcos, and Rancho Santa Fe.</p> <p>Day 4 800 km² involved with an estimated 20% containment. Fire progression slows west/southwest fronts. Warm, dry and unstable conditions exist at the higher elevations and the eastern areas of the fire. Fire continues to burn within and around structures with moderate to high intensity. Perimeter growth persists in east in mature, heavy brush (including brush that grew after the 2003 fire siege).</p> <p>Day 5 Fire progression slows due to improvement in weather and additional resources. Damage assessments report 239 destroyed vehicles.</p> <p>Day 6 Re-entry of residents continues in some areas.</p> <p>Day 7 Further containment.</p> <p>Day 8 95% containment. All communities are repopulated, and San Diego Gas and Electric continues to restore utility services.</p> <p>Day 9 Line construction and improvements are nearly complete in all branches</p> <p>Day 10 The Witch Fire reports progress on closing the last portions of open line. All residents have returned to evacuated communities</p> <p>Day 11 Good progress continues on the Witch Fire with full containment expected by evening</p>
17	Time of initial order to evacuate and locations	State of emergency declared on 21 st October. Reverse 911 evacuation system employed - contacted 200k people.
18	Time when evacuation was considered completed	Day 10 - 30 th October
19	Deaths/Injuries	2 fatalities / 45 injuries
20	The number of people evacuated	Eventually a million were displaced in response to the many wildfires at the time

	The location people initially evacuated	No information available
21	Reasons why people decided to evacuate	Mandatory order issues by local authorities
22	Evacuation type	Vehicular transport such as cars
	Any drill/education/instructions on large outdoor fires provided beforehand?	Multiple training
23	Personnel involved in rescue operations	Cooperating Agencies: California Highway Patrol, San Diego County Sheriff, Red Cross, Animal Control, San Diego Police Department, Escondido Police Department, Escondido Police Department, San Diego Gas & Electric, Bureau of Indian Affairs, Bureau of Land Management, Department of Corrections and Rehabilitation, and various local fire agencies. 1,841 firefighters were assigned to Californian fires at time (224 to Witch Fire alone)
24	Did the smoke hindered significantly the evacuation because of low visibility or health problems	Roads were closed due to the presence of fire and smoke.
25	Possible causes of issues in management operations	The number of simultaneous fires and the complexity of their development, the number / level of agencies involved and the need for spotters to be in place before helicopters could be deployed may have contributed.
26	References	<p>Scientific literature:</p> <p>Maranghides, A., & Mell, W. E. (2009). A case study of a community affected by the Witch and Guejito Fires. National Institute of Standards and Technology. Building and Fire Research Laboratory.</p> <p>Fire, C. (2007). California Fire Siege 2007: An Overview. www.fire.ca.gov/fire_protection/downloads/siege/2007/Overview_CompleteFinal.pdf</p> <p>Websites:</p> <p>National Institute of Standards and Technology. (2009, July 4). First Detailed Look at Progress of a Wildland-urban Fire. Science Daily. Retrieved July 2017 from www.sciencedaily.com/releases/2009/06/090617_123429.htm</p> <p>http://cdfdata.fire.ca.gov/incidents/incidents_details_info?incident_id=225</p> <p>https://interwork.sdsu.edu/fire/resources/2007_fires.html</p> <p>http://www.firefighternation.com/articles/2012/10/the-5-year-anniversary-of-the-witch-creek-fire.html</p>

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23. Skirball Fire (USA), 2017

The Skirball Fire in December 2017 was a small wildfire that impacted the neighbourhood of Bel-Air in the City of Los Angeles. The fire broke out around the same time as other fires in the area including the Thomas, Creek, Rye, and Lilac fires, which are collectively known as the 2017 December Southern California Wildfires. The Skirball ignited due to an illegal cooking fire near Interstate 405 and Mulholland Drive at a homeless encampment. The fire grew quickly, spreading over the hillside next to Interstate 405 and into the Bel-Air neighbourhood. Evacuation orders were issued for the neighbourhood and Interstate 405 was closed in both directions. With slower winds, firefighters were able to keep the fire around 400 acres, minimizing impact on residences. After firefighters put out ongoing hot spots, the Skirball Fire was declared contained a little over a week after igniting.

Approximately 4,600 people were ordered to evacuate from the Skirball Fire with several surrounding canyon communities warned to prepare to leave. The famed Getty Center also prepared to evacuate with personnel and art. The Skirball Fire destroyed 12 home, burned 422 acres, but did not kill anyone. With the outbreak of fires across the region, firefighting resources were still spread thin, particularly for other fires. The rapid response of the Los Angeles Fire Department was key for saving residences in Bel-Air. Additional details of the Skirball Fire are provided below.

1	Where?	Los Angeles County, City of Los Angeles, California, USA
2	When?	12/6/2017 – 12/15/2017
3	How was the fire started?	Illegal cooking fire
4	Initial fire size	Unknown
5	Area affected (burned area)	422 acres
6	Fuels involved in the fire	Shrub land vegetation with grassland, chaparral environment with oak woodlands; additional landscaped vegetation; high suburban density
7	WUI, urban, wildland or informal settlement fires?	WUI fire, Bel-Air in Los Angeles
8	Average weather conditions	Single digit humidity, Santa Ana winds with gusts upwards of 50 to 70 mph
9	Geographical highlights	Hillside with high suburban density in the neighbourhood of Bel-Air
10	Was there any fire break? (natural or artificial)	Interstate 405, Sunset Blvd., Stone Canyon Reservoir
11	Did the Fire Service report extreme fire behaviour?	Red Flag Warning; fire behaviour is extreme, wind driven
12	Number of structures and infrastructures affected (damaged)	12 destroyed, 6 damaged
13	Estimated direct and indirect economic damage	At least \$3.2 billion in economic loss of which \$2.2 billion were insured loss across all fires in the 2017 December Southern California Wildfires
14	Did it occur in conjunction with multiple fires in the country?	The Skirball Fire coincided with an outbreak of other major fires including the Creek, Rye, Lilac, and Thomas Fires. These fires are collectively known as the 2017 December Southern California Wildfires. Los Angeles was most impacted by the

		Creek and Skirball fires. The Rye Fire threatened Santa Clarita and Six Flags Magic Mountain. The Thomas Fire impacted Ventura and Santa Barbara Counties. With all active fires, firefighting resources were spread thin throughout the region.
15	Countries involved	United States
16	Brief timeline of the key events	<p>December 6 - 5:00 am: Firefighters respond to an out-of-control illegal cooking fire at a homeless encampment</p> <p>December 6 - 5:15 am: California Highway Patrol notifies motorists on I-405 of potential congestion due to fire; the public is alerted of a fast-moving fire in the Sepulveda Pass</p> <p>December 6 - 6:20 am: Mandatory evacuation orders are issued for most of Bel-Air neighbourhood; fire is estimated at 50 acres</p> <p>December 6 - 6:30 am: All northbound and southbound lanes of I-405 are closed</p> <p>December 6 - 8:30 am: Southbound lanes of I-405 are reopened</p> <p>December 6 - 11:05 am: Skirball fire expands to 150 acres in the midst of 25 mph winds</p> <p>December 6 - 12:30 pm: Northbound lanes of I-405 are reopened</p> <p>December 6 - 3:20 pm: Firefighters reach 5% containment but winds hamper firefighting; fire approaches the Getty Centre; Mandeville and Sullivan communities are warned to prepare to evacuate</p> <p>December 6: Evacuation compasses most of Bel-Air along with Sepulveda Pass</p> <p>December 7: Containment grows from 5% to 20% during the day as conditions improve</p> <p>December 8 - 9: Containment increases to 75% and all evacuation orders and road closures are lifted</p> <p>December 10 - 14: Hot spots remain in the area</p>

		December 15: The Skirball Fire reaches 100% containment.
17	Time of initial order to evacuate and locations	Begin: 12/6/17 - Evacuation orders are issued Bel-Air around 6:20 am
18	Time when evacuation was considered completed	End: 12/7/17 - All evacuation orders are lifted for residences
19	Deaths/Injuries	0 deaths
20	The number of people evacuated	Approximately 4,600 people (ordered)
21	The location people initially evacuated	About 66% evacuated within their county of origin(Wong et al., 2021, based on a 2017 Southern California Wildfire survey data; note: not wildfire specific)
22	Reasons why people decided to evacuate	Mandatory evacuation orders; strong belief of utility loss and strong belief of fast fire spread (i.e., risk perceptions); long-term residents (more than 10 years in residence); children in the household; higher level degree (e.g., Master's or higher) (Wong et al., 2021, based on a 2017 Southern California Wildfire discrete choice model using survey data; note: not wildfire specific)
23	Evacuation type	Predominately ground transport by private vehicles
24	Any drill/education/instructions on large outdoor fires provided beforehand?	No information available
25	Personnel involved in rescue operations	Administrative Unit: Los Angeles Fire Department Cooperating Agencies: Cal Fire, California Highway Patrol, City of Los Angeles
26	Did the smoke hindered significantly the evacuation because of low visibility or health problems	Smoke conditions cause some health problems in the area for responders and citizens; unhealthy air quality is declared for parts of Los Angeles County due to Creek Fire
27	Possible causes of issues in management operations	Firefighting: With multiple fires breaking out across Southern California, firefighting resources were stretched thin. Firefighters battled flames with high winds and steep terrain in the Sepulveda Pass. Winds also fuelled the fire, increasing the threat to homes and a possible jump across I-405. Evacuations: Evacuations were ordered for the neighbourhood of Bel-Air. Residents had enough time to leave, despite some congestion in the area. Commuters experienced flames in the early morning along I-405. Poor conditions led the California Highway Patrol to close I-405 in both directions. The Getty Centre was also threatened by the fire, particularly if it jumped I-405.
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24. Thomas fire (USA), 2017

The Thomas Fire in December 2017 to January 2018 was a destructive and long-lasting wildfire that severely impacted Ventura and Santa Barbara Counties in Southern California. The fire broke out around the same time as other fires in the area including the Creek, Rye, Skirball, and Lilac fires, which are collectively known as the 2017 December Southern California Wildfires. The Thomas Fire ignited near Thomas Aquinas College along route Highway 150 due to two power lines slapping together and creating an electrical arc. A second ignition location on Koenigstein Road sparked additional flames due to a fallen conductor. The fire was fuelled by extremely high winds, low humidity, and high temperatures. Within the first 12 hours, the fire impacted 45,000 acres and led to significant evacuations in Santa Paula and Ventura. Due to shifting winds, the Thomas Fire threatened the Ojai Valley area and crossed into Santa Barbara County. With significant fuel available, the Thomas Fire impacted the communities of Carpinteria and Montecito before threatening the city of Santa Barbara. Due to rugged terrain and high winds, firefighters were unable to make significant gains on containing the fire. Later on, the fire mostly continued to spread northward into wilderness areas. With over 8,000 personnel on the ground, firefighters were able to reach containment over a month after ignition in mid-January.

The Thomas Fire was the largest wildfire in California history at the time, burning 281,893 acres. The Mendocino Complex Fire in 2018 surpassed the Thomas Fire after burning 450,123 acres. The Thomas was also one of the most destructive wildfires in California history as it destroyed 1,063 structures. The size of the fire led approximately 90,000 people to be ordered to evacuate across Ventura and Santa Barbara Counties. Two people were killed from Thomas Fire. However, with unstable soil conditions in the burn scar near Montecito, wet winter storms induced a mudslide in the community that killed 23 people. Additional details for the Thomas Fire are provided below.

1	Where?	Ventura and Santa Barbara Counties, California, USA
2	When?	12/4/2017 – 1/12/2018
3	How was the fire started?	Southern California Edison power lines slapping together; Southern California Edison fallen conductor
4	Initial fire size	50 acres
5	Area affected (burned area)	281,893 acres
6	Fuels involved in the fire	Shrub land vegetation with grassland, chaparral environment with oak woodlands
7	WUI, urban, wildland or informal settlement fires?	WUI fire, Santa Paula, Ventura, Ojai, Casitas Springs, Oak View, Carpinteria, Summerland, Montecito, Santa Barbara
8	Average weather conditions	Single digit humidity, Santa Ana winds with gusts upwards of 50 to 70 mph
9	Geographical highlights	Mountain range with steep drainages and canyons; suburban density along the WUI; Pacific ocean to the south; Los Padres National Forest; multiple wilderness areas
10	Was there any fire break? (natural or artificial)	Pacific Ocean; Highway 101; Highway 126; Highway 33, Highway 150; Highway 192; Lake Casitas

11	Did the Fire Service report extreme fire behaviour?	Red Flag Warning; fire behaviour is extreme, wind driven, long-range spotting
12	Number of structures and infrastructures affected (damaged)	1,063 structures destroyed, 280 structures damaged (additional 214 structures destroyed, 194 structure damaged from the Montecito Mudslide)
13	Estimated direct and indirect economic damage	At least \$3.2 billion in economic loss of which \$2.2 billion were insured loss across all fires in the 2017 December Southern California Wildfires (Thomas Fire was most destructive of the wildfires); approximately \$200 million in damages from the Montecito Mudslide
14	Did it occur in conjunction with multiple fires in the country?	The Thomas Fire coincided with an outbreak of other major fires including the Creek, Rye, Lilac, and Skirball Fires. These fires are collectively known as the 2017 December Southern California Wildfires. Los Angeles was most impacted by the Creek and Skirball fires. The Rye Fire threatened Santa Clarita and Six Flags Magic Mountain. The Thomas Fire impacted Ventura and Santa Barbara Counties. With all active fires, firefighting resources were spread thin throughout the region.
15	Countries involved	United States
16	Brief timeline of the key events	<p>December 4 - 6:26 pm: Two Southern California Edison power lines create an electrical arc, causing hot material to touch the ground and ignite the fire in Anlauf Canyon near Thomas Aquinas College</p> <p>December 4 - 6:42 pm: Fire engines from Ventura County respond to a 50 acre fire</p> <p>December 4 - 7:30 pm: A Southern California Edison conductor falls to the ground, sparking another fire on Koenigstein Road, which would later merge to become the Thomas Fire</p> <p>December 4 - 8:49 pm: Fire grows to 2,500 acres; mandatory evacuation orders are issued for residences in Santa Paula</p> <p>December 4 - 9:15 pm: Officials close Highway 150 between Ojai and Santa Paula</p> <p>December 4 - 9:41 pm: Fire expands quickly to 5,000 acres</p> <p>December 4 - 10:39 pm: Thomas Fire explodes to 10,000 acres with ongoing Santa Ana winds</p>

		<p>December 4 - 11:20 pm: Mandatory evacuation orders are issued for East Ventura</p> <p>December 5 - 2:21 am: Fire continues to move rapidly towards Ventura, growing to 26,000 acres with no containment</p> <p>December 5 - 3:41 am: Officials estimate that 27,000 people have already evacuated; fire at 31,000 acres with 150 structures destroyed</p> <p>December 5 - 6:06 am: Mandatory evacuation orders are issued for multiple areas in Ventura</p> <p>December 5 - 9:43 am: Fire continues to expand to 45,500 acres with over 1,000 firefighters battling the fire; erratic winds and fire behaviour is expected throughout the day</p> <p>December 6: 7:00 am: Fire grows to 65,000 acres and reaches Highway 101, northwest of Ventura; evacuation orders continue to expand across Ventura County</p> <p>December 6 - 12:22 pm: Officials estimate that evacuation orders have been issued to 50,000 people; multiple shelters are accepting evacuees</p> <p>December 6 - 7:00 pm: Thomas Fire continues to expand to 90,000 acres with just 5% containment; fire moving towards Santa Barbara County and towards Los Padres National Forest and Sespe Wilderness; parts of the Ojai Valley are issued mandatory evacuation orders</p> <p>December 7 - 7:00 am: Fire continues to move north and west towards Santa Barbara County</p> <p>December 7 - 11:00 am: Mandatory evacuation orders are issued for more locations in Ventura County near Ojai and Santa Paula</p> <p>December 8 - 7:00 am: Fire grows to 132,000 to the north and west; fire continues to threaten multiple cities including Carpinteria</p> <p>December 8 - 4:00 pm: Most evacuation orders are lifted for Ventura and Santa Paula</p> <p>December 8 - 7:00 pm: Growth to 143,000</p>
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		<p>continues to threaten structures in surrounding towns; evacuation orders are issued for areas in and near Carpinteria</p> <p>December 9 - 7:00 am: Multiple areas in Santa Barbara are issued mandatory evacuation orders</p> <p>December 10: Mandatory evacuation orders are issued for more areas of Carpinteria along with Montecito; some areas in the city of Santa Barbara are issued advisory warnings</p> <p>December 10 - 7:00 pm: Fire grows to 230,000 acres with extreme plumes and wild fire spreading</p> <p>December 11 - 7:00 am: Fire continues to threaten Carpinteria, Montecito, and Summerland; fire continues to spread north into Los Padres National Forest</p> <p>December 11: Evacuation orders continue to be lifted for Ojai and Ventura; fire continues moving towards Santa Barbara, prompting additional voluntary and mandatory evacuations</p> <p>December 12 - 7:00 am: Containment grows to 20% but high winds threaten multiple communities, in particular in Santa Barbara County</p> <p>December 13: Fire threatens multiple neighbourhoods in northern Santa Barbara; plume and wind driven runs continue to hamper firefighting efforts; areas of Fillmore remain threatened on the eastern side of the fire; some evacuation orders are lifted in Santa Barbara county in areas with less fire spread</p> <p>December 14: Fire continues to surround multiple cities along the coast and Fillmore in Ventura County; acreage rises to 249,500 with total firefighting costs already exceeding \$80 million</p> <p>December 15: Firefighters grow containment to 35% and some mandatory evacuation orders in Santa Barbara County are lifted</p> <p>December 16: Strong winds cause rapid growth along the Santa Barbara front, leading to structure damage in Montecito; winds also impact the northern front near Fillmore; parts of the city of</p>
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		<p>Santa Barbara are issued mandatory evacuation orders</p> <p>December 17: Some mandatory evacuation orders in the Santa Barbara area are lifted; total acreage sits at 270,000 with 45% containment; poor conditions remain</p> <p>December 18: Repopulation continues across the area with improving humidity conditions</p> <p>December 19: While Montecito remains an area of concern, firefighters strengthen lines across the fire</p> <p>December 20 to December 21: Repopulation continues across Santa Barbara and Ventura Counties; the only uncontrolled fire edge is along the northern section, in mostly wilderness areas</p> <p>December 22 to January 8: Containment grows slowly with rugged terrain in mostly wilderness areas; most structures are no longer threatened</p> <p>January 9: A mudslide is started due to high soil saturation in the burn scar area near Montecito, killing 23 people, destroying 214 structures, and leading to upwards of \$200 million in damages</p> <p>January 10 to January 11: With wet conditions, the last hot spots are put out quickly</p> <p>January 12: The Thomas Fire is 100% contained, burning 281,893 acres, becoming the largest wildfire in California history</p>
17	Time of initial order to evacuate and locations	<p>Begin: 12/4/17 - Evacuation orders are issued around 8:49 pm for parts of Santa Paula</p> <p>Additional: 12/4/17 - East Ventura</p> <p>Additional: 12/5/17 to 12/7/17 - Ventura, Ojai, and multiple areas of Ventura County</p> <p>Additional: 12/8/17 to 12/16/17 - Carpinteria, Montecito, Santa Barbara, and multiple areas of Santa Barbara County</p> <p>Additional: 1/9/18 – Montecito for mudslides</p>
18	Time when evacuation was considered completed	<p>End: 12/21/17 - Most evacuation orders are lifted for residences for the wildfires</p>

19	Deaths/Injuries	2 deaths (with an additional 23 from the Montecito Mudslide)
20	The number of people evacuated	Approximately 90,000 people (ordered)
21	The location people initially evacuated	About 66% evacuated within their county of origin (Wong et al., 2021, based on a 2017 Southern California Wildfire survey data; note: not wildfire specific)
22	Reasons why people decided to evacuate	Mandatory evacuation orders; strong belief of utility loss and strong belief of fast fire spread (i.e., risk perceptions); long-term residents (more than 10 years in residence); children in the household; higher level degree (e.g., Master's or higher) (Wong et al., 2021, based on a 2017 Southern California Wildfire discrete choice model using survey data; note: not wildfire specific)
23	Evacuation type	Predominately ground transport by private vehicles
24	Any drill/education/instructions on large outdoor fires provided beforehand?	No information available
25	Personnel involved in rescue operations	Administrative Unit: Los Angeles Fire Department Cooperating Agencies: CAL FIRE, Ventura County Fire, Ventura County Sheriff, Santa Barbara County Fire, Santa Barbara County Sheriff, Santa Barbara City Fire, City of Ventura Fire, City of Ventura Police Department, USFS/Los Padres National Forest, CAL OES, Red Cross, Southern California Edison, CHP, California Dept. of Corrections and Rehabilitation, SoCalGas, Santa Paula Police, Santa Paula Fire, Ventura County OES, Santa Barbara OEM, Montecito Fire, Carpinteria – Summerland Fire, California Conservation Corp Total fire personnel: +8,000 Total fire engines: +1,000
26	Did the smoke hindered significantly the evacuation because of low visibility or health problems	Smoke conditions cause significant health problems in the area for responders and citizens; unhealthy air quality across the region; increase in hospital visits due to air quality
27	Possible causes of issues in management operations	Firefighting: With multiple fires breaking out across Southern California, firefighting resources were stretched thin. Firefighters battled flames with high winds and steep terrain in the mountains above Santa Paula and Ventura. With dry conditions and significant fuel, fire spread rapidly first towards Ventura and then along the

		<p>coast to Santa Barbara. Firefighters were unable to build containment lines due to the poor conditions and the sheer size of the fire.</p> <p>Evacuations: Evacuations were ordered across the region including the communities of Santa Paula, Ventura, Ojai, Carpinteria, Montecito, and Santa Barbara. Communication was a challenge in the beginning hours of the fire, particularly in notifying residents of Ventura. Some emergency calls were not transferred to the dispatch centre and a significant number of residents had not signed up for emergency alerts. Power outages also hampered evacuations. Despite significant road closures due to fire, evacuations proceeded relatively smoothly. Bus services were reduced but local transit agencies remained on alert if they were needed to evacuate citizens.</p> <p>Montecito Mudslide: Due to saturated soil from recent rain along the burn scar near Montecito, multiple mudslides were triggered on January 9th. Despite mandatory and voluntary evacuation orders, most residents remained in the danger zone. The mudslides destroyed 214 structures and killed 23 people. After the event, Santa Barbara County officials removed “voluntary” from its evacuation terminology.</p>
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25. Tubbs fire (USA), 2017

The Tubbs Fire in October 2017 was a destructive and deadly wildfire that severely impacted Sonoma and Napa counties in Northern California. The Tubbs Fire also coincided with multiple other wildfires – particularly the Atlas, Tubbs, and Pocket Fires – which are collectively known as the 2017 October Northern California Wildfires. The Tubbs Fire ignited near Calistoga due to a failed private electric system (local utility PG&E was not found at fault). With poor weather conditions, gusts up to 60 mph, and challenging terrain, the fire spread quickly into the wildland-urban interface downhill toward Santa Rosa. Due to the speed of the fire, officials were either unable to issue evacuation orders or issued orders too late. Most people learned about the fire due to smelling smoke, hearing falling trees, or seeing the fire. Within just several hours of igniting, the Tubbs fire reached heavily populated neighbourhoods of Santa Rosa including Fountaingrove, along with nearby Larkfield-Wikiup. Congestion became a major issue as fire spread across Highway 101, impacting the neighbourhood of Coffey Park. After the first day, the Tubbs Fire remained active, threatening other communities along the wildland-urban interface. Over the next several weeks, firefighters were able to contain the Tubbs Fire, reaching 100% containment in late October.

Approximately 100,000 people were ordered to evacuate from the 2017 October Northern California Wildfires. The Tubbs Fire impacted multiple dense communities and it is estimated that around 50,000 people were ordered to evacuate. The Tubbs Fire was one of the most destructive wildfires in California history, destroying 5,635 structures and killing 22 people. Most individuals killed in the fire were unable to escape their homes. Due to the devastation, multiple reports were issued, documenting the challenges faced by officials during the evacuation. Most scrutinized was the notification process, which often failed to reach people fast enough to alert them to evacuate. Firefighting was also a challenge in the dense communities within Santa Rosa. With multiple fires across the Northern California area, firefighting resources were spread extremely thin, leading to slow response against all fires in the region. Additional details are provided below.

1	Where?	Sonoma County, Napa County, California, USA
2	When?	10/8/2017 – 10/31/2017
3	How was the fire started?	Sparks from a failed private electrical system
4	Initial fire size	Unknown
5	Area affected (burned area)	36.907 acres
6	Fuels involved in the fire	Hardwood woodland and shrub land vegetation with grassland, some coniferous forest, and agriculture land (mostly viticulture), structure
7	WUI, urban, wildland or informal settlement fires?	WUI fire, Santa Rosa, Calistoga, Windsor
8	Average weather conditions	Warm temperatures, low humidity, high winds especially along ridge lines; Red Flag Warning; gusts in the region reaching 70 mph in some locations
9	Geographical highlights	Mountain range and rolling hills with steep drainages and canyons; heavily wooded area surrounded by viticulture; suburban density in the city of Santa Rosa
10	Was there any fire break? (natural or artificial)	Highway 101, Highway 12, Highway 128, Highway 29

11	Did the Fire Service report extreme fire behaviour?	Red Flag Warning, rapid fire development spreading quickly to the south, overwhelming firefighting efforts and entering the city of Santa Rosa with little notice, wind speeds of up to 50 mph pushing fire downhill and allowing burning embers to leap ahead
12	Number of structures and infrastructures affected (damaged)	5,636 destroyed, 317 damaged
13	Estimated direct and indirect economic damage	\$15 billion in direct damages across all 2017 October Northern California Wildfires
14	Did it occur in conjunction with multiple fires in the country?	Five large fires burning simultaneously in Northern California in October (Atlas, Partrick, Nuns, Tubbs, Pocket) with multiple smaller fires, which are collectively known as the 2017 October Northern California Wildfires. The Atlas, Partrick, and Nuns are collectively known as the Southern LNU Complex. Later, the Noorbom, Adobe, and Pressley Fire would merge with the Nuns Fire and were included in the Southern LNU Complex. The Nuns Fire and associated fires would be reclassified again as the Central LNU Complex. The Tubbs and Nuns Fires most directly impacted residences and were the most destructive of the fires. With all fires igniting within a few hours, firefighting was nearly impossible and communication with residents and across agencies was challenging.
15	Countries involved	United States
16	Brief timeline of the key events	<p>October 8 - 9:43 pm: Tubbs Fire begins near Bennett Lane outside Calistoga due to faulty private electrical equipment</p> <p>October 8 - 10:00 pm: Highway 128 is shut down due to downed trees</p> <p>October 8 - 10:51 pm: Sonoma County Sheriff's Office sends its first alert regarding multiple fires in the county</p> <p>October 8: 11:03 pm: With rapid fire spread, mandatory evacuation orders are issued for Porter Creek Road and Petrified Forest Road</p> <p>October 8: 11:30 pm: Additional Nixle alerts are sent to the public recommending evacuations</p> <p>October 8: 11:58 pm: Fire spreads past Porter Creek Road and mandatory evacuation orders are</p>

		<p>issued for all areas between Calistoga and Santa Rosa</p> <p>October 9: 1:00 am: The Tubbs fire spreads quickly towards Santa Rosa, destroying multiple structures and killing six people</p> <p>October 9: 1:12 am: Firefighters warn that fire could reach the Santa Rosa City limits within an hour</p> <p>October 9: 1:40 am: Fire marshals issue mandatory evacuation orders for Fountaingrove and Skyfarm</p> <p>October 9: 2:00 am: Fire spreads deep into Santa Rosa; begins destroying the neighbourhoods of Larkfield-Wikiup and Fountaingrove</p> <p>October 9: 2:00 am - 3:00 am: Fire jumps Highway 101, surprising officials and catching residents of Coffey Park off guard; evacuation is hurried and chaotic</p> <p>October 9: 3:00 am: Fire begins destroying the neighbourhood of Coffey Park and multiple other neighbourhoods; Kaiser Permanente Santa Rosa Hospital and Sutter Health Hospital evacuate patients; fire perimeter stops just short of the Kaiser Permanente Hospital</p> <p>October 9: 4:00 am: Over the next several hours, fire slows but continues to spread into dense neighbourhoods including a mobile park</p> <p>October 9: Fire continues to burn in and around structures; lower temperatures during the day along with higher humidity help firefighters; overnight, fire continues to expand</p> <p>October 10: 10:00 am: Tubbs Fire reaches 27,000 acres with 0% containment</p> <p>October 10: 7:00 pm: Reports indicate that firefighters are having trouble navigating downed trees and power lines; some relief with cooler temperatures is expected</p> <p>October 11 - 10:00 pm: Ongoing fire spreading to the north and east leads to new mandatory evacuation orders for Calistoga and</p>
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		<p>unincorporated Sonoma County near Windsor, Geyserville, and along Highway 128</p> <p>October 12 - 7:00 am: Fire grows to 34,000 acres but with 10% containment</p> <p>October 13 - Officials begin permitting re-entry to some impacted areas; containment grows to 44%</p> <p>October 14 - October 30: Fire containment continues to grow; evacuation orders are also slowly reduced; some residents experience challenges returning to impacted areas</p> <p>October 31: The Nuns Fire is 100% contained</p>
17	Time of initial order to evacuate and locations	<p>Begin: 10/8/17 - Evacuation orders are issued for areas between Calistoga and Santa Rosa at 11:03 pm</p> <p>Additional: 10/8/17 - Orders are issued for additional areas towards Santa Rosa and eventually Fountaingrove, Larkfield-Wikiup, and Coffey Park</p> <p>Additional: 10/11/17 - Orders are issued for Calistoga and multiple areas near Windsor and Geyserville</p>
18	Time when evacuation was considered completed	End: 10/23/17 - Most mandatory evacuation orders are lifted for residents and re-entry is allowed in most damaged areas
19	Deaths/Injuries	22 deaths
20	The number of people evacuated	100,000 people ordered to evacuate across all 2017 October Northern California Wildfires (note: required evacuations of dense neighbourhoods, 50,000 estimated)
21	The location people initially evacuated	Additional data required
22	Reasons why people decided to evacuate	Additional data required
23	Evacuation type	Predominately ground transport by private vehicles
24	Any drill/education/instructions on large outdoor fires provided beforehand?	No information available
25	Personnel involved in rescue operations	<p>Unified Command: Cal Fire</p> <p>Cooperating Agencies: Santa Rosa PD, Sonoma County OES, Sonoma County Sheriff's Office, CAL OES, CHP, Caltrans, and CA National Guard. Napa County OES, Napa County Sheriff's Office, Lake County Sheriff's Office, Lake County</p>

		<p>OES, Calistoga City Fire, California Conservation Corp.</p> <p>Total fire personnel: +1,000 (may include personnel from other fires)</p> <p>Total fire engines: +100 (may include engines from other fires)</p>
26	Did the smoke hindered significantly the evacuation because of low visibility or health problems	<p>Significant smoke in the area that caused severe health issues; smoke from the 2017 Northern California Wildfire severely impacted the San Francisco Bay Area, leading to extremely unhealthy air quality for weeks; AQI over 400 in Napa, rising to just below 200 in San Francisco and Oakland, and hitting 150 in Gilroy (over 100 miles away)</p>
27	Possible causes of issues in management operations	<p>Evacuations: The Tubbs Fire grew rapidly, aided by strong winds. Officials were caught off-guard by the speed of the fire, leading to hasty evacuation orders. Consequently, some people were unable to evacuate their homes and were overrun by fire. Evacuations also caused severe congestion in multiple neighbourhoods in Santa Rosa. Highway 101, a major thoroughfare, was surrounded by fire, which severely impacted evacuations. The highway was also heavily congested in both directions away from the fire. Many individuals had only a few minutes to evacuate due to the speed of the flames. Both major hospitals in Santa Rosa evacuated and the fire stopped just short of Kaiser Permanente Hospital. Several buses from the public transit agency Santa Rosa CityBus were able to evacuate assisted living residents, apartments, and hospitals.</p> <p>Firefighting: The Tubbs Fire threatened and impacted multiple developed neighbourhoods along the WUI. The outbreak of multiple fires in the region made firefighting difficult and spread resources thin. Firefighters were also unable to stop the fire expanding rapidly downhill towards Santa Rosa. With embers creating new fires ahead of the main blaze, firefighters were overwhelmed and were unable to establish any fire breaks. The Tubbs Fire also jumped Highway 101, a major four-lane road that splits Santa Rosa.</p> <p>Notifications: Due to the speed of the Tubbs Fire, officials were sometimes unable to issue evacuation orders. Officials did not send out information about the Tubbs Fire until about one</p>

		<p>hour after starting. While mandatory evacuation orders began to be issued, the fire grew too quickly and people did not have enough time to evacuate. Officials also failed to warn residents of Santa Rosa fast enough before fire reached suburban neighbourhoods. Reports also note that some individuals may have failed to receive the evacuation orders due to communication challenges. Moreover, citizens sometimes experienced delays in the arrival of the message and many residences had not signed up for the opt-in emergency alert system. Most people learned of the fire by smelling smoke, hearing trees fall, or seeing the fire. Sonoma County also decided against using the Wireless Emergency Alert (WEA) system, out of the fear of causing a panic and additional congestion. Many individuals who attempted to call 911 did not receive full information on the fire location, evacuation orders, or potential routes. Due to notification challenges, officials sometimes had to go door-to-door and notify people through sirens.</p> <p>Shelters: Due to the speed of the fire, shelters were quickly filled to capacity leading to overcrowding. Moreover, the American Red Cross arrived later than expected as the organisation was obligated to assist in other disasters in California. Multiple shelters relied heavily on volunteers and community organisations. Some residents were sent to shelters in Marin and Solano counties due to overcrowding.</p>
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26. Victoria fire (Australia), 2009

The Victoria fire of 2009, also known as Black Saturday 2009 bushfire in Victoria, was the most disastrous fire in Victorian history causing the deaths of 173 people, burnt land of 4500 km², and an economic cost of A\$4.4billion (or US\$2.8billion). The Black Saturday fire started due to extreme weather conditions around February 7th with Victoria experiencing a heatwave for a week during the 2008-09 summer season with temperatures reaching ~45°C in- and around- Melbourne days before the bushfire. The Victorian government issued a warning of bushfires in early February of increased likelihood of severe bushfires in the upcoming days using radio, news media, and related websites. Residents from bushfire prone zone were asked to evacuate.

1	Where?	Near Melbourne, Victoria, Australia
2	When?	07/02/2009-14/02/2009
3	How was the fire started?	Majority of the fires were natural, some were started by direct or indirect results of human activity such as failure in electricity network, accidental
4	Initial fire size	15 significantly damaging bushfires breakout at different locations across Victoria
5	Area affected (burned area)	4500 km ²
6	Fuels involved in the fire	Grassland, shrubland, bushland, and predominantly eucalyptus globulus, and pine plantations and forests. Structures
7	WUI, urban, wildland or informal settlement fires?	WUI fire
8	Average weather conditions	The vegetation was exposed to a severe heatwave during the last week of January 2009 with temperature reaching to ~43°C. The ambient condition during the bushfire were 40°C by 11.00am in Melbourne while some parts of Victoria recorded temperature as high as 46.4°C with strong wind (~100 km/h), and relative humidity dropping to 2% causing the generation of pyrocumulus clouds and firestorm in the Kinglake- Maryville region.
9	Geographical highlights	Upslope, downslope, valley, hill top, flatland near the WUI were present when compiling with all the fires recorded
10	Was there any fire break? (natural or artificial)	River, highway, lakes, dams
1	Did the Fire Service report extreme fire behaviour?	316 bushfires in grassland, shrubland, and forest were observed out of which 15 were large scale and disastrous fire.
12	Number of structures and infrastructures affected (damaged)	~3500 structures destroyed -2133 houses -59 commercial properties (e.g. pubs, club) -12 community properties (e.g. school, church, fire station)
13	Estimated direct and indirect economic damage	Estimated damage was over AU\$4.4billion (or US\$2.8billion) including the government

		estimated cost of lives but excluding the cost of damage to crops, livestock, pasture, injuries, uninsured or partially insured properties
14	Did it occur in conjunction with multiple fires in the country?	Yes
15	Countries involved	National support came from Queensland, New South Wales, Southern Australia, ACT, Western Australia, Tasmania, International support came from New Zealand, Canada, and the US.
16	Brief timeline of the key events	<p>On the evening of February 6th, 338 firefighting personnel from CFA and DSE deployed across the state in anticipation of extreme bushfire event on February 7th. On February 7th, the temperature reached ~40°C and wind strength reached 100 km/h at 11 am. At 11.50 am, an electricity pole in the Kinglake area started the fire. The CFA and DSE attempted to extinguish the resultant fire. The temperature in Melbourne topped 46°C around 3 pm leading to over hundred fires across Victoria. The sudden change in the wind direction in Melbourne caused the formation of a fire column in the Kinglake area producing spotting across tens of kilometres. The smoke plume and resultant pyro-cumulus cloud reached up to 15 km in height at around 6 pm. Approximately 200 people were evacuated by the Victorian Police when one of the officers suspected that the Kilmore fire (at Kinglake) would worsen. The air conditions were so severe that the firefighting aircraft were not allowed to take off to map the Kilmore area.</p> <p>The Victorian resident population were following the ‘Stay or Go’ policy, as instructed and trained. Although this policy was deemed successful in previous bushfires it was inadequate in the 2009 incident given the extreme nature of the conditions faced. Roughly 7500 people were evacuated. Congestion and delayed firefighter access to key sites were observed. By 9 pm (on the Feb. 7th), the first fatality was confirmed and many people with burn injuries were admitted to Melbourne hospitals. Smoke hindered the evacuation process in other associated fires (e.g. Beechworth, Bunyip State Park, and Weerite fire). At 10 pm, Victorian Police estimated 14 fatalities.</p> <p>The Kilmore East fire merged with the Murrindindi Mill fire on February 8th, with fatalities rising to 25. Over the next few days, more severe fires erupted across Victoria (e.g.</p>

		Dandenong and Ottway fires developing on the February 23 rd). The Kilmore fire was contained on March 4 th , helped by changes in the weather and the arrival of rain. The severity of this fire made significant changes in the bushfire policy of Australia, specifically in the area of Victoria.
17	Time of initial order to evacuate and locations	-1 week prior (initial warning of bad weather conditions in Victoria) -1 day prior (Warning of severe weather on February 7 th)
18	Time when evacuation was considered completed	-1 day to few minutes before the fire reached
19	Deaths/Injuries	Deaths: 173 Injuries: 414
20	The number of people evacuated	~7562
21	The location people initially evacuated	No information available as many people living in bushfire prone zone evacuated early on their own after getting intimation from local authorities and fire service personnel
22	Reasons why people decided to evacuate	Evacuation was recommended as per order issues by local authorities with residents following leave early or defend policy, many resident late evacuated after they see the actual fire coming, mandatory order (Kilmore area)
23	Evacuation type	-Warning from the 28th of January 2009 in regards to high bushfire prone conditions were released through media and radio to the community (the instructions were to follow the 'Stay or Go' policy), people who evacuated early used their personal vehicular transport for evacuation even a night before Black Saturday 2009 -A day before the bushfire, the Government released a warning due to extreme conditions and a very high probability of fire on February 7 th by radio, website and media - People alerted predominantly by local radio, community radio, websites. -Police authorities evacuated ~200 people in person in Kinglake area just before the firestorm hit in response to seeing the formation of pyrocumulus
24	Any drill/education/instructions on large outdoor fires provided beforehand?	CFA personnel have been trained to combat bushfires
25	Personnel involved in rescue operations	358 people deployed on the evening of February 6 th from Country Fire Authority (CFA) and Department of Sustainability and Environment (DSE) [now: Department of Environment, Land, Water and Planning (DELWP)] Minister Police and Emergency Services

		<p>Incident Management Teams (IMT) Victoria Police Municipal Emergency Coordination Centres Over 5000 firefighters, 19000 CFA members, 17 aircrafts, uncounted volunteers, police personnel, private and industrial firefighters</p>
26	Did the smoke hindered significantly the evacuation because of low visibility or health problems	Smoke hindered the evacuation process in other fires like Beechworth, Bunyip State Park, and Weerite fire in Victoria. In Kinglake area, the smoke reached as high as 15km in height significantly affecting the evacuation and the mapping of the fireline, causing deaths
27	Possible causes of issues in management operations	CFA and DSE trialled their first joint operation which lacked clarity in authority in-charge and hence, carried out many of evacuation jobs in duplicate. Further, there were communication issues between the state and commonwealth government regarding the use of an aircraft carrier for suppression which delayed the use of aircrafts. Improper roadblocks affected the response of fire trucks and firefighters which posed a hurdle by denying the access.
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27. Västmanland fire (Sweden), 2014

The 2014 Västmanland wildfire was a wildfire that started during the afternoon of the 31st of July 2014 on the border between Sala Municipality and Surahammar Municipality in Västmanland, Sweden. It was Sweden's largest wildfire in 40 years. Fire suspected to be start by a vehicle fire near a wildfire prone region which was exposed to severe weather in the summer season (see below).

1	Where?	Sala Municipality, Västmanland, Sweden
2	When?	31/07/2014 – 11/09/2014
3	How was the fire started?	Accident; fire started in a ground-preparation vehicle (scarification machine) in the forest
4	Initial fire size	30x30 m then 400x600 m (after 40 min)
5	Area affected (burned area)	138 km ²
6	Fuels involved in the fire	Ground was extremely dry after a heat wave. Coniferous forest (86%) mostly made of pine forest (65%). Only 4% covered by deciduous forest. Forest floor was made of berry bushes. Low moisture content due to the weather. Structures
7	WUI, urban, wildland or informal settlement fires?	WUI and it threatened the urban area of Ängelsberg and the world heritage site Engelsberg.
8	Average weather conditions	It happened after a month of hot and dry weather (forest fire index was 5E which corresponds to the highest scale, extreme high fire risk [Swedish forest fire risk is calculated using the Canadian Fire Weather Index (FWI) system]. Less than 20 mm of rain during the month before the fire. Relative humidity was at 50-60% daytime in July and it dropped to 30-40% some days before ignition. Wind was at 40 km/h on 31/07, 43 km/h on 01/08, 22 km/h on 02/08 and 43 km/h on 03/08 and 04/08. On the 4-5/08 peaks of 27-34° C.
9	Geographical highlights	Mostly flat with an altitude of 100-120 m (above sea level), except from the northernmost part where there is the Stora Hoberget mountain (178 m above sea level)
10	Was there any fire break? (natural or artificial)	Kolbäcksån river valley and the lakes Virsbosjön and Åmängen limit the fire on the West. Svartån river valley and the lakes Fläckesjön and Hördesjön limit the fire on the East. Lake Snyten is a limit in the north.
11	Did the Fire Service report extreme fire behaviour?	High spread rate
12	Number of structures and infrastructures affected (damaged)	30 properties destroyed The roads 256 (Norberg-Hastebäck-Västerfärnebo), 664 (Västanfors-Ängelsberg), 668 (Ramna-Virsbo-Ängelsberg-Hastebäck), 681

		(Rörbo-Västerfärnebo), 685 (Ramna-Rörbo), 756 (Olsbenning- Karbenning-county road 256), 758 (Karbenning - Karbenning church) and 759 (Hökmora-Karbenning church) were closed entirely or partly. The entire airspace over the fire area was blocked to other aircraft than those used in the rescue work. The evening of August 4 the forest fire caused a power outage in Vattenfall's network.
13	Estimated direct and indirect economic damage	138 km ² of forest destroyed. Preliminary figures for the insurance is between 196,000 SEK (or US\$23500) (Norberg) and 720,000 SEK (or US\$86500) (Sala) for the four municipalities directly affected. 5,000,000 SEK (US\$0.6million) per day were estimated by the Norberg Municipality to be spent on rescue operations on the 7 th of August. 300,000,000 SEK (US\$37million) were allocated by the government to the Swedish Contingency Agency for expenses (250million SEK for firefighting and 50million SEK for surveillance and other activities). Approximately 98% of the 9 600 ha of forest was affected by the fire, with a subsequent economic loss of almost 1 billion SEK (US\$123 million).
14	Did it occur in conjunction with multiple fires in the country?	No
15	Countries involved	National, Sweden (initially), then support for special forest-fire airplanes from Italy and France (delayed by bad weather, they arrived on the 6 th of August).
16	Brief timeline of the key events	<ul style="list-style-type: none"> - On 31 July at 13:29, SOS alarm. Wrong assessment of the initial position of the fire by the fire brigade. Mistake discovered in approx. 30 min. Two fire trucks, a tanker, two passenger cars and two command vehicles arrive on scene after 40 minutes. When fire trucks arrive, the fire is 300x500m. In the afternoon, the incident commander assessed they needed more assistance and alert other stations. Water bombing in the evening with a private helicopter. An armed force helicopter reaches the fire scene in the evening. Request from support to the defence force is left - On 1st of August, Sala-Haby rescue service is in command. In reality there are two separate responses by two organisations. Fire intensity increased in the afternoon. Firefighting with water cannons and helicopter doing water bombing (private and from armed force). - On the 2nd of August, change in wind direction. 70 firefighters involved. Water

		<p>bombing with helicopter continues. Police and armed force involved.</p> <ul style="list-style-type: none"> - On the 3rd of August, there was less wind and more humidity in the air. 2700 ha and 100 firefighters are involved. - The 4th of August was a warm day with wind, quick fire spread. One person is killed and 1 injured. 200 people involved in response. - On the 5th of August, less wind and more humidity and rain. - On the 6th of August fire did not spread. Rains produced favourable weather conditions. - On the 11th of August it rained again. Response organisations take control of the fire. - On the 11th of September, the rescue operation is officially terminated.
17	Time of initial order to evacuate and locations	Afternoon of the 4 th of August, the decision to evacuate Gammelby is taken. In the evening, also Ängelsberg and Västervåla are evacuated. Evacuation is on route 256.
18	Time when evacuation was considered completed	5 th of August, 1000 people evacuated.
19	Deaths/Injuries	1 death/1 injury
20	The number of people evacuated	1000+
21	The location people initially evacuated	No information available
22	Reasons why people decided to evacuate	Mandatory order by local authorities (based on parts 17 and 22)
23	Evacuation type	Mostly using public announcement (IPA system, Important Public Announcement). In one of the villages, Gammelby, (on the 04/08, with 100 inhabitants) evacuation was needed so quickly that there was no time for using the IPA. Firemen and policemen perform the evacuation directly door-to-door. An evacuation of 4,500 people was threatened (20 busses were ready in Norberg for this).
24	Any drill/education/instructions on large outdoor fires provided beforehand?	No information available
25	Personnel involved in rescue operations	Swedish defense force, Swedish and rescue services, forest company, private citizens approx. 200 firefighters Private helicopter, Armed force helicopter, Italian and French special forest-fire planes, ground firefighting
26	Did the smoke hindered significantly the evacuation because of low visibility or health problems	Extensive smoke around the fire area, but smoke did not significantly hindered evacuation.

27	Possible causes of issues in management operations	Inadequate situational awareness and great difficulties in the coordination of resources (especially given the number of responding agencies). This is mostly due to the lack of clear procedure in leadership of operations. Delayed intervention due to human error.
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29	Name/Surname/Email/Date of who filled in this template	Ronchi, E., Rein, G., Gwynne, S., Wadhvani, R., Intini, P., & Bergstedt, A. (2017). e-Sanctuary: Open Multi-Physics Framework for Modelling Wildfire Urban Evacuation. Quincy, MA (USA)

28. Woolsey fire (USA), 2018

The Woolsey Fire in November 2018 was a fast-moving wildfire that severely impacted Ventura and Los Angeles Counties, especially the town of Malibu, California, burning just under 100,000 acres. Igniting in the Santa Susana Mountains, the Woolsey Fire was fuelled by dry vegetation, high winds, and low humidity. While the fire remains under investigation, preliminary reports indicate that the fire originated from electrical equipment owned by Southern California Edison. The fire began relatively small, only threatening several smaller communities. However, with resources being diverted to the nearby Hill Fire and worsening conditions, the Woolsey Fire spread rapidly, overrunning communities and leading thousands to evacuate within two days. After jumping Highway 101, the fire quickly spread throughout the Santa Monica Mountains to Malibu. The city was ordered to evacuate and thousands more in surrounding communities were also ordered to leave. With Highway 101 and multiple other routes blocked by fire, congestion was heavy, especially along the Pacific Coast Highway. Contraflow was instituted along the highway to try to increase throughput of vehicles. The Woolsey Fire eventually spread to the Pacific Ocean and was at one point, 14 miles wide. The fire reached rapid containment due to favourable conditions just two weeks after igniting.

Approximately 300,000 people were ordered to evacuate from the Woolsey Fire and 3 people were killed. The fire was also one of the most destructive wildfires in California, leading to approximately \$6 billion in damages with over 1,600 structures destroyed. The fire occurred on the same day as the deadly Camp Fire in Butte County and the smaller Hill Fire in Ventura County. The Hill Fire received the bulk of firefighting resources in the early hours of both fires, which played a key role in the rapid development of the Woolsey Fire. Additional details are provided below.

1	Where?	Ventura County and Los Angeles County, California, USA
2	When?	11/8/18 - 11/21/18
3	How was the fire started?	Southern California Edison electrical equipment (under investigation)
4	Initial fire size	5 acres
5	Area affected (burned area)	96,949 acres
6	Fuels involved in the fire	Mixed including chaparral shrub-land, grassland, and oak woodlands, structures
7	WUI, urban, wildland or informal settlement fires?	WUI fire, impacted the communities of Thousand Oaks, Oak Park, Westlake Village, Agoura Hills, West Hills, Simi Valley, Chatsworth, Bell Canyon, Hidden Hills, Kevington, Malibu, and Calabasas. Malibu was especially hard hit.
8	Average weather conditions	Prior to fire, dry conditions in the area along with Santa Ana winds; during the wildfire, winds up between 29 and 34 mph; gusts of wind up to 60 mph.
9	Geographical highlights	Chaparral mountain range and foothills with nearby valleys and coastal range; impacted the Santa Susana and Santa Monica Mountain Ranges which are characterized by rolling hills along with narrower canyons and multiple drainages; fire also

		reached the coastal areas around Malibu and Pepperdine.
10	Was there any fire break? (natural or artificial)	Pacific Ocean near Malibu; Highway 101, Pacific Coast Highway (CA-Highway 1)
11	Did the Fire Service report extreme fire behaviour?	Red flag warning; critical fire weather conditions fuelled by high Santa Ana winds; rapid fire spreading
12	Number of structures and infrastructures affected (damaged)	1,643 structures destroyed, 364 structures damaged
13	Estimated direct and indirect economic damage	Approximately \$6 billion USD in damages
14	Did it occur in conjunction with multiple fires in the country?	Occurred the same day as the Camp Fire in Butte County. Resource overlap with state air tankers. Occurred at the same time as the nearby Hill Fire. With the Hill Fire threatening more people, significant firefighting resources were diverted away from the Woolsey for the Hill Fire. Reports indicate that even as the Woolsey Fire grew, the number of personnel remained high at the Hill Fire. A lack of unified command and jurisdictional differences contributed to the confusion on the ground, allowing the Woolsey Fire to grow rapidly.
15	Countries involved	United States
16	Brief timeline of the key events	<p>November 8, 2:30 pm: Fire begins at the Santa Susana Field Laboratory, property of Boeing</p> <p>November 8, 2:50 pm: First personnel arrive at the Woolsey fire; due to the location of the fire near the county line separating Los Angeles and Ventura counties, command structure and resource deployment is unclear</p> <p>November 8, ~5:40 pm: Mandatory evacuation orders are issued for Bell Canyon</p> <p>November 8, 7:30 pm: 150 firefighters battle the Woolsey fire, but 400 firefighters are deployed to the Hill Fire which threatens more structures and people</p> <p>November 9, 12:00 am: Fire spreads quickly in the Santa Susana Mountain Range due to resources being diverted to the nearby Hill Fire; mandatory evacuations are quickly ordered for Oak Park</p> <p>November 9, 2:20 am: Mandatory evacuation order are given for Kevington and the fire threatens over 30,000 homes</p>

		<p>November 9, 5:15 am: Fire moves rapidly south, jumping Highway 101; mandatory evacuations are issued for multiple communities and neighbourhoods south of Highway 101</p> <p>November 9, 10:00 am: Fire size increases rapidly with ongoing winds; Malibu is ordered to evacuate</p> <p>November 9, ~12:00 pm: Fire reaches heavily populated areas of Malibu; over the next few days, fire would reach all the way to the Pacific Ocean; students at Pepperdine University shelter in place</p> <p>November 10-11: Firefighters begin to make progress against the fire but additional evacuations occur in the hills along the San Fernando Valley</p> <p>November 12: Firefighting remains challenging, especially after a power shutout by Southern California Edison leads to decreased water pressure</p> <p>November 13-20: Fire continues to burn but containment is rapid</p> <p>November 21: Woolsey Fire reaches 100% containment</p>
17	Time of initial order to evacuate and locations	<p>Begin: 11/8/18 (10:00 am) - Bell Canyon</p> <p>Additional: Ongoing evacuations across the region</p> <p>Additional: 11/9/18 (12:15 am) - Oak Park</p> <p>Additional: 11/9/18 (10:00 am) - Malibu</p>
18	Time when evacuation was considered completed	End: 11/23/18 - All areas of Malibu are considered repopulated
19	Deaths/Injuries	3 deaths
20	The number of people evacuated	Approximately 300,000 people (ordered)
21	The location people initially evacuated	No information available
22	Reasons why people decided to evacuate	Additional data needed
23	Evacuation type	Predominately ground transport by private vehicles.
24	Any drill/education/instructions on large outdoor fires provided beforehand?	No information available
25	Personnel involved in rescue operations	<p>Administrative Unit: Ventura County Fire Dept. and Los Angeles County Fire Dept.</p> <p>Cooperating Agencies: Southern California Edison, Southern California Gas Company, California Department of Corrections and</p>

		<p>Rehabilitation (CDCR), California Conservation Corps (CCC), California Department of Fish & Game, California Highway Patrol, Public Health Department, California State Parks, Caltrans, Ventura County Animal Control, LA County Animal Control, Office of Emergency Management, American Red Cross, Los Angeles Police Department, Los Angeles City Fire Department</p> <p>Total fire personnel: 1,086</p> <p>Total fire engines: 265</p>
26	Did the smoke hindered significantly the evacuation because of low visibility or health problems	<p>Extremely poor visibility greatly impacted evacuations and led to additional car accidents. Air quality was poor during the fire but did not drift far.</p>
27	Possible causes of issues in management operations	<p>Firefighting Resources: The nearby Hill Fire threatened more homes and people. Consequently, Ventura County sent most of its resources to combat the Hill Fire. Los Angeles County, through mutual aid, arrived at the Woolsey Fire but a unified command structure remained lacking during the early hours of the fire. With the Woolsey Fire growing rapidly, resources were not enough to keep the fire in check. The fire quickly overran neighbourhoods, jumped the 101 Highway, and spread to the Pacific Ocean and Malibu.</p> <p>Evacuation: Congestion during the evacuation was heavy, especially along the Pacific Coast Highway, leading officials to institute contraflow. However, older individuals and individuals with disabilities had difficulty evacuating and many called the Ventura County dispatch centre asking for assistance. The fire also blocked off a number of potential routes, leading to increased congestion. Los Angeles County reported that parked, crashed, and abandoned cars were a key cause of congestion.</p>
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29	Name/Surname/Email/Date of who filled in this template	Stephen Wong/stephen.wong@berkeley.edu 5/31/19

5. Discussion

Twenty-eight case studies are included in this report from 11 countries (i.e., USA, Israel, Norway, Canada, South Africa, Spain, Portugal, New Zealand, Japan, Australia, and Sweden) as summarized in Table 1. The type of large outdoor fires covered were: wildfires/WUI fires (n = 24), urban fires (n = 2), informal settlement fires (n = 1), non-urban building fires escalating into a large fire event (n = 1).

These case studies are a useful starting point to analyse variability and similarities in large outdoor fire evacuation scenarios. These examples demonstrate some of the main scenario conditions that may occur and depict possible sequence of events that may take of place. In addition, they help identify evacuation issues (e.g. availability of different evacuation modes, size of the evacuation in relation to the fire, organisational response needed, choices performed by the evacuees [19], [20]). The reported incidents were all severe, generally needing a range of resources to be deployed from numerous organisations and in some instances even needing support from multiple countries. Most case studies involved a mandatory evacuation of the general population. However, evacuations were not always ordered such as during the South Africa’s Imizamo Yethu informal settlement, where over 2000 structures were lost. Economic losses caused by the fires ranged from 90,000 euros to 56 billion US Dollars, with some fires lacking information of the damages involved. Across the events, hundreds of thousands of people were affected in different ways - injuries, deaths, displacements, mandatory evacuations. The number of affected people (displaced or evacuated) ranged from 26 individuals to 1 million people. Across all case studies, 317 individuals were killed based on available information. When mandatory evacuation was issued, people fled from the fires mostly using their private vehicles. However, in some cases people evacuated on foot, were transported via public vehicles (e.g., school/city buses), or used alternative modes such as boats and helicopters. Alternative modes were often used in cases when the road network was disrupted by the fire.

Table 1. The number of case studies in each region and country.

Region	Country	Number of case studies	Number of case studies
North America	USA	12	15
	Canada	3	
South America	/	0	0
Europe	Spain	2	6
	Norway	2	
	Portugal	1	
	Sweden	1	
Africa	South Africa	1	1
Asia	Japan	1	2
	Israel	1	
Oceania	Australia	1	2

This report presents a set of limitations. One important limitation is that this list should by no means be considered a census of all large-outdoor fires, but rather as a collection of key cases. It is currently geographically unbalanced, as many case studies were collected from North American (see Table 1). Therefore, future work should expand this list to more incidents and consider a wider geographical distribution. Similarly, most of the case studies in this list relate to wildland fires or WUI fires. This is due to the fact the number of wildland fires and WUI fires in recent years have been higher than urban fires or informal settlement fires. Consequently, future research using data from this report may need to be supplemented with additional case studies of different types of fires. The data presented in this report was collected to the best of the ability of individuals who have reviewed the information available on each case study. However, in some instances, the case studies were pieced together from diverse sources (as opposed to a single source). Consequently, the data presented should be evaluated with caution, taking into consideration misreporting and possible inconsistencies between sources. This issue draws attention to the challenges that continue to exist in reviewing case study data and the need for the development of standardized procedures for reporting incidents.

6. Conclusion

This report presents a list of case studies concerning large-outdoor fires involving evacuations. This work is an important starting point to build a large database of case studies and identify common trends and differences across such type of incidents.

The set of case studies presented can assist in the identification of critical issues related to evacuation scenarios and offer lessons learned and best practices. Understanding the spatial and temporal scales of past events, along with an analysis of their consequences, can help inform policymakers in developing guidance and recommendations during different stages of emergency management and evacuation planning.

Future work with this database will likely require assistance from the wider fire safety science community. This early work and report represent an important first step in obtaining a global picture of large-outdoor fires involving evacuations in an open-access and central format for researchers and policymakers.

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Appendix A. Template for case studies

A template for a review of case study was developed and then presented in this report (Ronchi, E., Rein, G., Gwynne, S., Wadhvani, R., Intini, P., & Bergstedt, A. (2017). e-Sanctuary: Open Multi-Physics Framework for Modelling Wildfire Urban Evacuation. Quincy, MA (USA): Fire Protection Research Foundation). The template has been slightly modified in order to allow to build an IAFSS database on case studies involving evacuation in large outdoor fires.

Note: the template was slightly modified again 2019 December to expand case study collection and include all types of large outdoor fire evacuations.

1	Where?	<i>Location of the incident</i>
2	When?	<i>Duration of the incident</i>
3	How was the fire started?	<i>Trigger event</i>
4	Initial fire size	<i>Scale of the initial fire</i>
5	Area affected (burned area)	<i>Area involved</i>
6	Fuels involved in the fire	<i>Vegetation, structures, etc.</i>
7	WUI, urban, wildland or informal settlement fires?	<i>Type of fire event</i>
8	Average weather conditions	<i>Environmental conditions during event</i>
9	Geographical highlights	<i>Landscape topography</i>
10	Was there any fire break? (natural or artificial)	<i>Constraints on the fire development</i>
11	Did the Fire Service report extreme fire behaviour?	<i>Recognised fire conditions</i>
12	Number of structures and infrastructures affected (damaged)	<i>Scale of physical impact</i>
13	Estimated direct and indirect economic damage	<i>Scale of physical impact</i>
14	Did it occur in conjunction with multiple fires in the country?	<i>Coincidence with other events (leading to resource issues)</i>
15	Countries involved	<i>Either as the incident spanned a border or because aid was provided.</i>
16	Brief timeline of the key events	<i>High-level narrative of key events.</i>
17	Time of initial order to evacuate and locations	<i>Precise commencement time allows evacuation delays or exposure conditions to be established.</i>
18	Time when evacuation was considered completed	<i>Allows length of evacuation to be established.</i>
19	Deaths/Injuries	<i>Impact of incident on human population-well-being.</i>
20	The number of people evacuated	<i>Impact of incident on human population-location.</i>
21	The location people initially evacuated	<i>Where people tried to escape – just from fire or went to shelter or anything</i>

22	Reasons why people decided to evacuate	<i>mandatory order, evacuation was recommended, they see the news or they see actual fire coming,</i>
23	Evacuation type	<i>Mode of transport (car, on foot, public service)</i>
24	Any drill/education/instructions on large outdoor fires provided beforehand?	<i>People's preparedness to large outdoor fires</i>
25	Personnel involved in rescue operations	<i>Complexity of procedural response to emergency.</i>
26	Did the smoke hindered significantly the evacuation because of low visibility or health problems	<i>Interaction between environmental conditions and the evacuation.</i>
27	Possible causes of issues in management operations	<i>Underlying factors that affected efficiency and effectiveness of procedural response.</i>
28	References	<i>Information sources</i>
29	Name/Surname/Email/Date of who filled in this template	<i>Information on who filled in the template and when</i>