Government of **Western Australia**
Department of **Health**

Estimated excess hospitalisations and emergency department attendances due to landscape fires in the Bunbury and Busselton health districts of the South West region of Western Australia

Aim

This bulletin is to present the methods and results from the analysis of the possible* impact of landscape fires (LFs), including prescribed burns (PBs), on health service utilisation in terms of hospitalisations and emergency department attendances among residents of Bunbury and Busselton Health Districts in the South West region of Western Australia.

*NB: the data provided are not actual counts but an estimate based on increased particulate matter with a diameter < 2.5μm ($PM_{2.5}$) as the air quality measure for risks of smoke from LFs.

Background

Landscape fires (LFs) include both bushfires (BFs) and prescribed burns (PBs) and are defined as fires that occur in forest, scrub, or grassland. Bushfires are a growing concern globally as they are expected to increase in frequency and intensity due to changes in climate (Westerling, Hidalgo et al. 2006, Fried, Gilless et al. 2008, Spracklen, Mickley et al. 2009). Prescribed burning is the process of planned, applied and controlled fires to predetermined areas, under specific environmental conditions to reduce the fuel load available for BFs (Haikerwal, Reisen et al. 2015). Between 2015-2017, there were approximately 8,000 LFs in Western Australia, including approximately 739 (9.12%) in the South West region. Of these, 205 (27.7%) were PBs and 534 (72.3%) were BFs, respectively (internal unpublished government data, Clappinson et al, 2019).

This analysis was conducted to address community interest in the possible impacts of LFs on health service utilisation in the South West region. Because the methods for calculating health service utilisation requires air quality data (see below) and there are only air quality monitoring stations in the Bunbury and Busselton areas, the analyses could only be conducted in these two areas.

Methods

Study area and data sources

The study period was from 1 July 2015 to 31 December 2017. In 2016, the population in the Bunbury and Busselton Health District areas combined was 86,834, which contributed to nearly half (49.46%) of the total population in the South West region. The study area consisted of the Bunbury and Busselton Health Districts geographical boundaries, defined by the Department of Health WA, and associated 10 statistical area level 2 (SA2) areas within, as defined by the Australian Bureau of Statistics (2016) and shown in Figure 1.

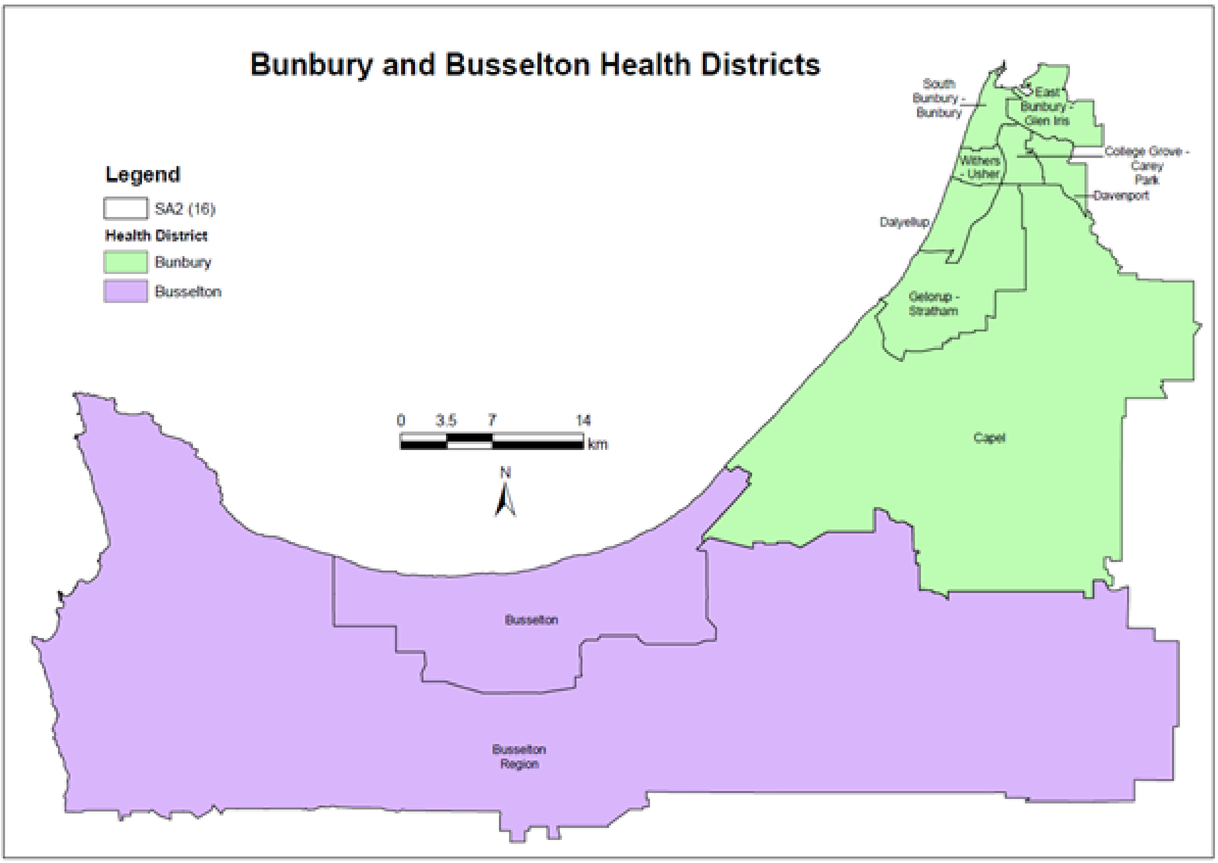

Figure 1. Study areas and SA2 areas within

There were four data sources for the estimation.

Firstly, the air quality data was sourced from the WA Department of Water and Environmental Regulation. The data was from two air quality monitoring stations in Bunbury and Busselton. Particulate matter with a diameter < 2.5μm ($PM_{2.5}$) was used as the air quality measure for smoke from LFs. Particulate matter is the most common measure of smoke.

Secondly, data on LFs in the South West region was sourced from the WA Department of Biodiversity, Conservation and attractions (DBCA). All LFs, including PBs and BFs, recorded in the three areas of the South West region in the DBCA dataset, namely, Donnelly, Blackwood and Wellington, were used for analysis as smoke can travel long distances. If a day had a BF or PB recorded, the day would be treated as a BF or PB day for the area. All days with either a BF or PB were combined and recorded as a LF day. If on the same day there were both BF and PB events (9.7% of all days with fire events), only PB events were considered when assessing the effects of PBs on health utilisation.

Thirdly, hospitalisation data was from the WA Hospital Morbidity Data Collection (HMDC), covering all hospitalisations for the Bunbury and Busselton Health District residents regardless of public or private hospitals during the study period. Only admissions to hospitals that were classified as emergency admissions were included and elective admissions were excluded from the analysis.

Finally, emergency department (ED) attendance data was from the WA ED Data Collection, covering all ED attendances by the Bunbury and Busselton Health District residents during the study period.

Determining daily smoke related $PM_{2.5}$ level

The air quality data for Bunbury and Busselton stations was combined to calculate daily average $PM_{2.5}$ concentrations to represent the smoke related $PM_{2.5}$ level in the whole Bunbury and Busselton areas. The average $PM_{2.5}$ concentrations, in micro-grams per cubic metre of air (µg/m3), were categorised into three levels based on the results in the Perth metropolitan study (Shirangi et al, 2020). These were low (≤95th percentile, i.e. ≤8.73), medium (96th-98th percentile, >8.73 and <12.60) and high level (≥99th percentile, i.e. ≥12.60). Smoke events were defined as those days when the $PM_{2.5}$ was high (≥99th percentile). The 99th percentile was chosen as it enables a clear delineation between background PM and PM on bushfire days. The 99th percentile cut off has also been used in other Australian studies investigating the effect of bush fires on health outcomes (Johnston, Hanigan et al. 2011, Johnston, Purdie et al. 2014).

Estimating health effects

The daily $PM_{2.5}$ level data was merged with LF data to identify smoke related $PM_{2.5}$ levels (low, medium and high) of all LF, and PB only, days. The risk ratios (RRs), obtained from a previous study conducted in the Perth metropolitan region (Shirangi et al, 2020), were applied to estimate the effects of medium and high levels of smoke related $PM_{2.5}$ exposure on hospitalisations and ED attendances compared with low levels of smoke related $PM_{2.5}$ exposure in the areas. Compared with a low level of exposure, if RR equals 1, the smoke related $PM_{2.5}$ level of interest (say, medium or high level) would have no effect on health service utilisation. If RR >1, the smoke related $PM_{2.5}$ level of interest would greatly increase the use of health services such as hospitalisations or ED attendances. If RR <1, the smoke related $PM_{2.5}$ level of interest would have reduced the use of health services. The 95% confidence intervals (CIs) of a RR indicate a possible range of the RR with 95% confidence.

Lagged effects of LFs including PBs on health utilisation were also assessed by examining hospitalisations and ED attendances that occurred 1-3 days after the smoke events. Table 1 shows the risk ratios and 95% confidence limits of effects of different smoke related $PM_{2.5}$ levels on hospitalisations and ED attendances by lag days and smoke level compared with low level of smoke related $PM_{2.5}$ level from the Perth metropolitan study. Lags 0-3 corresponded to the effects of PBs on same day of the fire event, 1, 2 and 3 days after the fire event. It was found in the Perth metropolitan study (Shirangi et al, 2020) the effects of LFs decrease over time after the fire events and usually at Day 4 after the event the effects become not statistically significant. Thus in this bulletin only the lagged effects up to Day 3 were reported.

Estimated excess numbers (EENs) were defined as additional hospitalisations or ED attendances that were most likely related to the LFs or PBs medium and high smoke level days. It was calculated by multiplying the difference between risk ratio and 1 (i.e., RR-1) by the average daily hospitalisations or ED attendances during the non-smoke days for the month. All excess hospitalisations or ED attendances during medium and high smoke level days were summed up to obtain a final excess estimate.

Based on the RR and its 95% CIs in Table 1, a possible range of EENs was also derived.

Table 1. Risk ratios and 95% confidence limits of effects of different smoke related $PM_{2.5}$ levels on hospitalisations and ED attendances by lag days and smoke level compared with low level of smoke related $PM_{2.5}$ level from the Perth metropolitan study

Lag (in days)	Smoke level	Hospitalisations			EDA		
		RR	RR LCL	RR UCL	RR	RR LCL	RR UCL
0	Medium	1.02	1.01	1.04	1.02	1.01	1.03
0	High	1.02	1.00	1.05	1.05	1.03	1.06
1	Medium	1.02	1.01	1.03	1.02	1.01	1.03
1	High	1.03	1.01	1.05	1.04	1.03	1.05
2	Medium	1.01	1.00	1.02	1.02	1.01	1.02
2	High	1.02	1.01	1.04	1.03	1.02	1.04
3	Medium	1.01	1.01	1.02	1.01	1.01	1.02
3	High	1.02	1.00	1.03	1.03	1.03	1.04

Notes: EDA=ED attendance, RR=risk ratio, LCL=95% low control limit for RR, UCL=upper confidence limit for RR. Lag 0-4 correspond to the effects of PBs on same day of the fire event, 1,2 and 3 days after the fire event.
Source: Shirangi et al, 2020.

Results

In the South West region, there were 152 PBs and 449 BFs during the study period with an average fire size of 1,115 (ranging from 0.66 to 10,977) and 212 (ranging from 0.009 to 4,397) hectares for PBs and BFs, respectively during the study period.

During the two and half years (912 days) study period in the two study areas, 106 days (11.6%) were considered as smoke event days with a high $PM_{2.5}$ level (≥99th percentile) that could contribute to the smoke related health utilisation.

Geographical distributions of LFs and PBs in the South West region

Figure 1 shows the geographical distribution of PBs and BFs in the South West region during the study period and the pink area was the study area. PBs were far more wide spread and each fire covered larger areas but less frequent than BFs. Note that a large number of BFs do not show in Figure 1 due to small fire size.

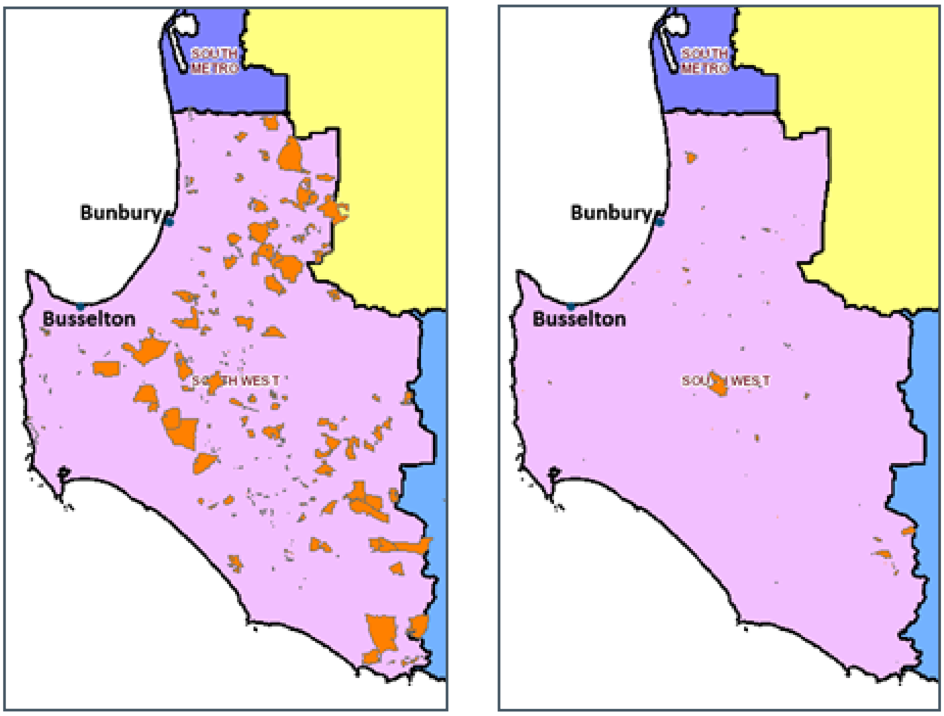

Figure 2. Geographical distribution of PBs (map on the left) and BFs (map on the right) in the South West region, July 2015 to December 2017

Excess hospitalisations and ED attendances due to PBs

Table 2 shows the estimated excess hospitalisations and ED attendances due to PBs in the Bunbury and Busselton Health Districts during July 2015 to December 2017. If all lagged effects of PBs were combined, the estimated excess number of hospitalisations and ED attendances in the area were 63 (95% CI, 24 to 118) and 388 (95% CI, 254 to 523), respectively. These contributed to 0.25% (95% CI, 0.09% to 0.46%) of all emergency hospital admissions (n=25,811) and to 0.52% (95% CI, 0.34% to 0.71%) of all ED attendances (n=74,117), respectively.

Table 2. Estimated excess hospitalisations and ED attendances due to PBs, Bunbury and Busselton Health District areas, July 2015-December 2017

Lag	Hospitalisations			EDA		
	EEN	LCL	UCL	EEN	LCL	UCL
0	18	6	40	120	67	161
1	20	9	32	108	67	149
2	13	3	26	93	53	106
3	12	5	20	67	67	107
Total	63	24	118	388	254	523
% of all health utilisation	0.25	0.09	0.46	0.52	0.34	0.71

Notes: Lag 0-3 correspond to the effects of PBs on same day of the fire event, 1,2 and 3 days after the fire event; EEN=estimated excess number, EDA=ED attendance, LCL=95% low control limit for EEN, UCL=upper confidence limit for EEN.

Excess hospitalisations and ED attendances due to LFs

Table 3 shows the estimated excess hospitalisations and ED attendances due to LFs in the Bunbury and Busselton Health District areas during July 2015 to December 2017. If all lagged effects of LFs were combined, the estimated excess number of hospitalisations and ED attendances in the area were 213 (95% CI, 78 to 395) and 1,261 (95% CI, 835 to 1,686), respectively. These contributed to 0.82% (95% CI, 0.30% to 1.53%) of all emergency hospital admissions (n=25,811) and to 1.70% (95% CI, 1.13% to 2.27%) of all ED attendances (n=74,117), respectively.

Table 3. Estimated excess hospitalisations and ED attendances due to LFs, Bunbury and Busselton Health District areas, July 2015-December 2017

Lag	Hospitalisations			EDA		
	EEN	LCL	UCL	EEN	LCL	UCL
0	59	18	129	396	222	523
1	72	30	113	348	221	474
2	42	12	84	297	172	344
3	40	18	69	220	220	345
Total	213	78	395	1,261	835	1,686
% of all health utilisation	0.82	0.30	1.53	1.70	1.13	2.27

Notes: Lag 0-3 correspond to the effects of PBs on same day of the fire event, 1,2 and 3 days after the fire event; EEN=estimated excess number, EDA=ED attendance, LCL=95% low control limit for EEN,
UCL=upper confidence limit for EEN.

Limitations of the analysis

These data are estimates only. They are estimated from risk ratios calculated from the Perth metropolitan study that are applied to the number of days with medium and high $PM_{2.5}$ levels, corresponding to LFs/PBs, in the study area.

An important limitation of the analysis was that the Perth data might not be directly applied to the Bunbury and Busselton Health District areas and accurately reflect the association between LFs and health service utilisation in the study areas.

Another important limitation of the analysis was that elevated levels of $PM_{2.5}$ caused by smoke from landscape fires might not be attributed fully to events recorded in the DBCA data for Wellington, Blackwood and Donnelly districts as there were many other sources of smoke that would not be captured in the DBCA data including:

- Bushfires attended by DFES career and volunteer Fire and Rescue personnel in gazetted fire districts around larger communities;
- Bushfires attended by local government bush fire brigades on private property in rural areas, where DBCA may not necessarily provide assistance and therefore not report a bushfire incident;
- Prescribed burning and other forms of burning off undertaken by local government, industry, agricultural enterprises and private individuals. Some of this burning will take place around the urban fringes of Bunbury and Busselton and therefore potentially have a disproportionately greater effect on the observations made at DWER air quality monitoring stations in these locations.

Furthermore, there are a limited number of air quality stations in the region (one in Busselton and one in Bunbury) and the air quality from these monitors are applied to all people in the study area, i.e. it assumes that everyone has the same level of exposure.

Due to the lack of air quality monitoring data in other areas of the South West region, the analyses could only be applied to the population of Bunbury and Busselton Health Districts but not the whole South West region. In addition, in the estimation of excess health service utilisation due to prescribed burns in the area, possible delayed effects of wild fires on a prescribed fire day and possible mixed effects of the two fire types on the same day could not be assessed.

Nevertheless, this is the first attempt of this kind in Western Australia to estimate the excess health service utilisation due to PBs and LFs in the study area. When air quality monitoring/modelling data and landscape fire data collection improve, more sophisticated analyses may become possible.

Conclusions

After applying the key results from a Perth study, the estimated excess hospitalisations and ED attendances due to all LFs (BFs and PBs) in the Bunbury and Busselton Health District areas were 213 and 1,261, respectively between 1 July 2015 and 31 December 2017. It is equivalent to 85 excess hospitalisations and 504 excess ED attendances per year.

The *estimated* excess hospitalisations and ED attendances due to PBs only in the Bunbury and Busselton Health District areas were 63 and 388, respectively between 1 July 2015 and 31 December 2017. It is equivalent to 25 excess hospitalisations and 155 excess ED attendances per year.

These numbers need to be treated with extreme caution due to limitations of the analyses - they are estimates only. Furthermore, the numbers are calculated by comparing PB smoke days with days of no smoke. There is no consideration of the potential health impacts of smoke from bushfires that could occur in the absence of planned burns. This is an important consideration as PBs are part of a strategy to reduce the number and intensity of bushfires.

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For more information

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