Emergency service demand in Queensland during natural disasters

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Abstract

Community resilience is a growing research area due to increased frequency, intensity and the extent of damage caused by recent natural disasters. There are different aspects which need to be accounted in a community resilience model. One key area that needs to be examined in this context is the mobility of people. Natural disasters cause changes in travel demand before, during and after the event. Travel demand in these three phases significantly varies in terms of need, pattern and mode of travel. The need for mobility of people also varies around a natural disaster, and hence, it expects a change in travel patterns for emergency services, general household activities and reconstruction activities. Demand for emergency services generally expects to be peaking in time of the incident starting a few hours before the event, for natural disasters like floods and bushfires. These variations in travel demand may depend on the intensity and frequency of the natural disaster, impact on the community and the duration of the event. Studying travel demand variations due to natural disasters are an important aspect in developing a resilience model, particularly for road infrastructures such as bridges, culverts and floodways. This paper examines emergency service demand variation in Queensland, Australia during bushfires and floods. The paper highlights that demand for emergency services depends on the type of natural disaster, the demographic and geographic characteristics. Future resilience models should, therefore, include emergency service demand variation for different types of natural disasters and demographic and geographic characteristics of the region.

Keywords: Travel demand; natural disasters; road infrastructures; mobility; household travels; emergency services; reconstruction activitie

1. Introduction

The resilience of communities has been repeatedly questioned by the Mother Nature all across the world at different levels and faces ranging from Tsunamis, earthquakes, flooding, bushfires, hurricanes or severe thunderstorms. Queensland, the third highest populated state in Australia, is one of the regions that have been repeatedly affected by severe flood events, bushfires and cyclones in recent time. For an example, the 2011 Queensland flood event caused a devastating impact to the community (Queensland Floods Commission of Inquiry, 2011). This event not only highlighted major overhauls in the knowledge, experience and preparedness of the community, but also highlighted concerns over climate change and new challenges that the whole world is facing in this century or foreseeable future. Side effects of this event raised questions over some of the engineering terminologies and definitions on merits of clarity of meaning, technical correctness, practicality, and acceptability. For an example, Bureau of Meteorology now defines the accumulated rainfall over a given period of time using the term Annual Exceedance Probability (AEP) replacing the old terminology Annual Recurrence Interval (ARI), for the interest of the public and to avoid confusions made on some decision makers (Bureau of Meteorology, 2015). On the other hand importance of enhancing the resilience of communities were identified and recognized by individuals, communities and government bodies.

In Australia, flooding has been reported as the most expensive type of natural disaster (Wahalathantri et al., (accepted)). The 2011 Queensland flood event was one of the extreme and widespread floods that caused huge social and economic impact to the Australia (IBISWorld, 2011). Many lifeline infrastructures were damaged across Queensland, leaving communities completely or partially isolated. In this context, damage to road infrastructures such as bridges, culverts, and floodways created short-term as well as long-term adverse impacts on communities. Higher damage bills combined with budget restraints of local governments caused delays in the repair and reconstruction of damaged road infrastructures, leaving rural communities completely or partially inaccessible for extended periods of time. Road infrastructures in some regions in Queensland such as the Lockyer Valley Regional Council (LVRC) area were severely damaged for another time during the 2013 flood event, before the aftermath of the 2011 flood were rectified (Lokuge et al., 2014). Many of the reconstructed road infrastructures were severely damaged in the 2013 flood leading to longer repair and reconstruction activities, not only due to the budget constraints but also due to the concerns over design and construction practices.

Delays in reconstruction works of road infrastructures have direct and indirect impact to the mobility of people. The mobility of people can be broadly categorized into three clusters, namely, general household travels, emergency related travels and travels for construction activities. General household travels are the primary source of mobility which includes work, health, education, shopping, entertainment, socialization and religious related activities. Emergency related travels can be generated due to health, security and natural disasters. Emergency travel needs in case of a natural disaster can include warning services, evacuation procedures and rescue activities. Travels related to construction activities can include new projects, reconstruction or repair activities for infrastructures. Demand for each of the above three broader clusters can vary before, during and after a natural disaster. Qi and John E (2014) have concluded that natural disasters perturb mobility of people and change the travel frequency. For an example, before a natural disaster event, warnings, and evacuation related activities can increase. During a natural disaster, demand for emergency services will be increased, but demand for general household travels such as recreation activities will be declined. Following a natural disaster, assessment, rehabilitation and reconstruction activities are expected to be peaked. Also, general household travels will gradually increase to its normal level following the disaster event. The degree of fluctuations for each of those activities can vary based on geographic and demographic features as well as the rate of recovery.

This paper examines emergency service demand variation during natural disasters in Queensland, Australia. The study is limited to the period between 2011 and 2014 and covers the emergency service demand variation during the 2011 and 2013 Queensland flood events in the LVRC area.

2. Total emergency service demand in Queensland

Demand for the emergency services is caused by many reasons and some are related to natural disasters. Emergency service demand during a natural disaster includes activities arising due to floods, bushfires, storms, cyclones and similar events. Examples of activities for a flood event are rescue operations, providing emergency medical services, assisting the police or local government bodies and providing or assisting with services such as water removal. Some examples of activities not related to natural disasters are: mobile property damage, building or structural fires and medical assistance. According to monthly statistics received from

Queensland Fire and Emergency Services (QFES), approximately 6000 incidents per month have been received requesting emergency services across the Queensland during July 2011 – June 2014. However, average incidents received in different months indicate a seasonal variation as shown in Figure 1. January 2013 indicates a peak that corresponds with the 2013 flood event. Similarly, the other peak during September – November period coincides with the increase in bushfire events across Queensland during the dry period. Therefore, emergency service demand fluctuates towards peak during periods which are more prone to natural disasters.

Fig. 1: Average number of incidents per month

Emergency service demand indicates significant variations across different parts of Queensland due to geographical, climatic and demographic changes. Queensland Fire and Emergency Services (QFES) have classified seven main regions in Queensland for their operational and maintenance activities, namely, Far Northern, Northern, Central, North Coast, Brisbane, South Eastern and South Western (Queensland Fire and Emergency Services, 2015) as shown in Figure 2. Brisbane region has about 36% of the total Queensland population within about 0.3% of the total land area in Queensland (Queensland Fire and Emergency Services, 2015). The South Eastern region includes the major cities of Gold Coast, Logan and Ipswich and regional councils of Scenic Rim, Lockyer Valley, and Somerest, is also relatively small in land area but heavily populated. Other regions are comparatively large in land area but low in population density.

Table 1 shows the distribution of the average number of incidents across seven QFES regions. The highest monthly average demand for emergency services has recorded in the Brisbane region, which has the highest population, followed by the South Eastern Region. Figure 3

indicates the monthly variation of emergency service demand for seven QFES regions. All regions indicate a similar pattern, except clear peak in January, 2013 for Brisbane, South Eastern, North Coast and Central regions. These peaks correspond with the 2013 January flood events and affected areas.

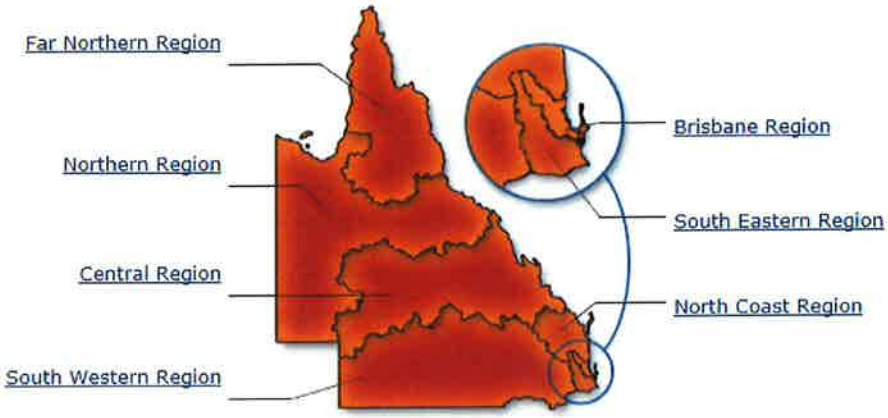

Fig. 2: QFES Regions (Queensland Fire and Emergency Services, 2015)

Table 1: Monthly average number of incidents received for the QFES

QFES Region	Emergency Service Demand for the period July 2011 – June 2014	
	Average Number of incidents	As a Percentage from total (%)
Brisbane	2013	33.3
South Eastern	1245	20.6
North Coast	738	12.2
Central	632	10.5
Northern	596	9.9
Far Northern	420	6.9
South Western	401	6.6

Fig. 3: Emergency Service Demands per Month for Seven QFES regions

3. Emergency service demand during natural disasters

Emergency service demand for natural hazards highly depends on the nature, frequency and the extent of the event. In this manuscript, emergency service demand variation due to bushfires and floods are analyzed.

3.1. Bushfires

Bushfires have the possibility to occur at any time of the year, but the numbers of events are reduced during wet seasons. In general, Australia has been divided into different bushfire prone periods based on past events and the climate of the regions by the Bureau of Meteorology, as shown in Figure 4. According to Figure 2 and 4, bushfire prone periods for different QFES regions are: Far Northern region during June – November, South Western region during September – February and other regions mostly during spring periods or September – November. This observation complies with the Queensland Parks and Wildlife (QPWS) wildfire events as shown in Figure 5.

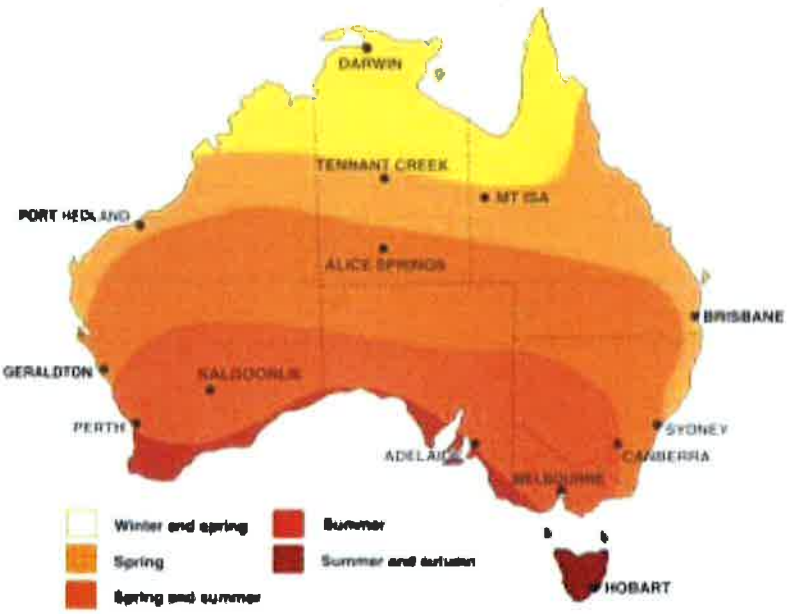

Fig. 4: Fire Seasons across Australia (Cary et al., 2003)

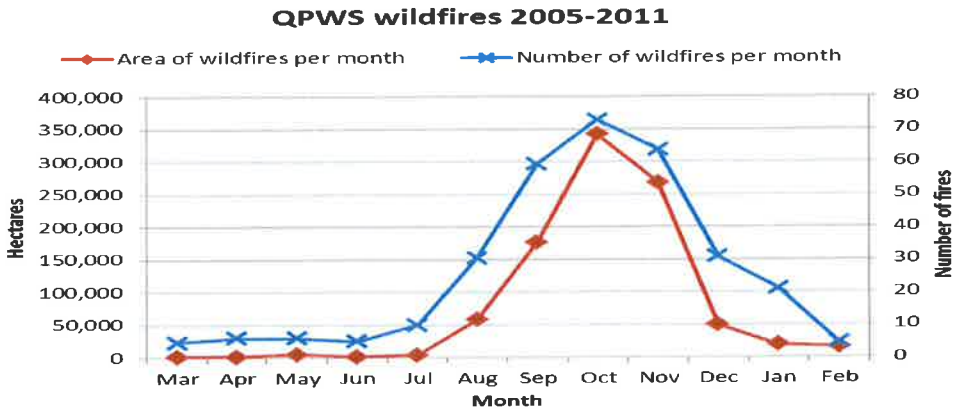

Fig. 5: Average QPWS wildfire numbers and burnt area in hectares per month (Leeson, 2013)

Figure 6 shows the percentage of emergency service demand due to bushfire related activities, compared to the total average number of incidents received on a monthly basis. More than 25% of total emergency service demand for September and October months were due to bushfire related activities in Queensland. This figure clearly indicates the clear relation between the increase in emergency service demand during the bushfire prone periods as indicated in Figure 4 and 5.

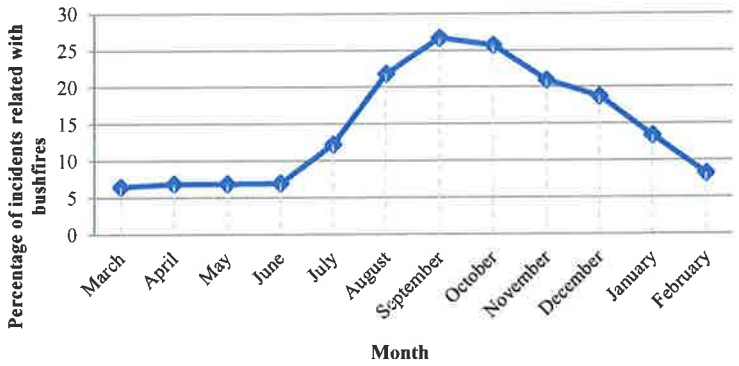

Fig. 6: Contribution of bushfire related activities based on the number of incidents received per month during July 2011 – June 2014

Emergency service demand due to bushfires across different QFES regions is presented in Table 2. About 22% of emergency service demands in the North Coast region were due to bushfire related events. More than 20% of emergency service demand for South Western and Central regions has also been risen from the Bushfires. Percentage of emergency service demand generation in Brisbane area due to bushfires is the lowest across QFES regions.

Table 2: Monthly average values for the emergency service demand due to landscape fires during July 2011-June 2014

QFES Region	Average Number of incidents related to landscape fires	
	Average Number of Incidents	As a percentage from total emergency service demand for the same area
Brisbane	154	7.7
South Eastern	197	15.8
North Coast	164	22.2
Central	132	20.9
Northern	104	17.4
Far Northern	68	16.2
South Western	86	21.4

3.2. Floods

Figure 7 shows that the total number of emergency service incidents received during the month of January in 2012, 2013 and 2014 for seven QFES regions. Brisbane, Central, North Coast, South Eastern and South Western regions indicate about 50% increase in emergency service demand during January 2013, compared with the January 2012 and January 2014. This corresponds with the 2013 flood event in Queensland.

The monthly data obtained from the QFES for the Queensland region cover only the 2013 flood event. However, these data provide an indication of emergency service demand for Queensland at a macro level. For detailed analysis, the Lockyer Valley Regional Council (LVRC) area and associated emergency service demand data for the 2011 and 2013 Queensland flood events were used. Both of these flood events were categorized as extreme events for the Lockyer Valley Regional Council area. Some areas of this region were severely affected by the 2011 flood event than the 2013 flood or the vice versa.

Figure 7: Emergency service demand variation during January

The LVRC is located about 90 km west of the Brisbane and bounded by the Great Dividing range, with a total population of about 37,000 within 2272 square kilometres of land area (Queensland Floods Commission of Inquiry, 2012). This area was subjected to heavy rainfall and flooding during 10th – 12th January 2011 and again during 26th – 29th January 2013. Rainfall data analysis indicated that the 2013 rainfall was higher in intensity, but limited in some regions as the downfall happened relatively within a short period of time compared with the 2011 event. Also, at the time of the 2013 flood event, people were more prepared as they had experienced the 2011 devastating flood and its repercussions. On the other hand, the 2011 flood event was a widespread in area with almost no previous experience across the community on how to react at once in a life time event. Figure 8 below indicates monthly totals for emergency service demand for flood related activities for the 2010/11 and 2012/13 financial years. It is clear that the community demand for the emergency services were significantly higher during the 2011 January flood event compared with the 2013 January flood event. This indicates that previous experience and frequency of natural disasters can have a significant impact to the community response and the resilience. However, the extent of the flooding should be accurately accounted for better decisions accounting population distribution and flood levels across different suburbs.

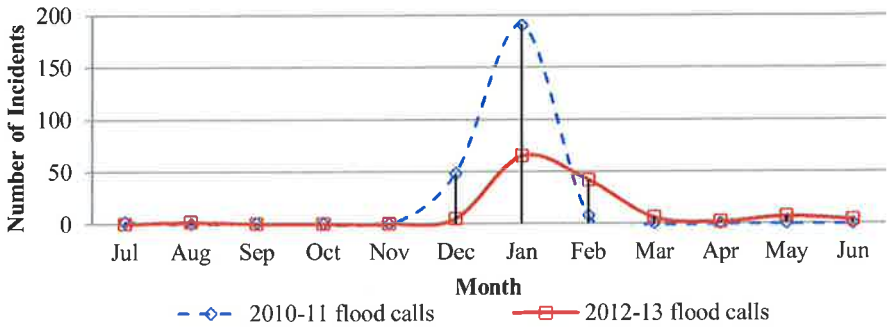

Fig. 8: Emergency service demand for flood related activities in LVRC

Total emergency service demand variation of the 7 day period during the 2011 and 2013 flood events is plotted in Figure 9. The clear peak on 10th January 2011 coincides with the period where the major flooding started across the LVRC area, including the Lockyer Creek and Sandy Creek (Bureau of Meteorology, 2011). Peaks of emergency service demand during the 2013 flood event are widespread compared to the 2011 event, indicating an improved or timely response to the flood event.

The emergency service demand derived using number of incidents received at the QFES indicates a general pattern for the bushfires, which reasonably agree with the number of

bushfires, burnt areas and the month of the year. However, with regard to flooding, previous studies or publications are not available to justify the change in emergency service demand. Nevertheless, the presented data in this paper can be used to gain understanding of emergency service demand variation at different natural disaster events. These patterns can be generalized considering the extent of the event, demographic and geographic features of the area that is subjected to the natural disasters. Also, these data can be related with the number of emergency vehicles and people deployed to obtain travel demand across road infrastructures. These factors will be addressed as an extension of the present study with the aim to develop a resilience index for road infrastructures.

Fig. 9: Emergency service demand for flood related activities in LVRC

4. Conclusion

This paper analyses the emergency service demand variation in Queensland for bushfires and flood events. Emergency service demand due to bushfires in Queensland peaks during September – November periods. Bushfires account for more than 20% of total emergency service demand in North Coast, Central and South Western regions, but only 8% in Brisbane area. However, formation of a direct relationship between the extents of event was a difficult task, due to lack of information to correlate the emergency service demand to the number of bushfires and burnt area. Similar difficulty was encountered with respect to flood events. More informative relationships and understanding can be gained through coordinating and collating data on the extent of natural disasters and community responses. Creating a database to record activities around natural disasters at national level is recommended to gain broader understanding of the community resilience. Emergency service data received in the LVRC area indicate a clear peak around the time of major flooding during the 2011 flood event. However,

demand for the emergency services in the same area has significantly reduced during the 2013 flood event. In general, bushfires and flood events have a preceding time for warning and response, in contrast to unprecedented events like earthquakes. Therefore, the data presented in this paper are useful to develop relationships for similar events which have a sufficient warning period for response. This information can be used to generate travel demand patterns for emergency services and study resilience of road infrastructures such as bridges, culverts and floodways.

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