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ECONOMIC GEOGRAPHY OF BUSHFIRE AND FLOOD VULNERABILITY IN VICTORIA AT THE STATISTICAL LOCAL AREA SCALE

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CONTENTS

1 EXECUTIVE SUMMARY

Strategic planning for managing natural hazard impacts needs to take into account different areas of vulnerability, both from the viewpoint of minimising damage before and during events, and in maximising the potential for recovery after events. This report summarises the vulnerability to bushfire and flood of income from 190 industry classes within 19 sectors across Victoria at the Statistical Local Area (SLA) scale.

Vulnerability here is measured as the product of the sensitivity and exposure to bushfire and riverine flood. The unit of exposure is income for each industry subdivision in 2011 at the SLA scale. Sensitivity measures potential levels of damage to hazard impacts. Exposure measures whether an activity is placed in danger by the presence of bushfire and riverine floods. Levels of exposure are proportional to how many bushfires and floods have occurred over the historical period. Sensitivity is assessed as negligible, low, moderate and high for each economic subdivision. Exposure and vulnerability are assessed over the same ratings at the SLA scale (see Table 1).

	Sensitivity			
Exposure	Negligible	Low	Moderate	High
Negligible				
Low				
Moderate				
High				

TABLE 1: VULNERABILITY RATING TABLE SHOWING SENSITIVITY, EXPOSURE AND VULNERABILITY

Vulnerability ratings of Victorian economic activity to bushfire include high (2.9%), moderate (5%) and low (11.7%) ratings, totalling over $58 billion. Vulnerability in each SLA depends greatly upon location, some having over 50% of their income rated as highly vulnerable (e.g., Moyne North West). The figures for flood are similar, with high (2.4%), moderate (3.6%) and low (7.5%) ratings statewide totalling over $40 billion in income. Variations between SLAs is high, with some SLAs having over half their income rated as highly vulnerable (e.g., Loddon North 67% and Swan Hill Bal 50%).

Individual sectors also range widely in vulnerability. For example, over 60% of the Agriculture, Forestry and Fishing sector is highly vulnerable to fire and over 50% to flood, whereas many of the service sectors show little vulnerability. It was not possible to include tertiary impacts and threshold effects, so that a sector such as Financial and Insurance Services, where about 80% of activity was rated as negligible to bushfire and flood, would be vulnerable to accumulated losses and external pressure from disasters in other parts of the world. Other service sectors that show little vulnerability at the state level may also contribute to significant local vulnerability.

Total vulnerability for each SLA was also assessed by multiplying income with a scale of 0, 1, 2 and 3 for the negligible, low, moderate and high ratings, respectively. These are mapped in Figure ES2 and show the wide variation in vulnerability across the state.

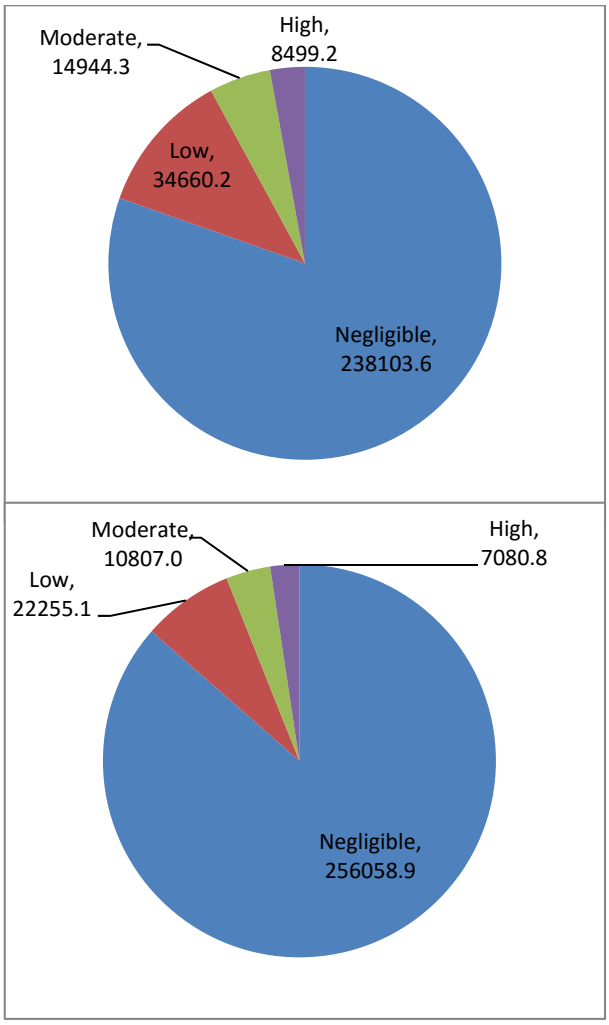

FIGURE 1: NEGLIGIBLE, LOW, MODERATE AND HIGH RATINGS FOR BUSHFIRE AND FLOOD VULNERABILITY IN VICTORIA

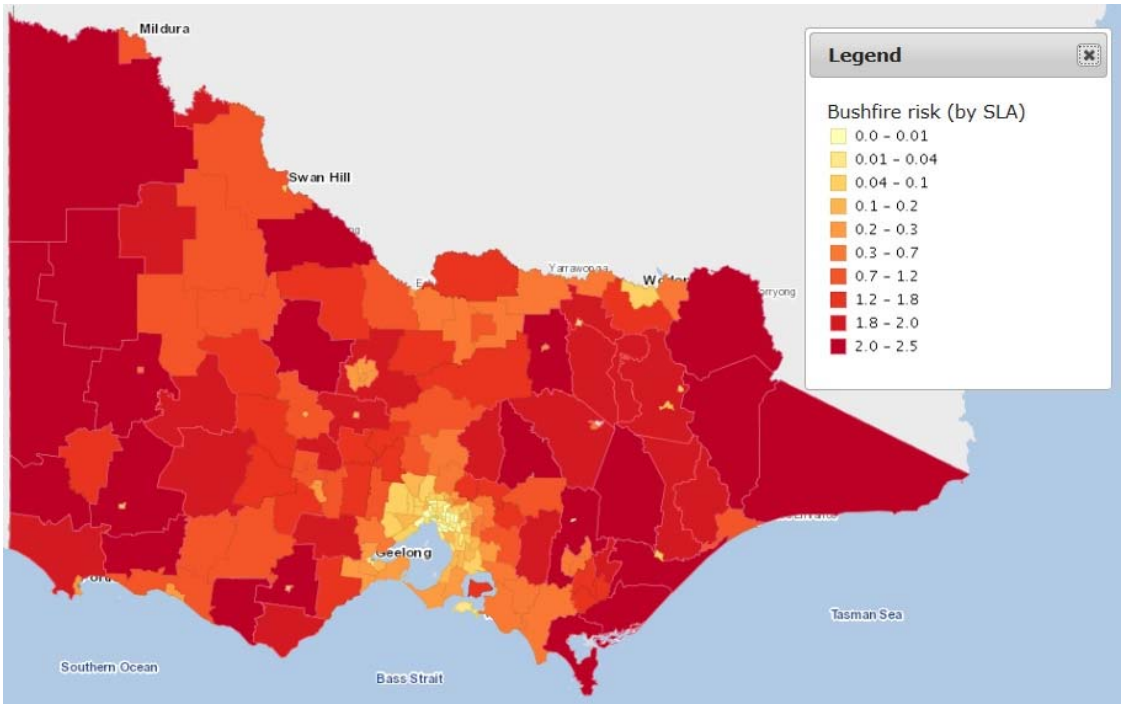

FIGURE 2: TOTAL BUSHFIRE VULNERABILITY RANKING PER SLA IN VICTORIA

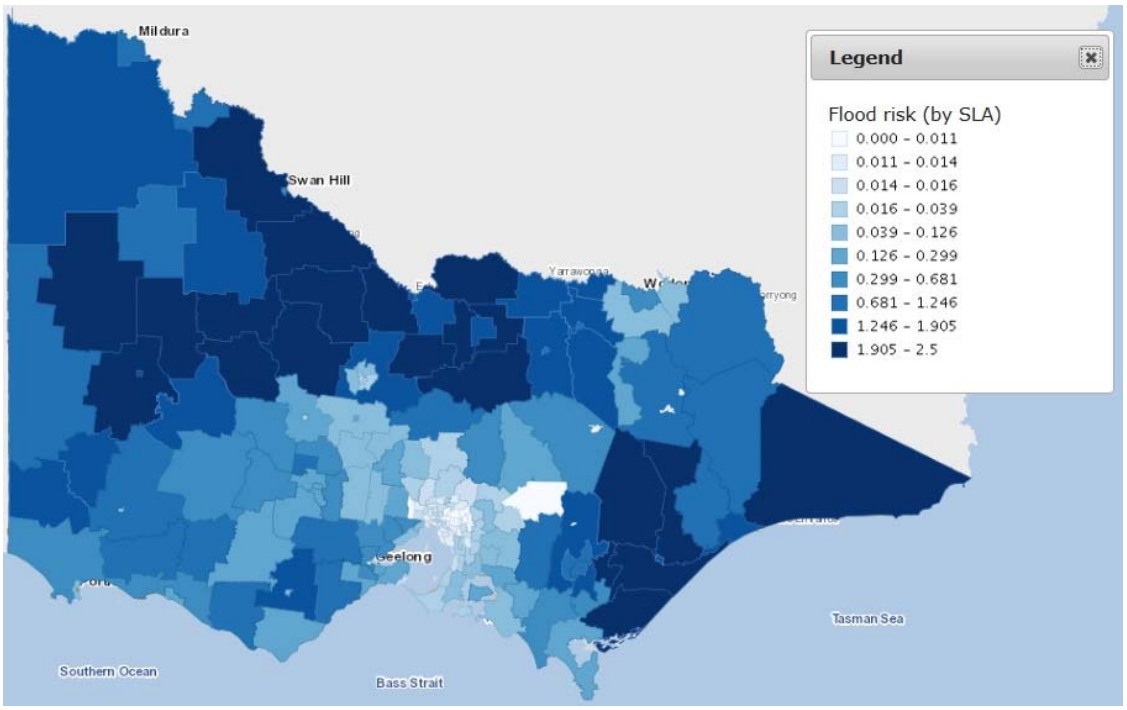

FIGURE 3: TOTAL FLOOD VULNERABILITY RANKING PER SLA IN VICTORIA

Not included as part of the vulnerability maps were assessments of economic magnitude and diversity. These serve as a partial proxy for adaptive capacity, indicating the potential for loss on the one hand and recovery on the other. Low income and diversity are a characteristic of many rural and fewer peri-urban SLAs with higher levels of vulnerability to bushfire and flood. A few urban centres are vulnerable to flood but not to bushfire.

A handful of SLAs show up with a high proportion of their income being vulnerable coinciding with high values at risk. For bushfire this includes Yarra Ranges (S) – North, Latrobe (C) – Traralgon, Baw Baw (S) – Pt B West and Macedon Ranges (S) Bal. For flood this includes Latrobe (C) – Traralgon and Gr. Shepparton (C) – Pt A. Further work into local value clusters, where values are interdependent, would help to identify areas of specific vulnerability at local to state scales.

An analysis of ecosystem services base on land-use types also identified areas where such services are exposed to bushfire and flood. This identified a few SLAs with high values exposed to bushfire and flood where further analysis may be warranted.

Most economic analyses of exposure to natural hazards concern built assets and infrastructure, rather than the activities that utilise those assets. Knowledge of industry-based vulnerability can help to pinpoint where efforts to prevent damage and loss and to aid recovery may be needed. While rapid assessments following an event will identify key activities that may need rebooting to aid recovery, a more methodical assessment as part of the planning for future events will assist in minimising losses and maximising recovery.

2 INTRODUCTION

The aim of this report is to identify, in a semi quantitative fashion, those sectors and regions of Victoria most vulnerable on the basis of economic output to the natural hazards of bushfire and flood.

Expert judgment is used to estimate vulnerability based on the analyses presented in this report, from sectoral reports of impacts and vulnerability for Victoria and Australia and from the general assessment literature. More detailed summaries based on individual assessments can be found in Pittock (2003), Hennessy et al. (2007) and Reisinger et al. (2014).

Vulnerability to bushfires and floods is a product of exposure to these natural hazards and the sensitivity of the affected activities. Exposure is affected by the rate and magnitude of these hazards, while sensitivity is also affected by both socio-economic and physical factors that can vary widely.

In this report, vulnerability is assessed for using income data for nineteen industrial sectors and Victoria's two hundred and five statistical local areas, sourced from the Centre of Policy Studies, Victoria University, and social data sourced from the Australian Bureau of Statistics (ABS). Vulnerability is framed as potential future impacts contrasted with our understanding of vulnerability to current impacts. Potential impacts are assessed using a triple-bottom-line approach, summarised according to their potential economic, social and environmental outcomes. It serves as an update to Jones and Webb (2008) who assessed vulnerability to a changing climate based on 2005–06 income data, but here analyses the available data at a finer scale.

Due to the limited understanding of how adaptive capacity is constituted and whether it is likely to be exercised, we are currently unable to comprehensively assess future vulnerability.

The main aim of this study is not to predict future vulnerability to bushfires and floods, but is to assess economic vulnerability from today's perspective, and thus provide evidence for planning and preparation to mitigate so that vulnerability can be minimised. The report indicates where efforts might be concentrated for further assessments, identifies knowledge gaps and describes further research needed to provide the underpinning knowledge for comprehensive assessments to take place.

3 FRAMING NATURAL HAZARD VULNERABILITY

The framing of natural hazard vulnerability is captured in Figure 4 (Allen Consulting Group, 2005).

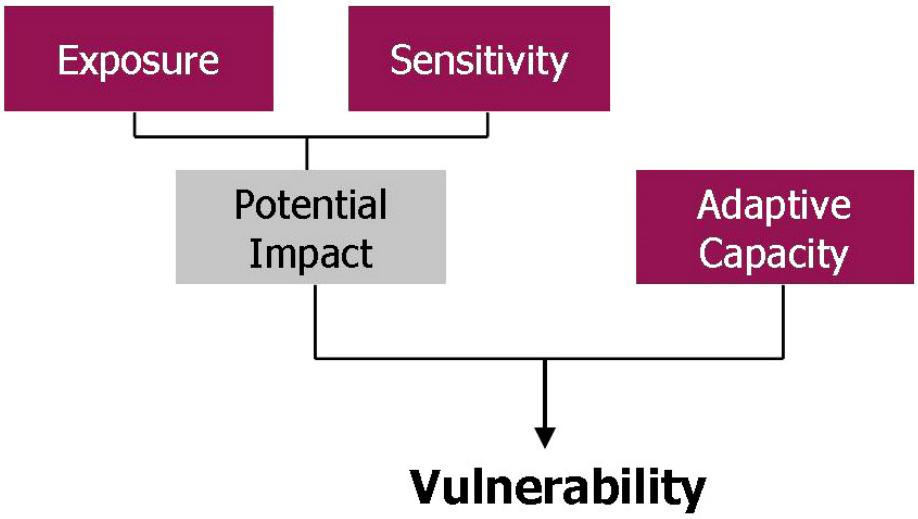

FIGURE 4: VULNERABILITY AND ITS COMPONENTS (ALLEN CONSULTING GROUP 2005).

3.1 How Vulnerability is Assessed in this Report

3.1.1 Exposure

Exposure is measured as the inventory of values in the presence of specific hazards – the people, property, systems, or other elements present in hazard zones that are subject to potential losses (UNISDR, 2009). Here, we measure economic activity based on income, exposing that to historical incidents of bushfires and flood potential in each statistical local area. While historical data is not necessarily an accurate predictor for future events, especially with climate change, it gives an indicative guide to the degree of exposure. It is possible to be exposed without being vulnerable, but it is not possible to be vulnerable without being exposed (Cardona et al., 2012). Levels of exposure are calculated by assessing values exposed to negligible, low, moderate and high hazard risk. This is estimated using a single measure for

3.1.2 Historical Bushfire and Flood Risk

The bushfire data is a collection of all bushfires and burns as illustrated in Figure 5 and the historic flood extent in Figure 6.

The ranking of the SLAs with respect to their exposure is dependent upon the total number of fires or floods in the 90 years of available data. The categorisation is summarised in Table 2.

Rating	Number of Fires	Number of SLAs	Number of Floods	Number of SLAs
Negligible	0	46	0	111
Low	1-10	82	1-2	33
Moderate	11-20	28	3-6	28
High	21+	49	7+	33

TABLE 2: SLA FIRE AND FLOOD EXPOSURE RATING

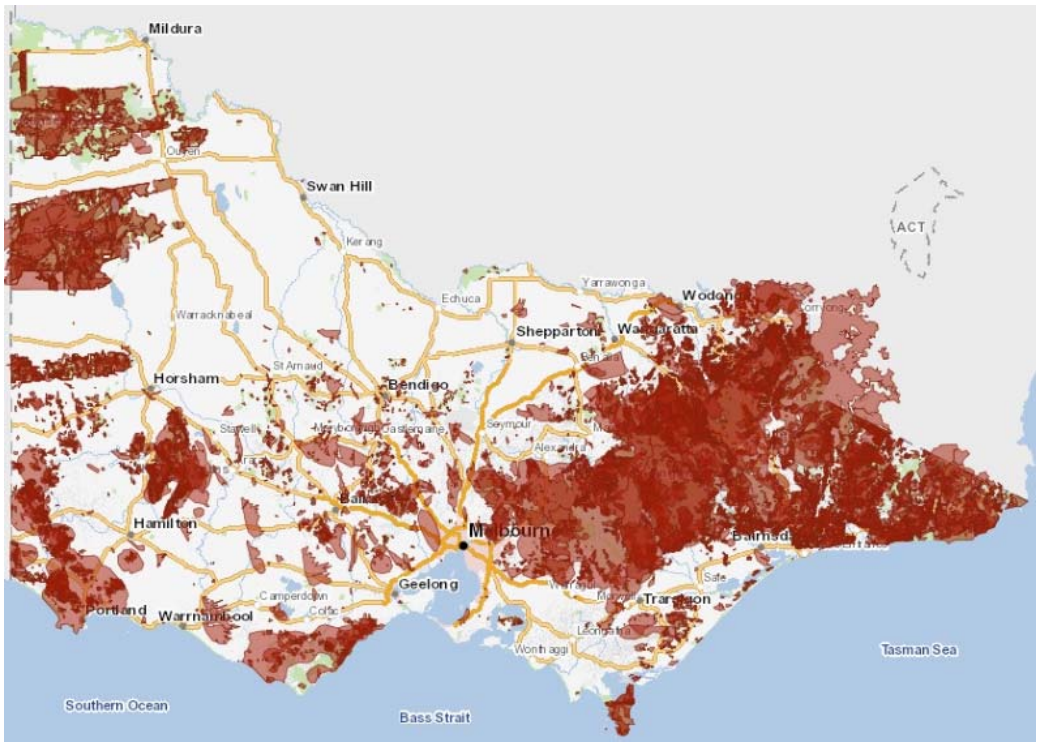

FIGURE 5: VICTORIA BUSHFIRE HISTORY

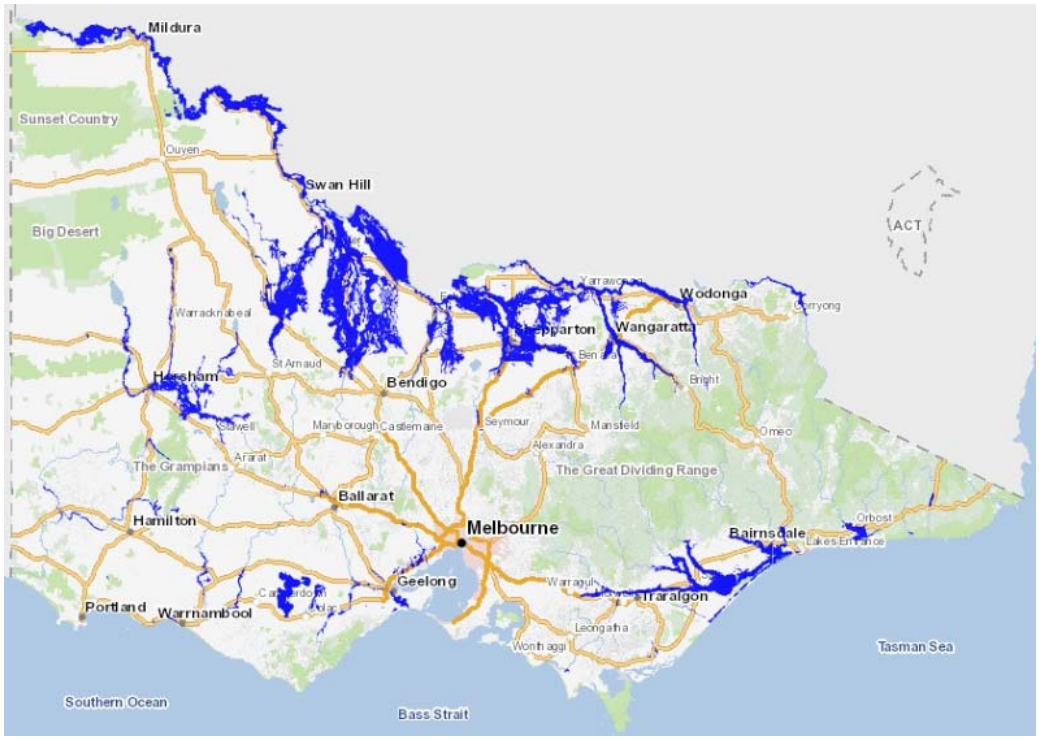

FIGURE 6: VICTORIA HISTORIC FLOOD EXTENT

3.1.3 Sensitivity

Sensitivity refers to the size of the resulting response to a given natural hazard. Exposure and sensitivity combine to produce a *potential impact*. The sensitivity rankings are based on work by Jones and Webb (2008), that estimates the degree of response to climate hazards.

To assess social and economic sensitivities to natural hazard impacts, we utilised data from Statistical Local Areas (SLA). The Statistical Local Area (SLA) is an Australian Standard Geographical

Classification (ASGC) defined area which consists of one or more Collection Districts (CDs). SLAs are Local Government Areas (LGAs), or parts thereof. The ASGC was replaced by the Australian Statistical Geography Standard (ASGS) which is the Australian Bureau of Statistics' new geographical framework in July 2011.

The economic output figures were obtained from the Centre of Policy Studies, Victoria Institute of Strategic Economic Studies for 190 subdivision codes of the Australia New Zealand Standard Industrial Classification (ANZSIC) for 1389 SLAs for 2011 across Australia, of which 205 are in Victoria. The subdivisions have been aggregated into 19 divisions, however, for the purposes of analysis each of the 190 divisions were given individual sensitivity ratings after Jones and Webb (2008).

High sensitivity – denotes activities affected by natural hazards over a large geographical area and/or that may suffer critical damage due to natural hazards. High sensitivity does not necessarily mean that an activity will suffer critical levels of damage in all possible cases, but rather, that there is a vulnerability to serious loss. Examples are most types of primary production, water resources, infrastructure and some aspects of natural resource management.

Moderate sensitivity – includes activities subject to natural hazards to some extent over a large geographical area and/or that may suffer critical damage in specific localities or circumstances. Also included are activities where significant impacts affect a supplier or customer. For example, manufacture of food and timber products, energy distribution and supply, and emergency services.

Low sensitivity – includes activities that may experience minor widespread impacts, moderate local impacts or very localised but severe impacts due to natural hazards. Also included are activities that may suffer moderate knock-on effects from other activities.

Negligible sensitivity – activities considered to be largely insensitive to natural hazards, experiencing minor amounts of damage and loss.

3.1.4 Potential impacts

Potential impacts range from direct to indirect:

Direct impacts include more frequent and severe natural hazards resulting in losses to primary productivity and affecting property, infrastructure and natural systems.

Indirect impacts include losses to manufacturing and services caused by reduced primary production; changes to financial arrangements caused by large insurance losses; as well as altered demands on government services due to of social and environmental impacts of bushfires and floods.

3.1.5 Adaptive capacity

Adaptive capacity is the ability to respond to experienced bushfires and floods. Exercising adaptive capacity by successfully adapting to natural disasters will reduce *vulnerability*.

Vulnerability can be assessed through a range of socio-economic indicators that measure aspects of economic, social, and environmental flows and capital. This report qualitatively assesses economic, social and environmental vulnerability based on exposure and sensitivity to bushfires and floods in Victoria. Adaptive capacity affects vulnerability but is not assessed in this report, where impacts directly related to potential vulnerability.

3.1.6 Economic impacts

Economic impacts – can be measured through changes in monetary flows and capital, finance and investment. Here economic impacts are measured by linking economic output to the sensitivity and exposure levels described above for Victoria and each SLA. Economic activities are categorised into

divisions, subdivisions, groups and classes. The data used in this report is at the group level. There are 190 economic groups according to the ANZSIC classification (2006) and these groups are ranked according to whether they exhibit negligible, low, moderate or high vulnerability to bushfires and floods.

3.1.7 Vulnerability matrix

A vulnerability matrix has been used which combines sensitivity and exposure levels to determine the level of vulnerability for each economic group in each SLA. This matrix is shown in Table 3.

	Sensitivity			
Exposure	Negligible	Low	Moderate	High
Negligible				
Low				
Moderate				
High				

TABLE 3: VULNERABILITY MATRIX

3.1.8 Data limitations and assumptions

Sensitivity is given a single rating for each ANZSIC subdivision, so will not reflect differences in biophysical, economic or social factors on spatial or temporal scales. For example, the sensitivity of a system will reflect very much on its condition at the time, especially if in the recovery phase from other events, whether natural hazards or not.

The scale of individual SLA also affects the resolution at which exposure can be expressed. Because they are largely defined by population, they vary widely in area so can contain a range of environments. For bushfire, exposure shows broad variations, being very high near flammable fuel sources and low in built-up areas. For riverine flood, the effect of location is probably even more distinct, being largely limited to flood plains and adjacent areas, although coastal flooding is also a factor. For flash-flooding, the risk is much more widespread but highly variable. The historical flood maps capture riverine flooding but not flash-flooding due to high-intensity rainfall or coastal flooding.

Higher resolution mapping requires knowledge of the hazard and the location of economic activities and the assets producing them on high spatial scales. While this resolution is improving for selected risks such as bushfire and riverine flood, it is lacking for many of the economic activities and assets of importance. Working at the SLA scale is dictated by the economic data in its current form. Further work to disaggregate such data would be required and is beyond the resources available for this project.

3.2 Economic activity

Total economic activity in Victoria in 2011 as measured by the Australian Bureau of Statistics (ABS) was $296.2 billion. The spatial distribution of economic activity in Victoria is shown in Figure 7. This figure was categorised into economic divisions as described the following section. The subsequent

sections also include maps showing the percentage that each economic division contributes to the particular SLA. As these maps show, while an economic division may not have a large absolute value, it may make up a significant percentage of the local economy and hence its importance should be emphasised. The maps

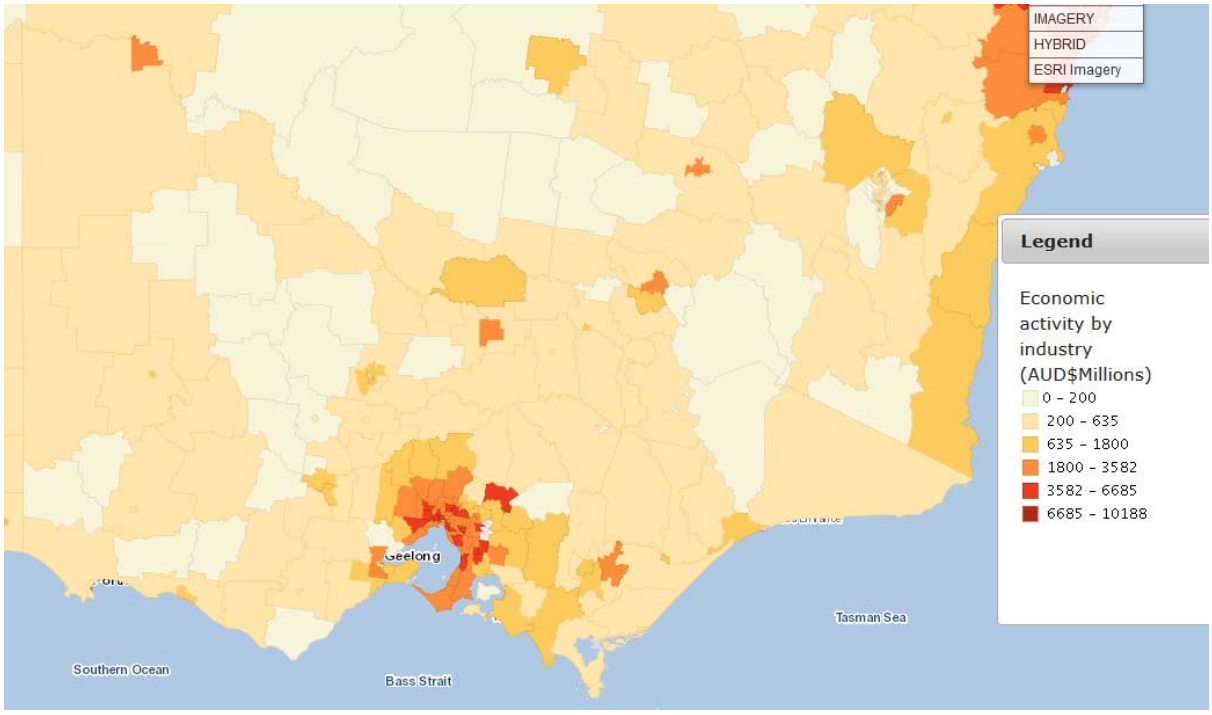

FIGURE 7: ECONOMIC ACTIVITY PER SLA IN VICTORIA

4 ECONOMIC VULNERABILITY

There are 19 divisions in the Australia New Zealand Standard Industrial Classification (ANZSIC), which are listed below:

- Agriculture, Forestry and Fishing
- Mining
- Manufacturing
- Electricity, Gas, Water and Waste Services
- Construction
- Wholesale Trade
- Retail Trade
- Accommodation and Food Services
- Transport, Postal and Warehousing
- Information Media and Telecommunications
- Financial and Insurance Services
- Rental, Hiring and Real Estate Services
- Professional, Scientific and Technical Services
- Administrative and Support Services
- Public Administration and Safety
- Education and Training
- Health Care and Social Assistance
- Arts and Recreation Services
- Other Services

Each economic division is summarised below in terms of the major output groups that make up that division as well as how much each division is vulnerable to both bushfires and floods.

4.1 Victorian Total Economic Activity Vulnerability

Figure 8 represents the amount of economic activity in Victoria that has a negligible, low, moderate and high vulnerability to bushfire based on historical bushfire data. As can be seen in Figure 8, only a small percentage of Victorian economic activity is considered to have a high (2.9%), moderate (5%) and low (11.7%) vulnerability to bushfire the proportion depends greatly upon the location with some locations having over 50% of their income considered to be highly vulnerable (e.g., Moyne North West). The spatial distribution of bushfire vulnerability per SLA is shown in Figure 9.

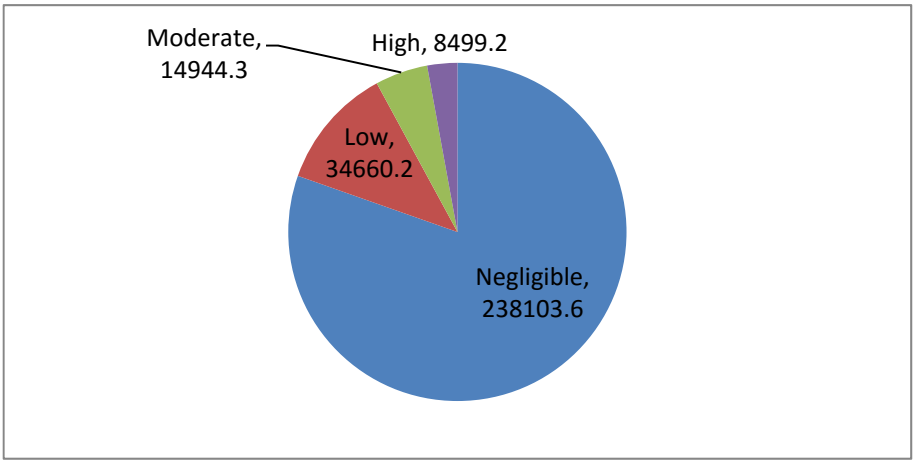

FIGURE 8: VICTORIAN TOTAL ECONOMIC BUSHFIRE VULNERABILITY ($MILLIONS)

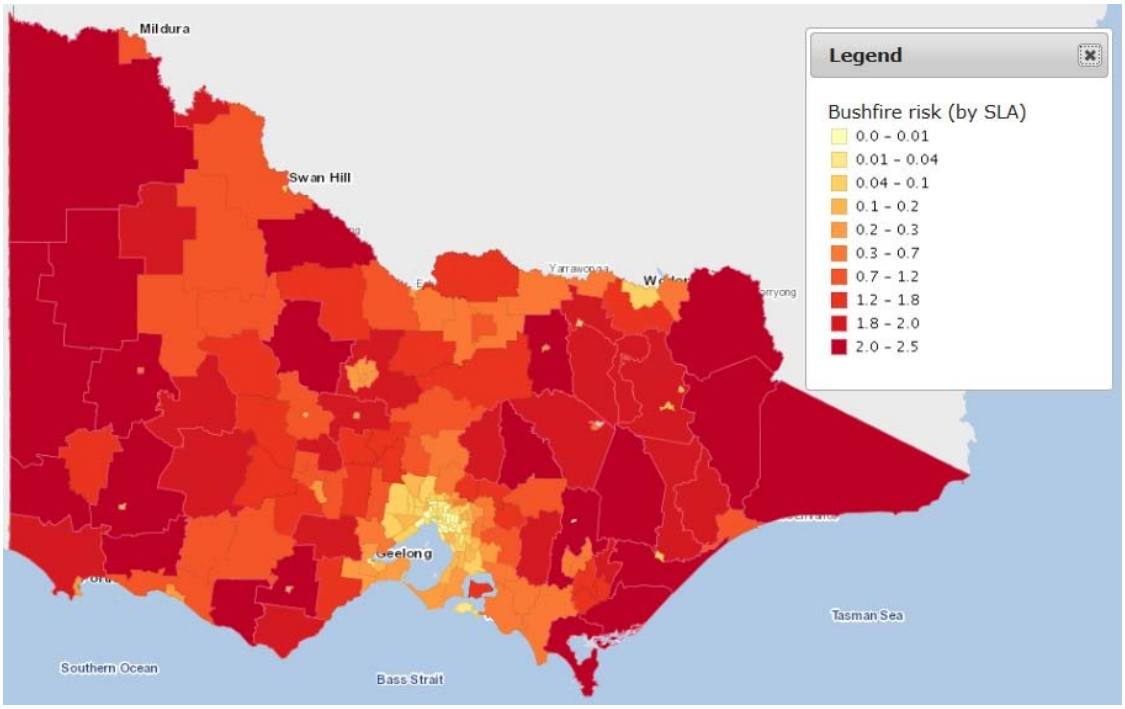

FIGURE 9: TOTAL BUSHFIRE VULNERABILITY RANKING PER SLA IN VICTORIA

The same is true for vulnerability to flood as shown in Figure 10 with the high (2.4%), moderate (3.6%) and low (7.5%) figures being relatively low. Again this masks great variability with some having over 50% rated as highly vulnerable (Loddon North 67% and Swan Hill Bal 50%). The spatial distribution of flood vulnerability per SLA is shown in Figure 11.

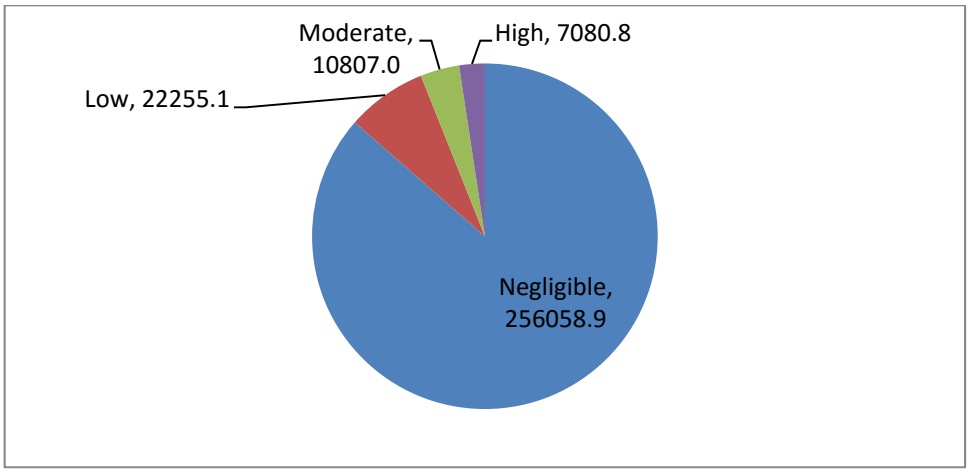

FIGURE 10: VICTORIAN TOTAL ECONOMIC FLOOD VULNERABILITY ($MILLION)

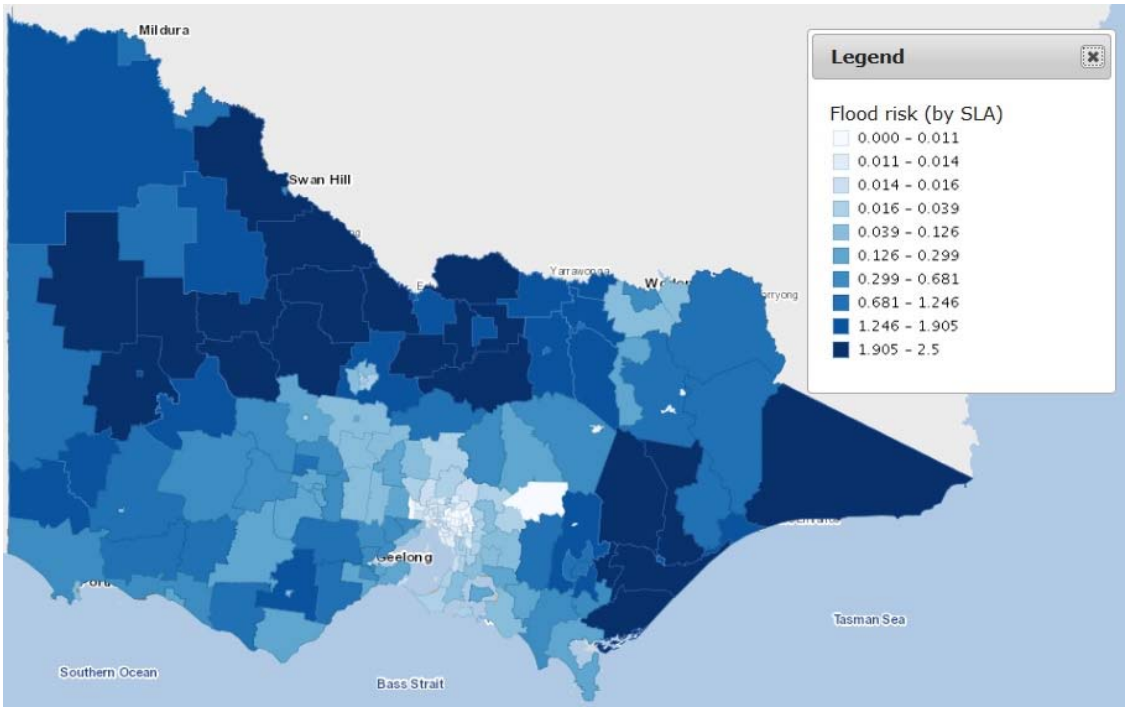

FIGURE 11: TOTAL FLOOD VULNERABILITY RANKING PER SLA IN VICTORIA

4.2 Agriculture, Forestry and Fishing

Agriculture forestry and fishing (AgFF) are the dominant forms of land use in Australia. Not surprisingly agriculture, forestry and fishing is the economic division with the greatest exposure to bushfires and floods, and consequently, the most vulnerable.

In Victoria AgFF generated $7.755 billion in income which was 2.6% of the state economic output. For Victoria the SLAs which generated the largest amount of AgFF income were Moira (S)-West ($211 million), Mildura Pt A ($205 million) and Baw Baw Pt B West ($190 million) as shown in Figure 12. For Victoria the percentage of AFF for the individual SLAs also varied greatly from 0% to over 50% (Loddon and Mildura) as shown in Figure 13 with large areas of north western and western Victoria having over 35% of their local economy composed of AgFF. Dairy cattle (14.8% of Vic AgFF), beef cattle (10.7% of Vic AgFF) and sheep (9.7% of Vic AgFF) are the largest forms of economic activity within Victoria's AgFF division (Figure 14).

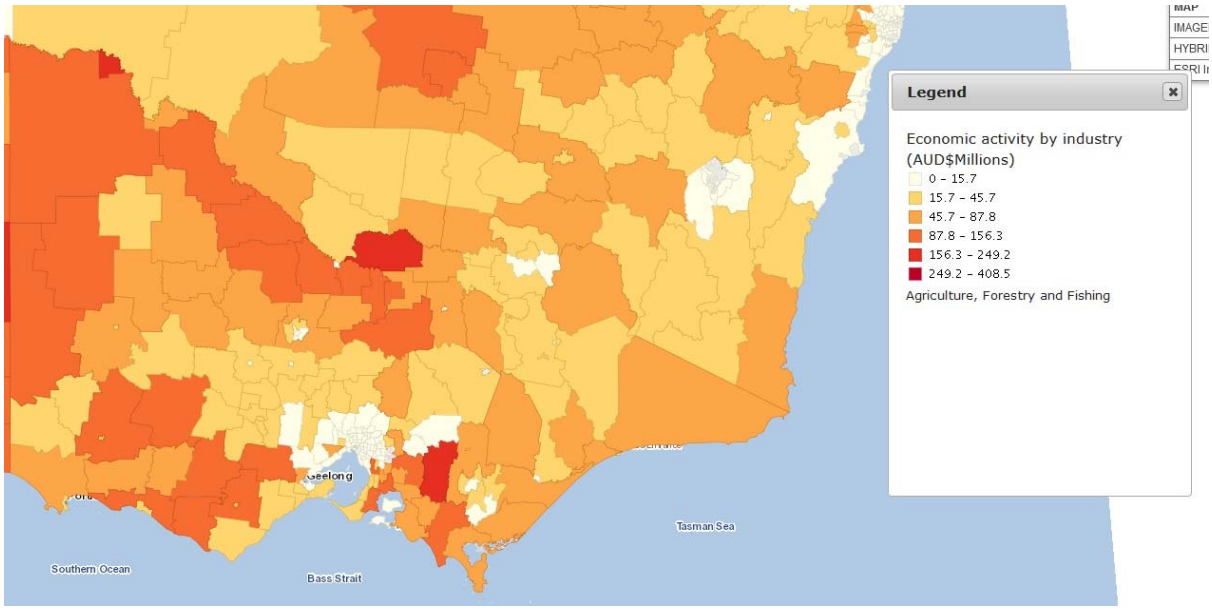

FIGURE 12: MAP OF SLA AGFF ABSOLUTE INCOME ($MILLION)

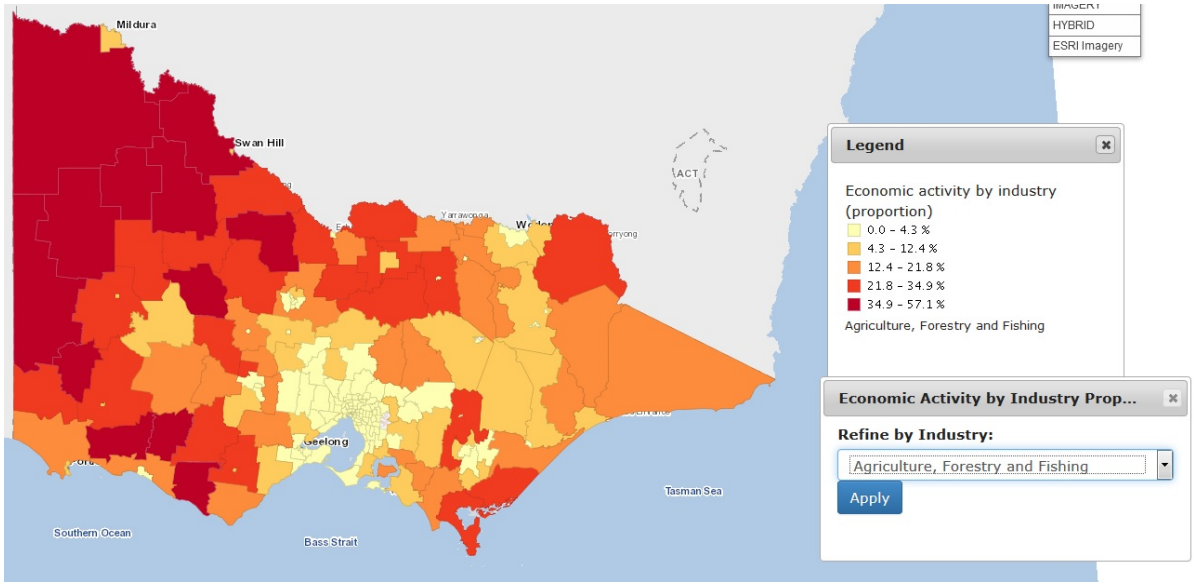

FIGURE 13: MAP OF SLA AGFF RELATIVE INCOME (%)

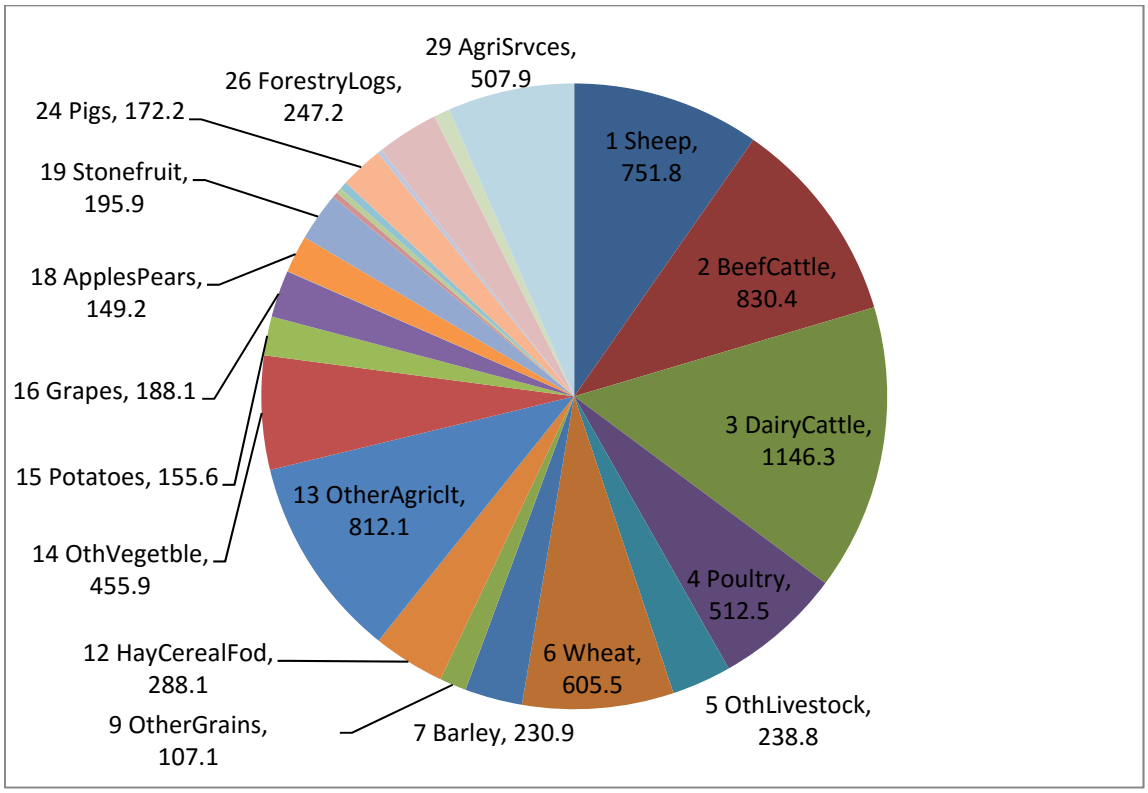

FIGURE 14: AGFF GROUPS OF VICTORIA STATE INCOME ($MILLION)

4.2.1 Agriculture, Forestry and Fishing Vulnerability

Agriculture, Forestry and Fishing are particularly vulnerable to natural disasters. Fires and floods destroy crops and kill livestock and hence the AgFF economic division is at the forefront of exposure to natural disasters and the economic impacts that flow from that as shown in Figure 15 and Figure 16. For the state, the breakdown of high, moderate and low sensitivity for fire is 59%, 34% and 7%. For the state, the breakdown of high, moderate and low sensitivity for flood is 51%, 20% and 29%.

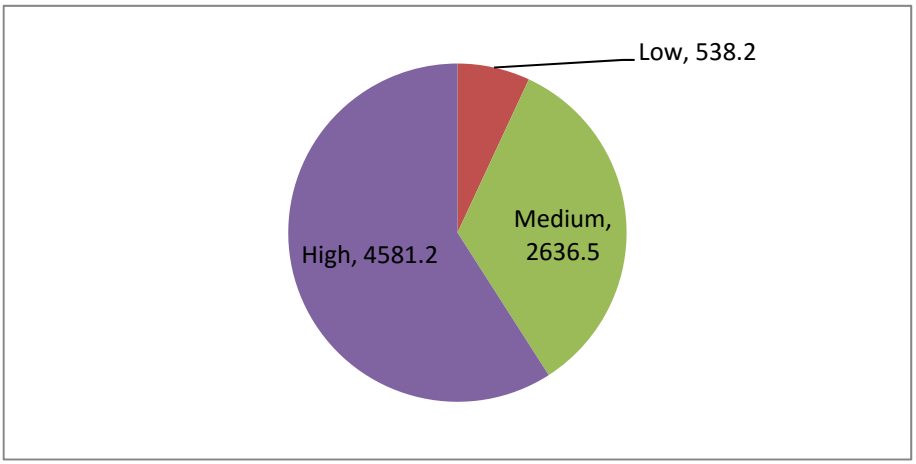

FIGURE 15: AGRICULTURE, FORESTRY AND FISHING BUSHFIRE VULNERABILITY ($MILLION)

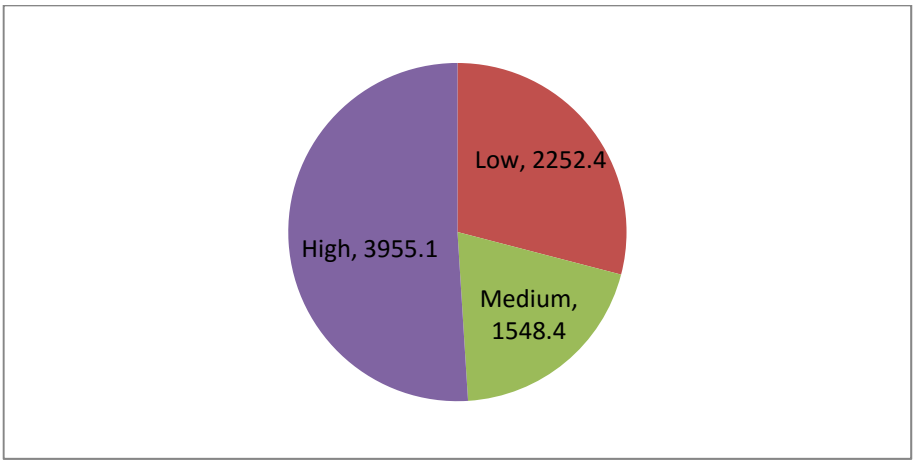

FIGURE 16: AGRICULTURE, FORESTRY AND FISHING FLOOD VULNERABILITY ($MILLION)

4.3 Mining

Mining generated $5.98 billion in Victoria in 2011 which represented 2.0% of the total state economic output with the largest amount generated in Wellington Sale ($310 million), Latrobe – Traralgon ($153 million) and Wellington Rosedale ($130 million) as shown in Figure 17. In Victoria the percentage that mining income generated of an individual SLA varied greatly with many areas having 0% (predominantly city SLAs) to over 25% (e.g., Wellington Avon 34%, North Grampians 27%) as shown in Figure 18.

Oil (23.6%), non-iron ores (19.3%), gas (14.3%) and LNG (14.2%) were the largest groups of the Mining division as shown in Figure 19.

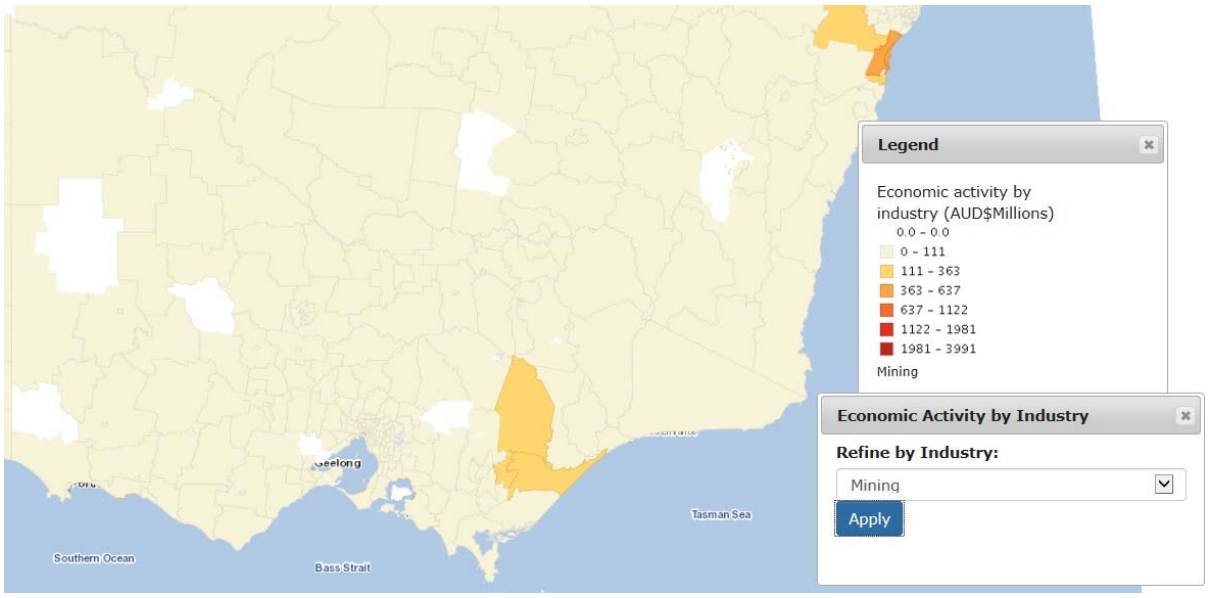

FIGURE 17: MAP OF SLA MINING ABSOLUTE INCOME ($MILLION)

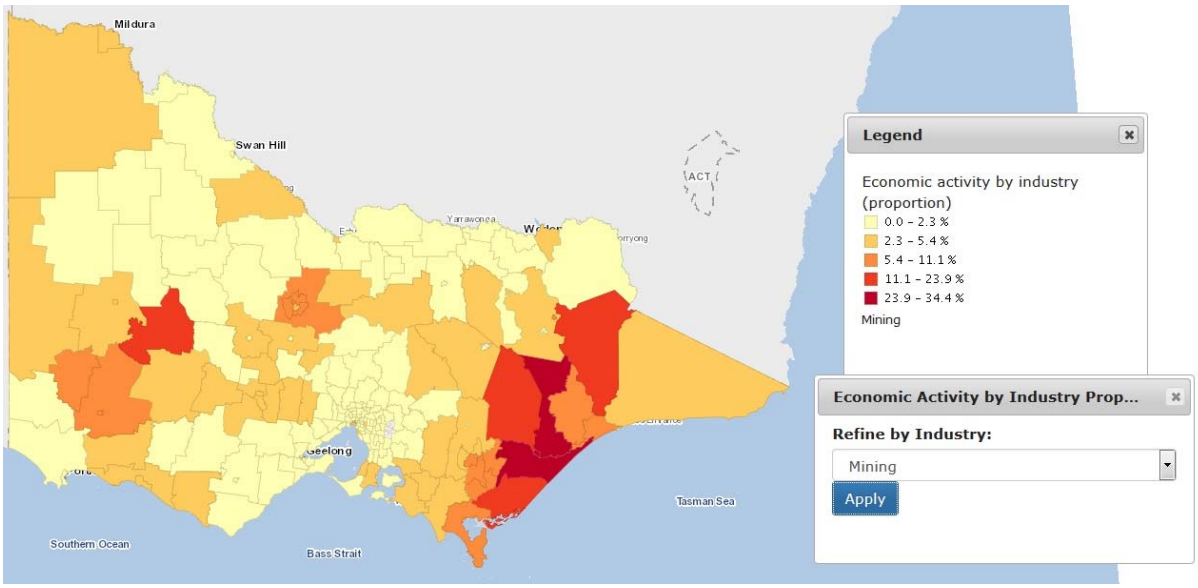

FIGURE 18: MAP OF SLA MINING RELATIVE INCOME (%)

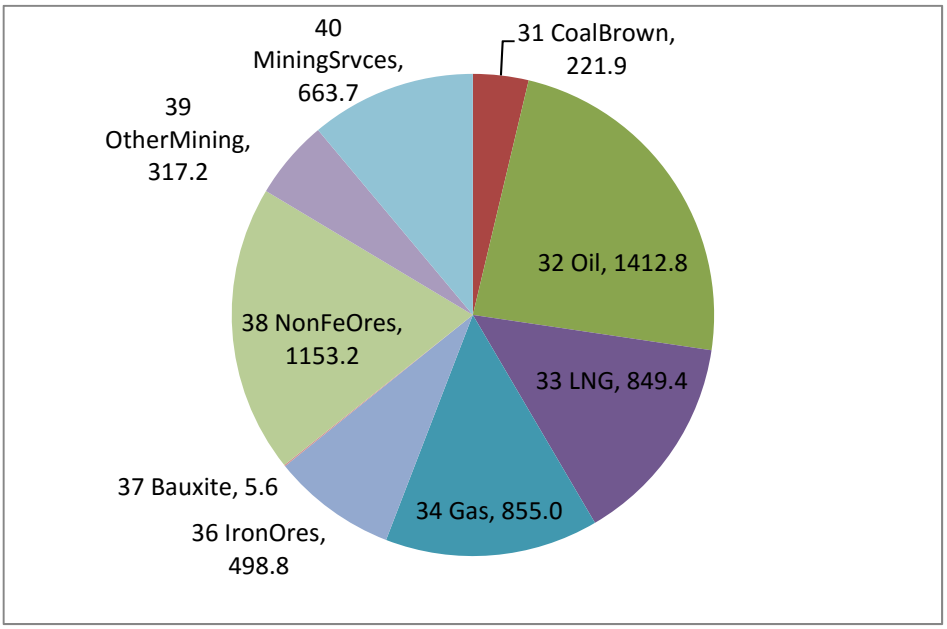

FIGURE 19: MINING GROUPS OF VICTORIA STATE INCOME ($MILLION)

4.3.1 Mining Vulnerability

Minerals and resource activities major vulnerabilities are related to the location of a specific activity. Fossil fuel extraction industries are also co-located with energy generation, so these sectors share many of the issues linked with bushfires and floods. If rated to local conditions, sensitivity

Fire vulnerability

Fire vulnerability is expected to become more common in forest regions, threatening mining operations in those regions, such as coal mining in the La Trobe Valley and near Anglesea, and precious and base metal mining in the forested regions of western, central and eastern Victoria. On the other hand, such operations have equipment that can be used to fight fires and in other emergencies. The economic value of these vulnerabilities is shown in Figure 20. For the state, the breakdown of moderate, low and negligible sensitivity for fire is 20%, 9% and 71%.

Flood vulnerability

Localised floods caused by convective events resulting in flash flooding may become more common, including on some of the larger rivers exposed to on-shore weather systems such as those in eastern Victoria. This can threaten mining operations in flood-exposed areas, including coalmines in Gippsland. The economic value of these vulnerabilities is shown in Figure 21. For the state, the breakdown of moderate, low and negligible sensitivity for flood is 22%, 11% and 67%.

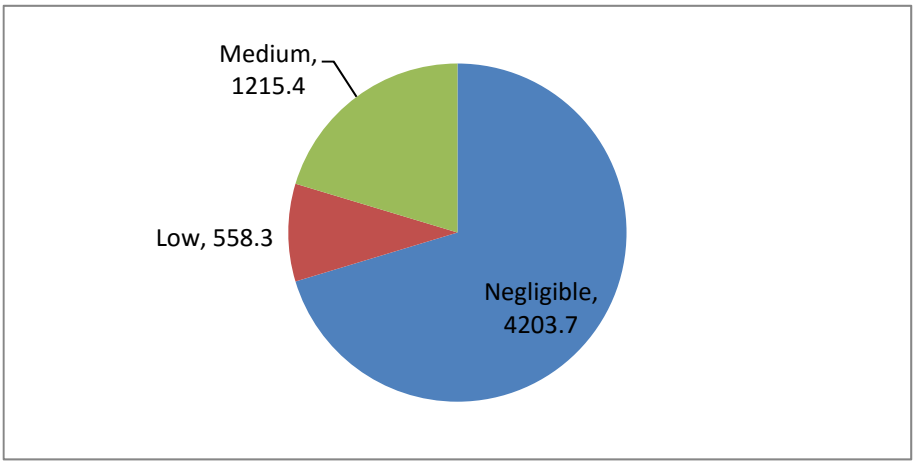

FIGURE 20: MINING FIRE VULNERABILITY ($MILLION)

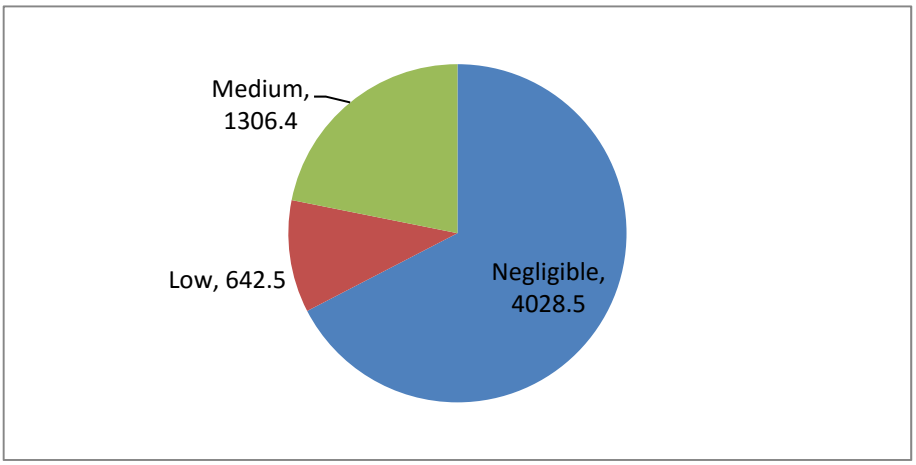

FIGURE 21: MINING FLOOD VULNERABILITY ($MILLION)

4.4 Manufacturing

Manufacturing is the third largest source of income in Victoria totalling $24.9 billion or 8.4% total income. SLAs generating the largest manufacturing income include Casey (Cranbourne) ($749 million), Gr Dandenong Bal ($682 million) and Casey (Berwick) ($633 million) as shown in Figure 22. In individual SLAs, manufacturing ranges from 0% (Yarrambiack North) to 26% (Glenelg – Portland) of SLA total income (Figure 23). Three quarters of manufacturing income and employment is centred in Melbourne.

This sector covers all manufacturing activities including food, mechanical, chemical, textile and clothing manufacturing and some manufacturing of construction and building materials as shown in Figure 24, the largest of which are Dairy products (5.5%), plastic products (5.5%) and other non-iron metals (5.1%). Much manufacturing outside of Melbourne is situated close to its source of raw materials. Raw materials from activities sensitive to bushfire and flood utilised in the manufacturing

industry are forest products, food and drink, and pulp and paper. Manufacturing supplying bushfire and flood-sensitive activities includes agricultural equipment.

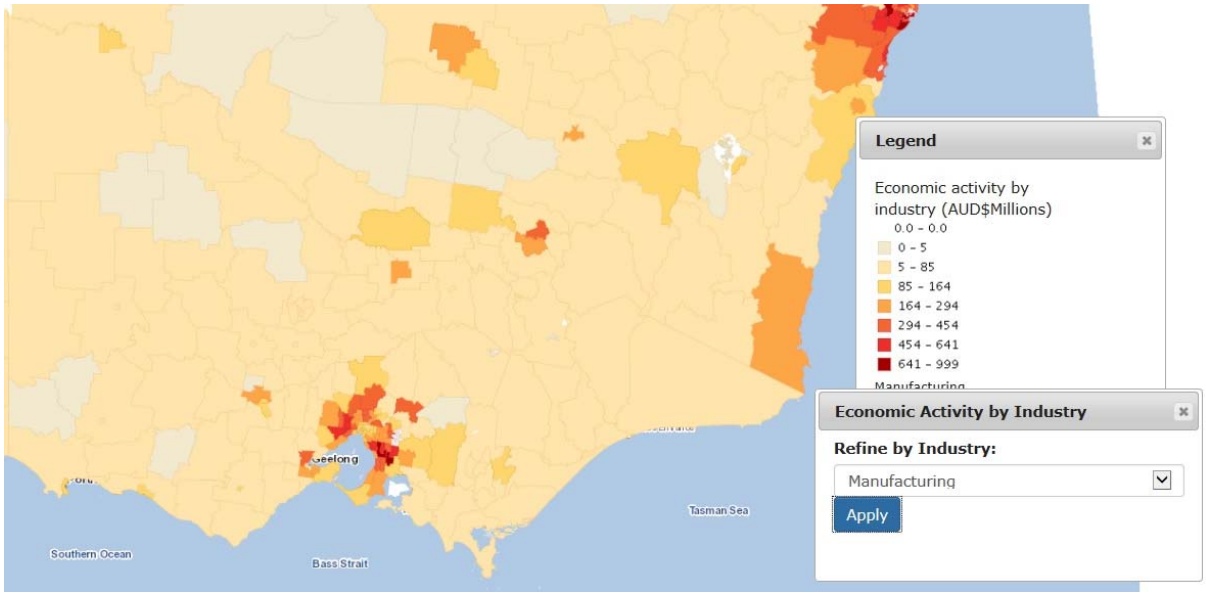

FIGURE 22: MAP OF SLA MANUFACTURING ABSOLUTE INCOME ($MILLION)

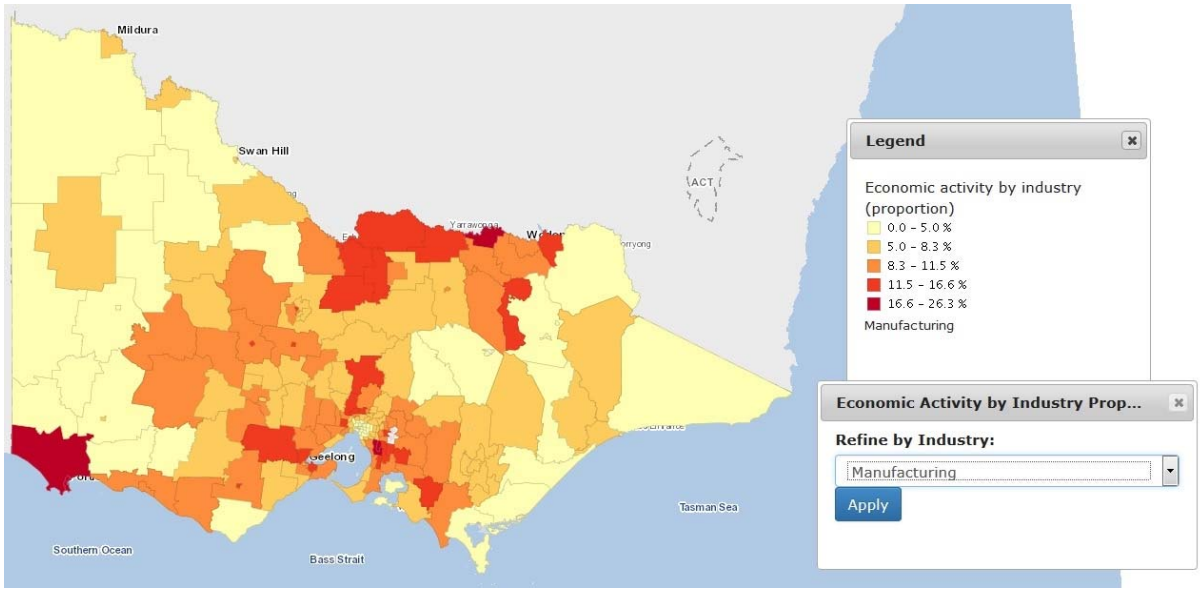

FIGURE 23: MAP OF SLA MANUFACTURING RELATIVE INCOME (%)

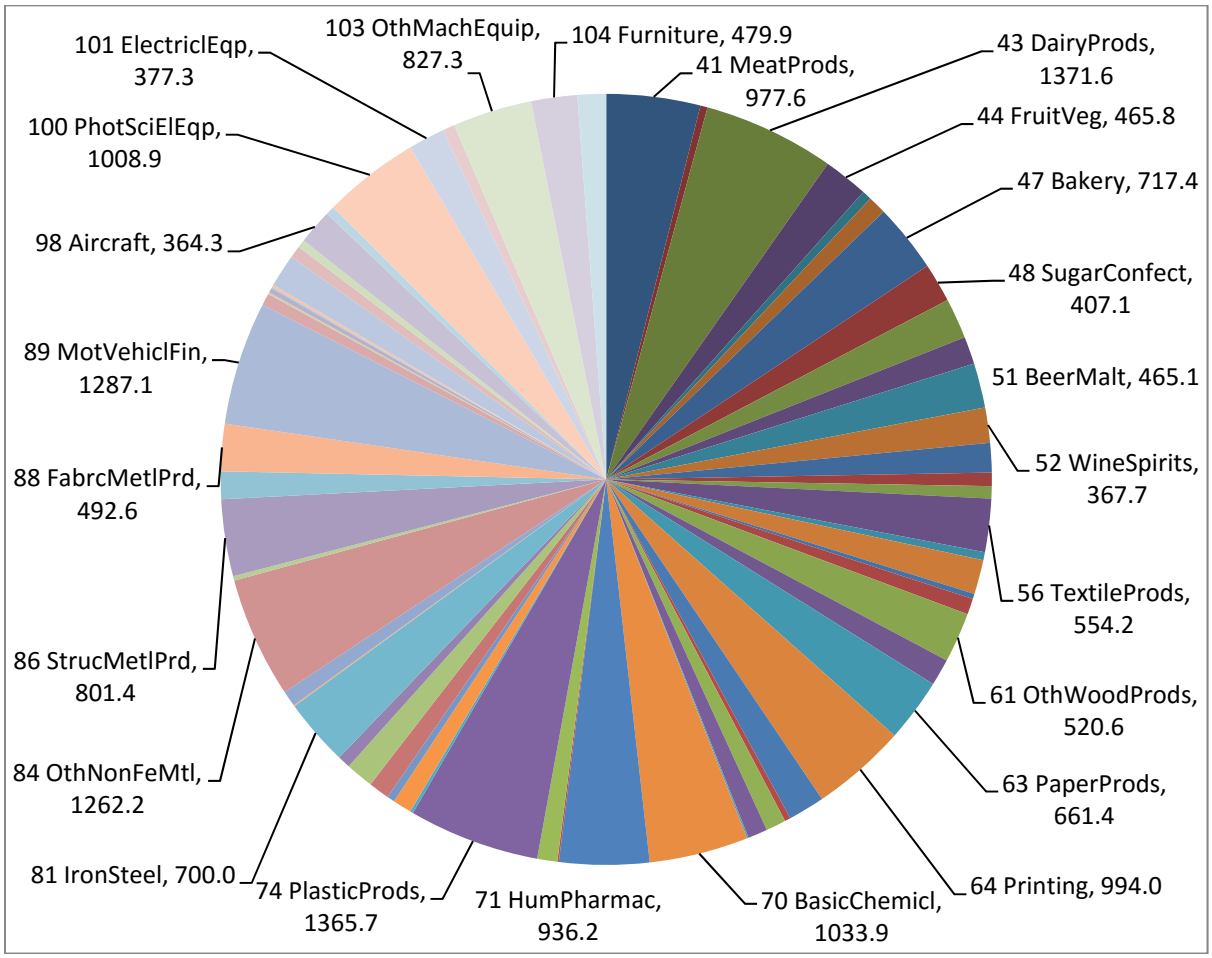

FIGURE 24: MANUFACTURING GROUPS OF VICTORIA STATE INCOME ($MILLION)

4.4.1 Manufacturing Vulnerability

Manufacturing utilising forest products is classified as moderately sensitive, and that using agricultural produce or producing equipment used in primary production is classified as having low sensitivity. For the state, the breakdown of high, moderate, low and negligible sensitivity for fire is 0.5%, 3%, 9% and 87.5% and for flood is moderate 22%, low 11% and negligible 67% as shown in Figure 25 and Figure 26.

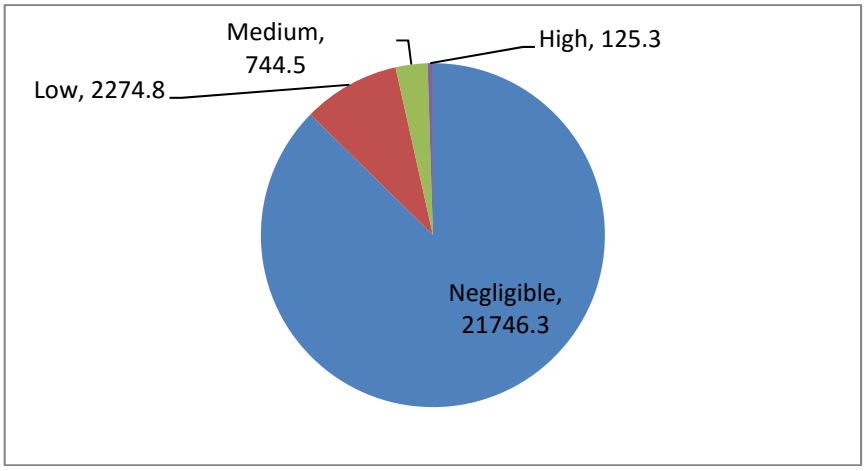

FIGURE 25: MANUFACTURING FIRE VULNERABILITY ($MILLION)

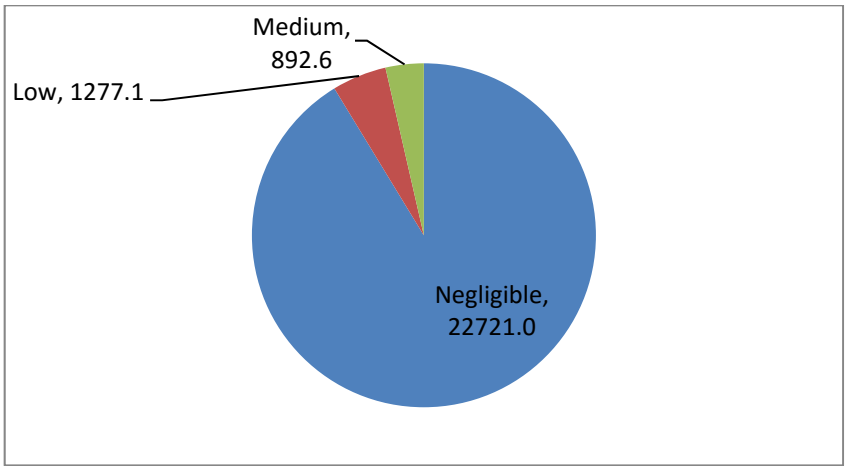

FIGURE 26: MANUFACTURING FLOOD VULNERABILITY ($MILLION)

4.5 Electricity, Gas, Water and Waste Services

The energy sector in Victoria in 2011 produced income of $46.8 billion, 2.3% of the State's income with the largest amount generated in Latrobe (Traralgon) ($411 million), Latrobe (Morwell) ($278 million) and Latrobe (Moe) ($226 million) as shown in Figure 27. It is an essential service that underpins both economic and social activities. Regional production higher than the state average occurs in Latrobe Morwell (24% of SLA income) and Latrobe Moe (24% of SLA income) as shown in Figure 28.

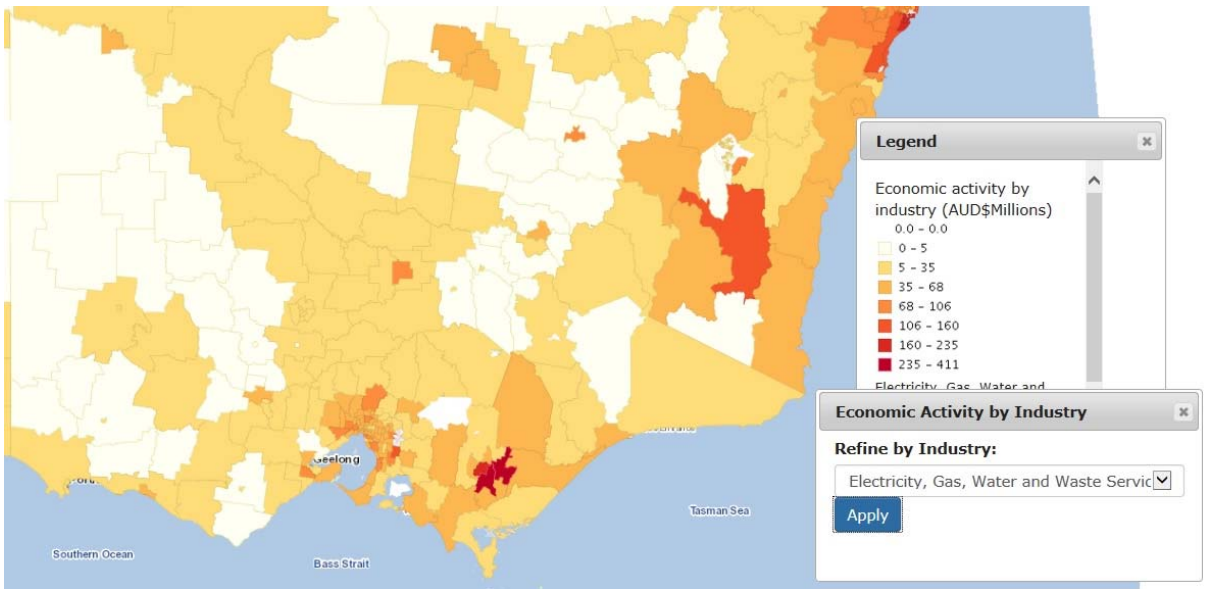

FIGURE 27: MAP OF SLA ELECTRICITY, GAS, WATER AND WASTE SERVICES ABSOLUTE INCOME ($MILLION)

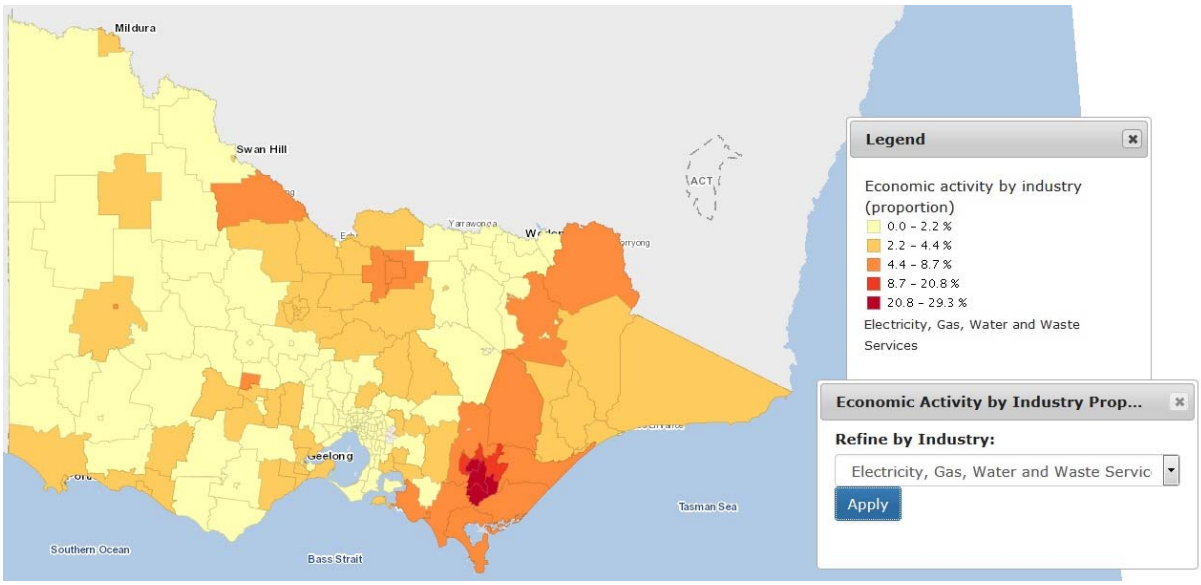

FIGURE 28: MAP OF SLA ELECTRICITY, GAS, WATER AND WASTE SERVICES RELATIVE INCOME (%)

The sector includes power generation and distribution. Generation of energy from brown coal is 24.1% and electricity distribution is 27.7% of total sector income. This sector also includes water supply, sewerage and drainage services which is 29% of total sector income as shown in Figure 29.

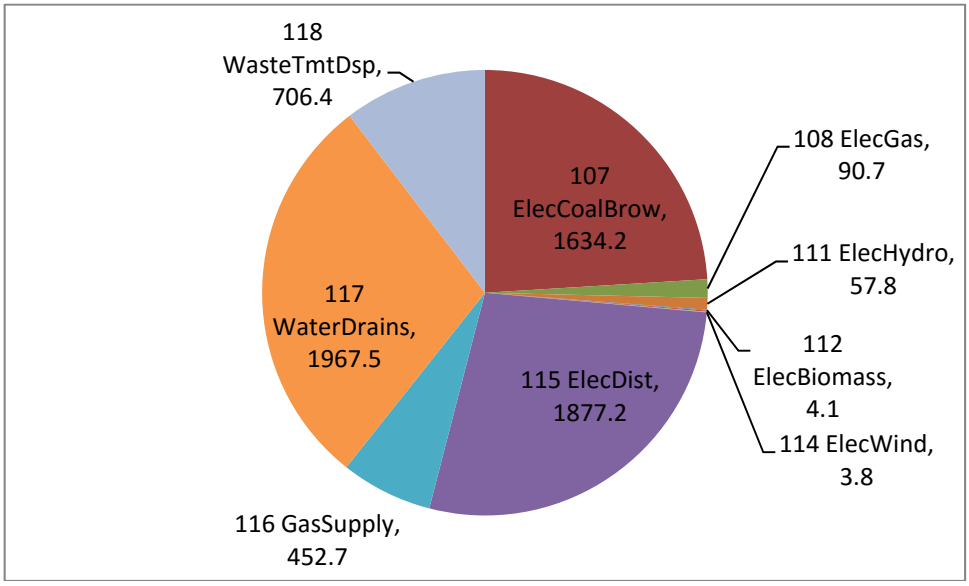

FIGURE 29: EGWW GROUPS OF VICTORIA STATE INCOME ($MILLION)

4.5.1 Electricity, Gas, Water and Waste Services Vulnerability

The mining of brown coal in Gippsland is rated as having low sensitivity to bushfires and floods, but some mines such as Yallourn would be rated moderate to high if local exposure could be taken into account. This vulnerability could potentially flow through to power generation, but usually stockpiles and different sources in the system are sufficient to provide an uninterrupted supply of fuel. Natural gas is sensitive to winter temperatures, its demand reducing during warm winters.

The production of thermal energy is temperature dependent. Efficiency is highest at low temperatures, requiring some form of cooling. Most existing power generation is water-cooled; water needs are generally met by a high security surface water supply, or in some cases, recycled water. Droughts in the La Trobe Valley have in the past led to energy generators purchasing water

for the production of electricity. Energy and water are both essential services and the link between the two has to date not been linked with potential vulnerability.

Hydroelectric power is a special case, because it relies on water supply for generation. Hydro-electricity has an important niche role in the generation of short-term peak power that thermal power (with the exception of gas turbines) cannot provide cheaply. Currently, hydropower is being sourced from Gippsland. Small generators in northern Victoria have previously been affected by drought so have operated at low levels or not at all. Hydropower is also sourced from the Snowy Mountains Electrical Scheme in the Victorian Upper Murray Region and NSW.

Hydropower and electric biomass are rated as highly sensitive, electricity from gas, biogas and wind, and gas and electricity distribution are moderately sensitive and coal-powered generation is rated as having low sensitivity. For the state, the breakdown of high, moderate, low and negligible sensitivity for fire is 23%, 28%, 39% and 10% while for flood it is 26%, 9%, 40% and 25% as shown in Figure 30 and Figure 31.

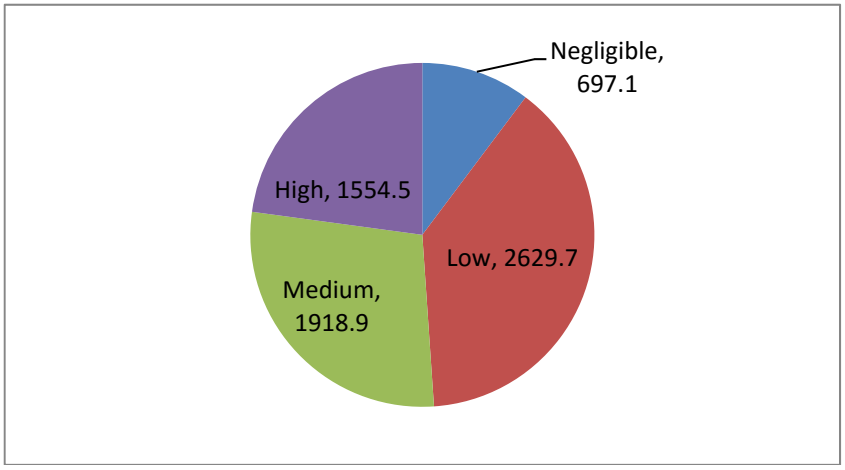

FIGURE 30: MANUFACTURING FIRE VULNERABILITY ($MILLION)

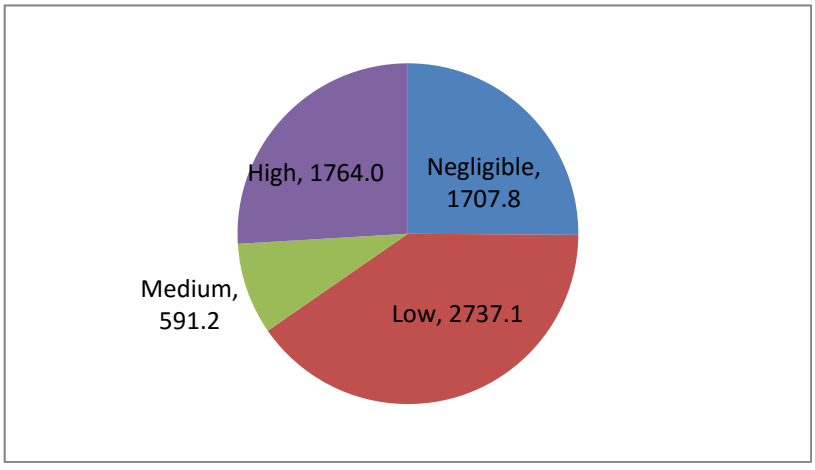

FIGURE 31: MANUFACTURING FLOOD VULNERABILITY ($MILLION)

4.6 Construction

Building, construction and infrastructure provided 6.6% ($19.7 billion) of Victoria's income in 2011 with the SLAs generating the largest income including Casey (Berwick) ($439 million), Yarra Ranges (North) ($438 million) and Wyndham (North) ($372 million) as shown in Figure 32. This sector covers major domestic construction (20.2%), non-residential building construction (15.4%), civil engineering construction (25%) and construction services (40.1%) as shown in Figure 34. Construction accounts for a wide variety of economic activity in different SLAs with the maximum found in Bass Coast (20%), Yarra Ranges (13%), Nillumbik (13%) and Mornington Peninsula South (13%) as shown in Figure 33. This map shows that construction makes up a significant proportion in many areas of the eastern Victoria.

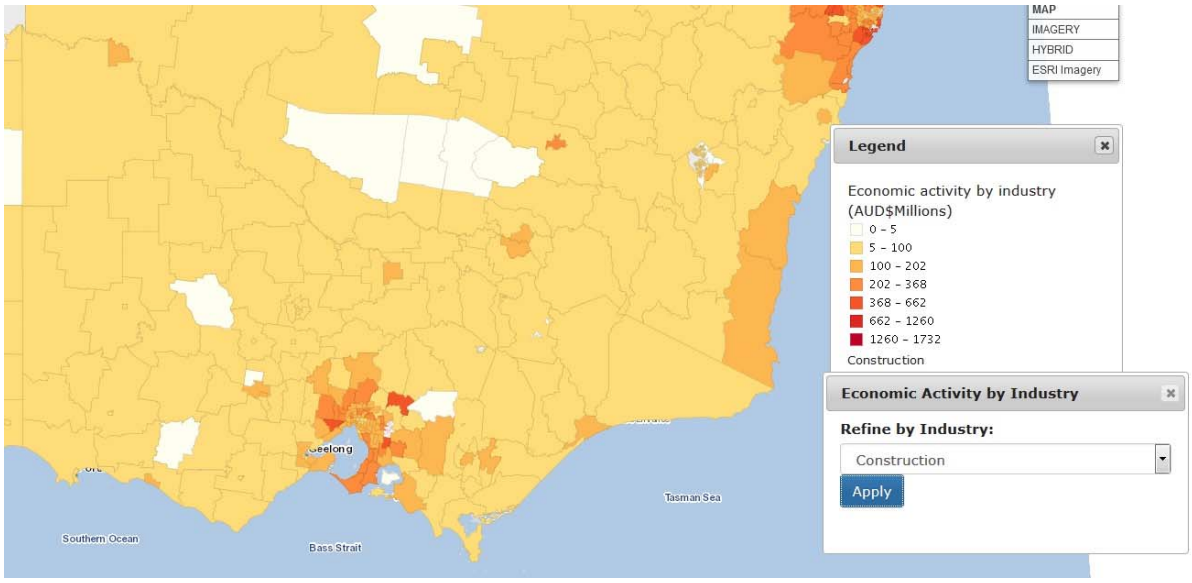

FIGURE 32: MAP OF SLA CONSTRUCTION ABSOLUTE INCOME ($MILLION)

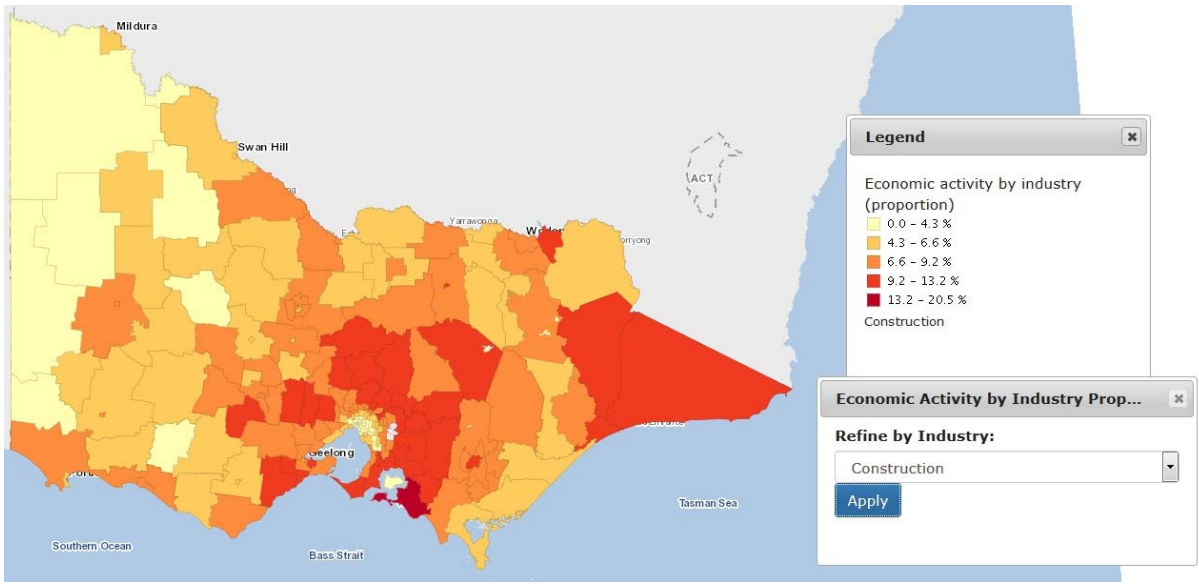

FIGURE 33: MAP OF SLA CONSTRUCTION RELATIVE INCOME (%)

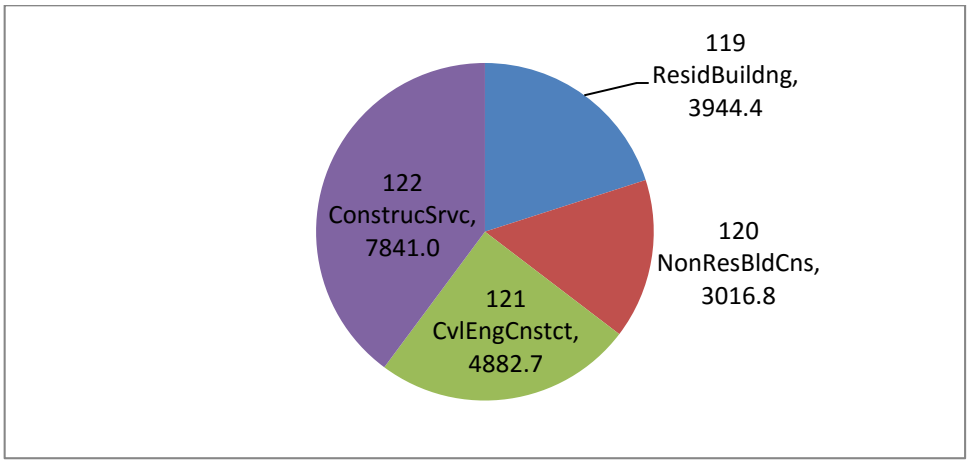

FIGURE 34: CONSTRUCTION GROUPS OF VICTORIA STATE INCOME ($MILLION)

4.6.1 Construction Vulnerability

The sector as a whole is rated as having low sensitivity, but this masks a great diversity based on hazard and locations that could be rated as negligible to high. For the state, the breakdown of moderate, low and negligible sensitivity for fire is 10.6%, 9.8% and 79.6% while for flood it is 6%, 10% and 84% as shown in Figure 35 and Figure 36.

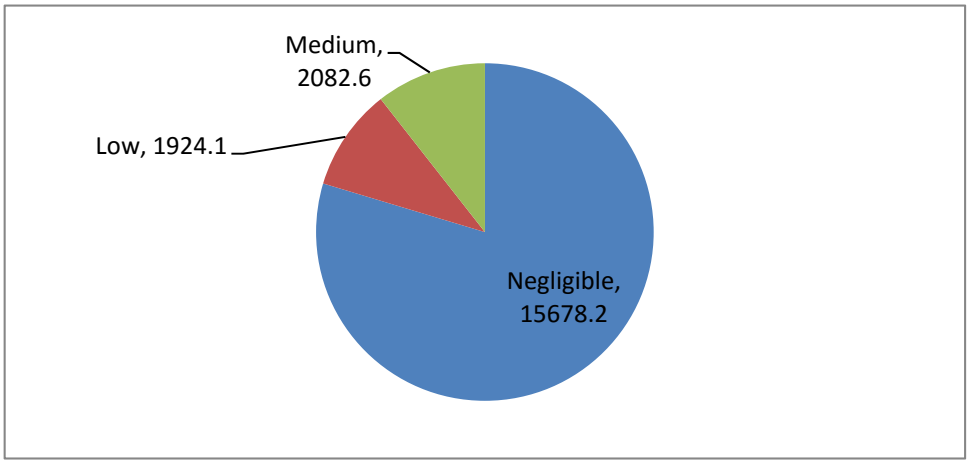

FIGURE 35: CONSTRUCTION BUSHFIRE VULNERABILITY ($MILLION)

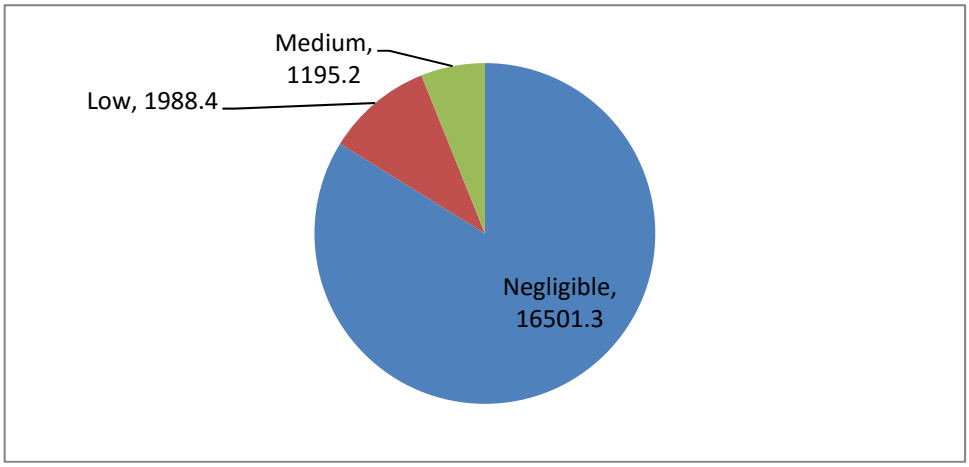

FIGURE 36: MANUFACTURING FLOOD VULNERABILITY ($MILLION)

4.7 Wholesale Trade

Wholesale trade generated $14.2 billion in 2011 in Victoria which represented 4.8% of the state's income, the largest Wholesale Trade value found in Casey (Berwick) ($369 million), Casey (Cranbourne) ($355 million) and Kingston (North) ($323 million) as shown in Figure 37 . Wholesale trade varied between zero and 8% of each SLAs income with the south eastern SLAs of Melbourne such as Knox and Cranbourne having 8% and Casey and Cardinia having 7%. Rural areas such as Wellington and Latrobe had figures of 1% as shown in Figure 38.

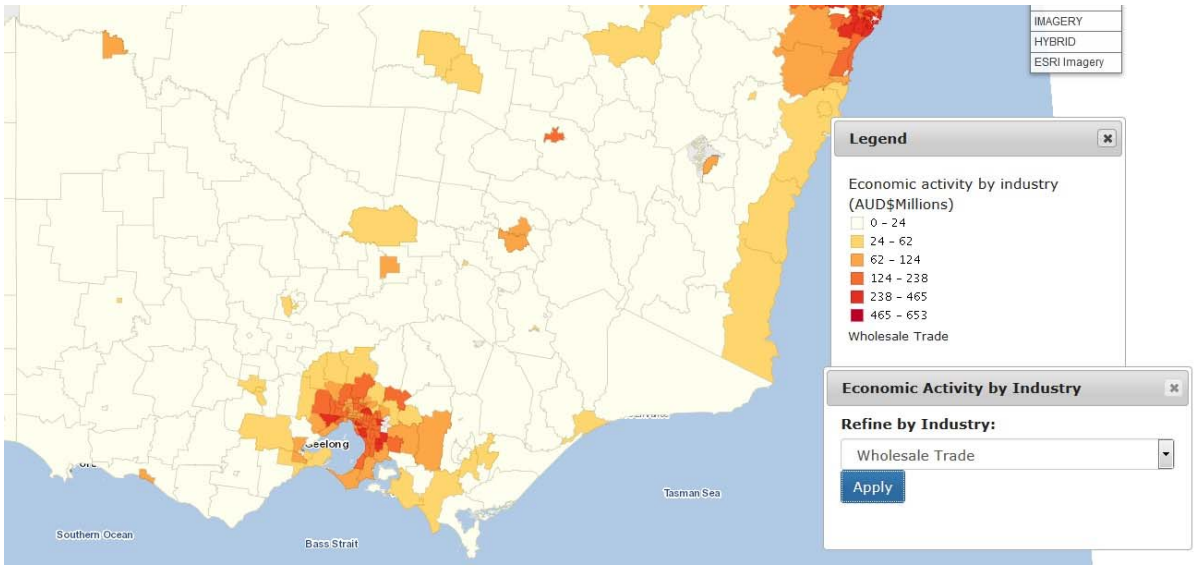

FIGURE 37: MAP OF SLA WHOLESALE TRADE ABSOLUTE INCOME ($MILLION)

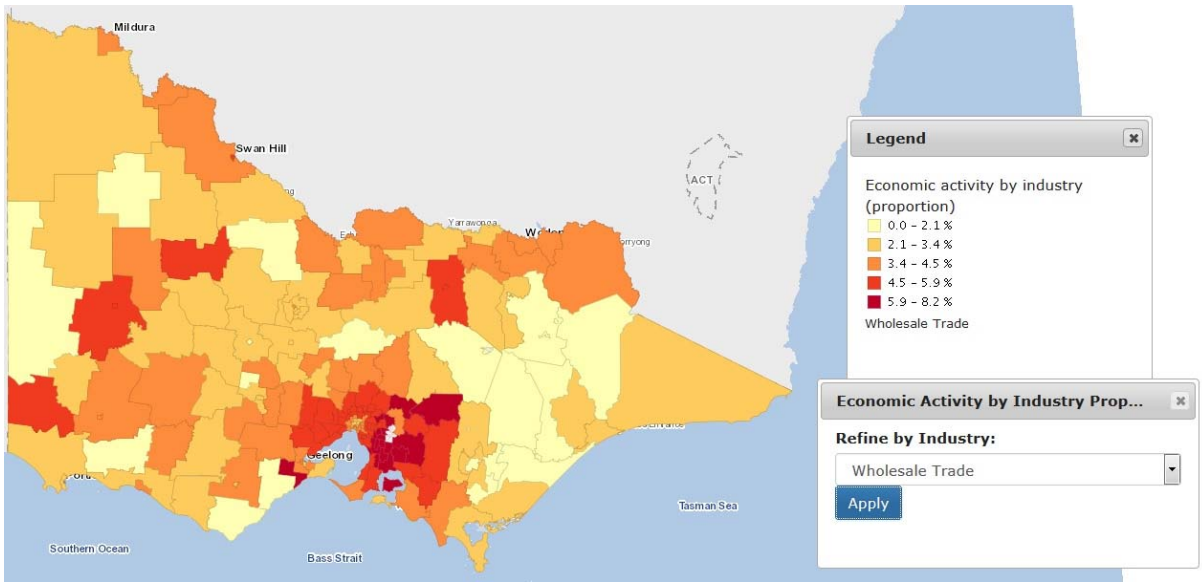

FIGURE 38: MAP OF SLA WHOLESALE TRADE RELATIVE INCOME (%)

4.7.1 Wholesale Trade Vulnerability

Wholesale trade was rated as having a low vulnerability due to its mainly urban focus and its lack of proximity to flood prone areas. For the state, the breakdown of moderate, low and negligible sensitivity for bushfire is 3.8%, 7.6% and 88.7% while for flood it is 6.4%, 6.6% and 87% as shown in Figure 39 and Figure 40

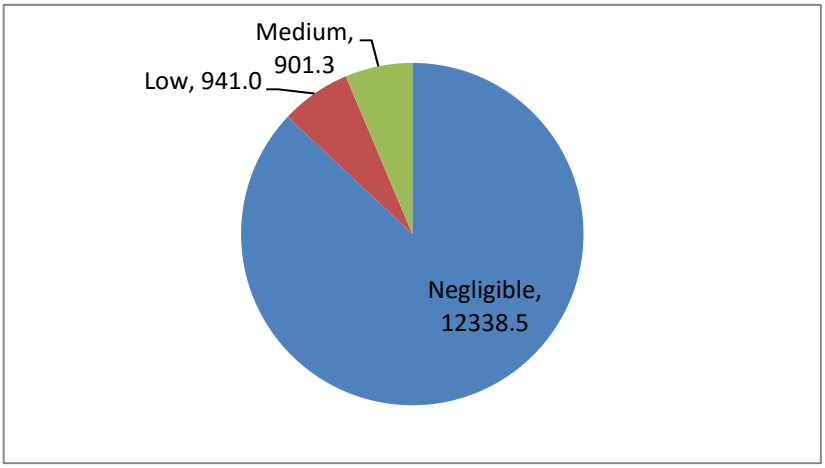

FIGURE 39: WHOLESALE TRADE BUSHFIRE VULNERABILITY ($MILLION)

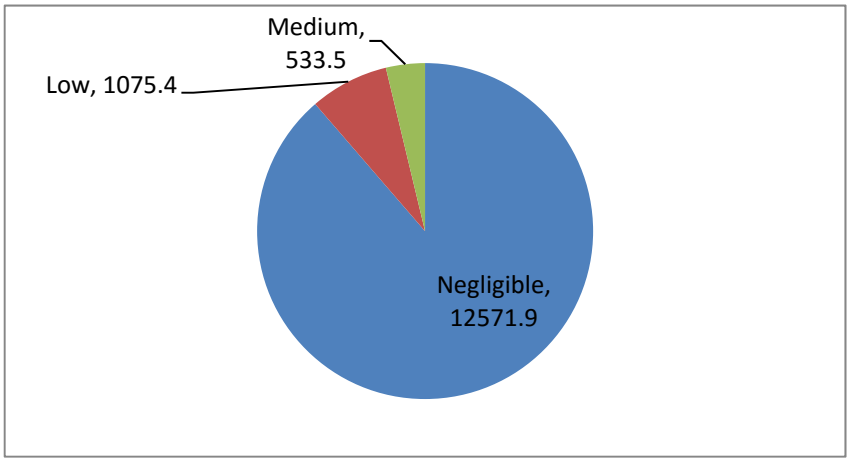

FIGURE 40: WHOLESALE TRADE FLOOD VULNERABILITY ($MILLION)

4.8 Retail Trade

Retail trade generated $14.17 billion in 2011 in Victoria which was 4.8% of the total state income with the SLAs having the largest retail trade including Casey (Berwick) ($298 million), Manningham (West) ($294 million) and Kingston (North) ($271 million) as shown in Figure 41. Unlike wholesale trade, retail trade account for a larger percentage of SLAs income in rural and regional SLAs as shown in, however, this map shows the absolute values, not the relative proportion. These include Central Goldfields Maryborough (9%), Greater Bendigo Eaglehawk (8%), Mt Baw Baw and Mt Buller Alpine resorts (7%) as well as Warrnambool and Shepparton (7%) as shown in Figure 42.

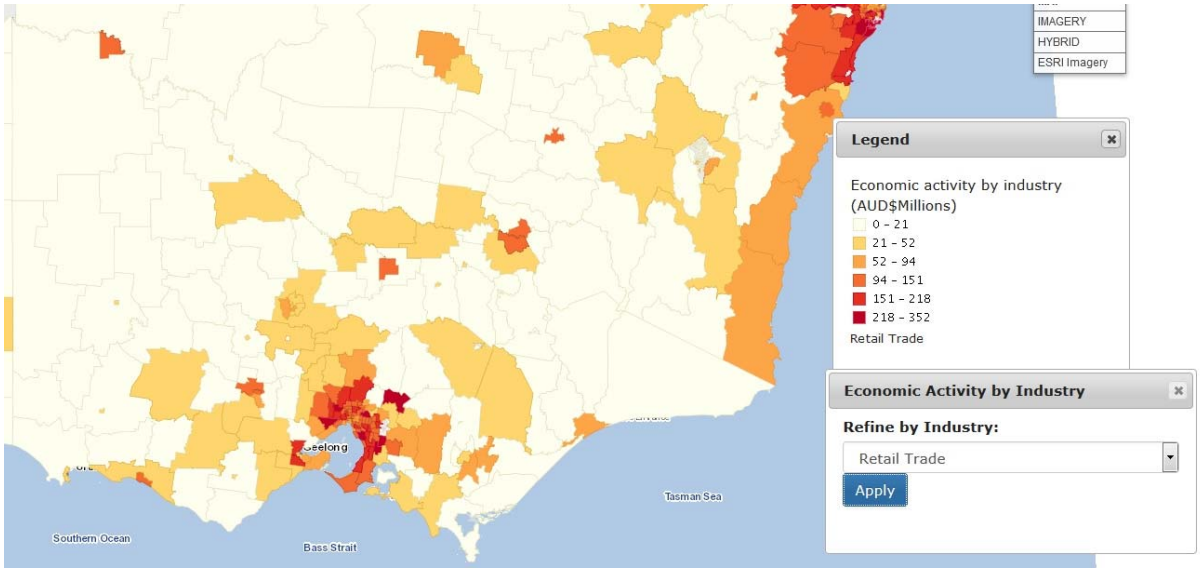

FIGURE 41: MAP OF SLA RETAIL TRADE ABSOLUTE INCOME ($MILLION)

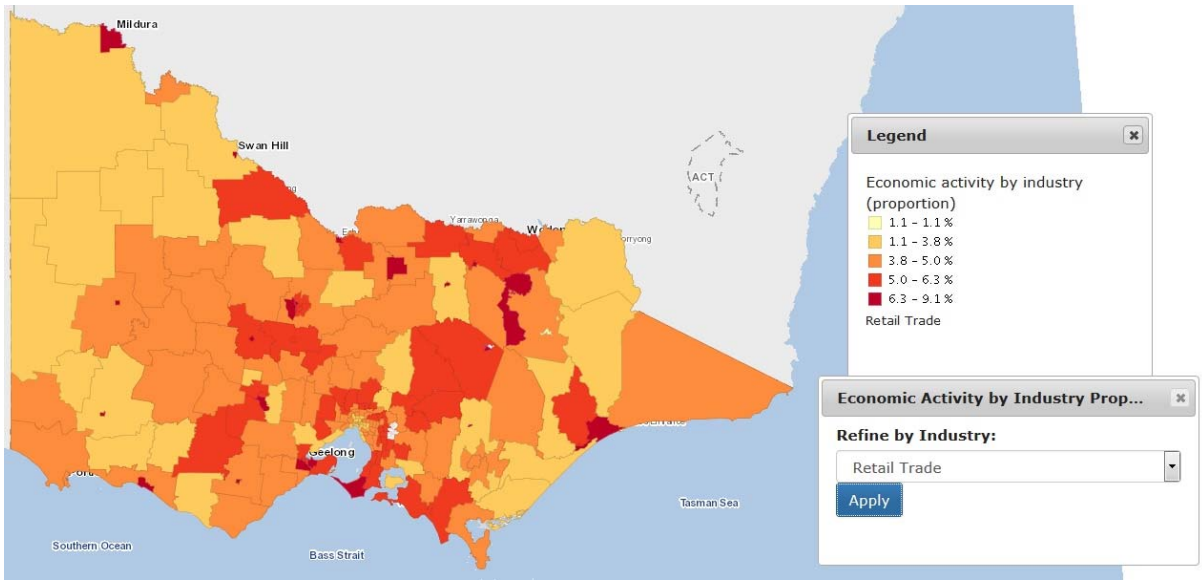

FIGURE 42 MAP OF SLA RETAIL TRADE RELATIVE INCOME (%)

4.8.1 Retail Trade and Bushfire Vulnerability

Retail trade was rated as having a low vulnerability due to its mainly urban focus and its lack of proximity to flood prone areas. However, this did vary depending on location such as Mt Buller and Mt Baw Baw which have significant exposure to bushfires.

For the state, the breakdown of moderate, low and negligible sensitivity for bushfire is 8%, 8.3% and 83.7% while for flood it is 6.1%, 10.1% and 83.8% as shown in Figure 43 and Figure 44.

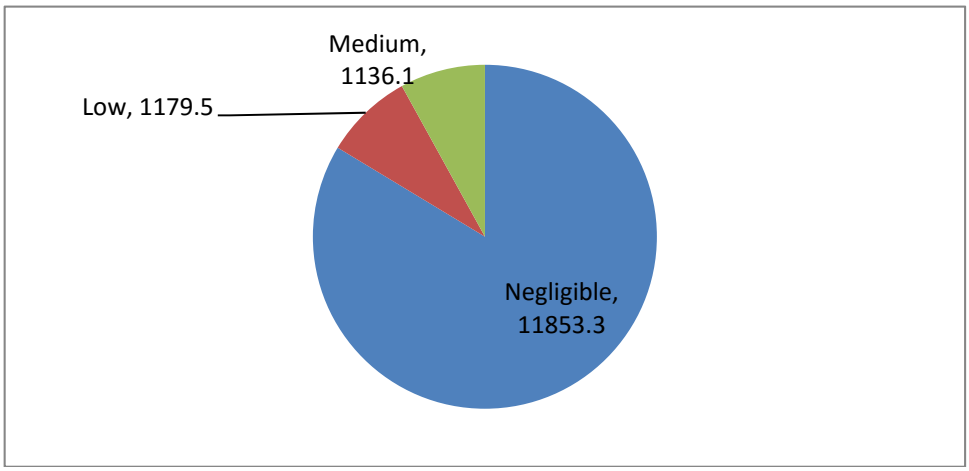

FIGURE 43: RETAIL TRADE BUSHFIRE VULNERABILITY ($MILLION)

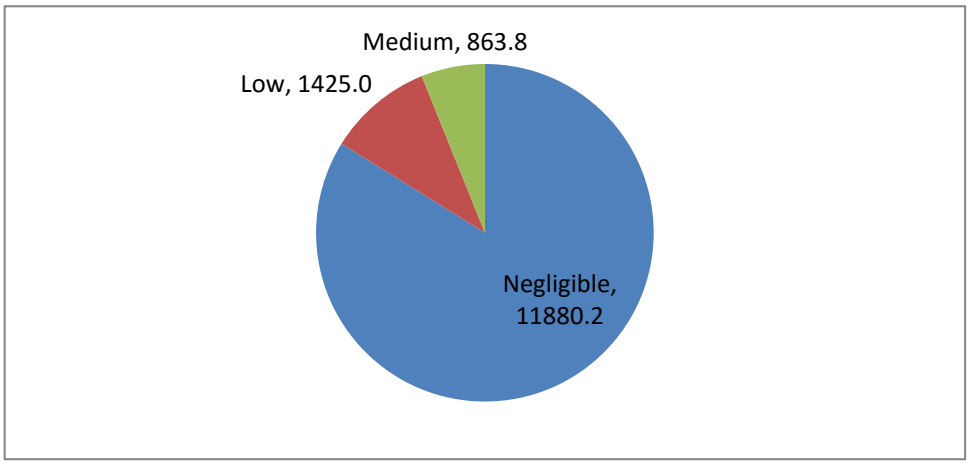

FIGURE 44: RETAIL TRADE FLOOD VULNERABILITY ($MILLION)

4.9 Accommodation and Food Services

The accommodation and food services sector receives $7.05 billion or 2.4% of Victoria's income (2011) with city based SLAs generating the largest income in this sector, Manningham (West) ($144 million), Melbourne (Remainder) ($136 million) and Darebin (Preston) ($131 million) (Figure 45). Restaurant income makes up 84.3% and accommodation 15.7% as shown in Figure 41. This sector is largest in relative terms in tourist based SLAs of Mt Buller, Falls Creek, Mt Baw Baw and Mt Hotham (27%, 20%, 17% and 15% respectively). The only other SLA where this economic group exceeds 10% is the Colac –Otway South SLA (11%) as shown in Figure 46.

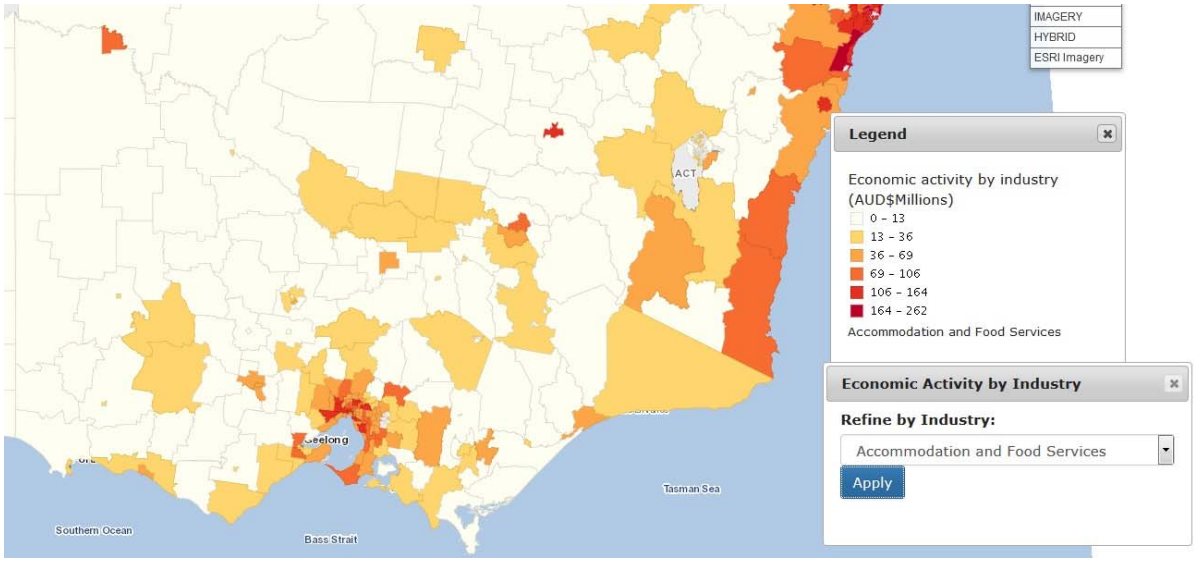

FIGURE 45: MAP OF SLA ACCOMMODATION AND FOOD SERVICES ABSOLUTE INCOME ($MILLION)

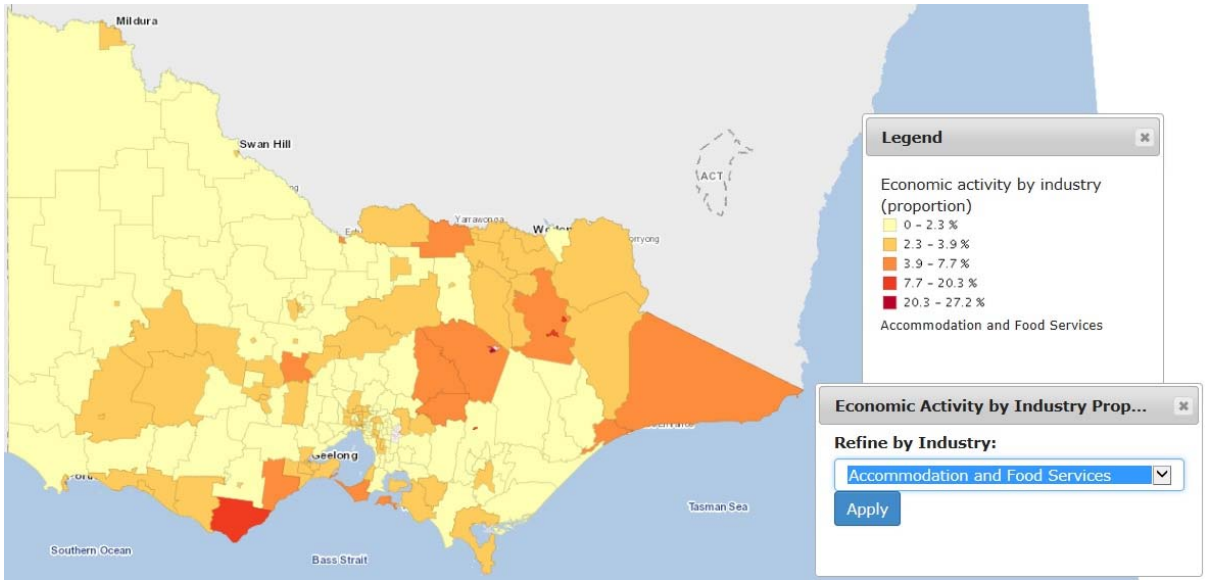

FIGURE 46: MAP OF SLA ACCOMMODATION AND FOOD SERVICES RELATIVE INCOME (%)

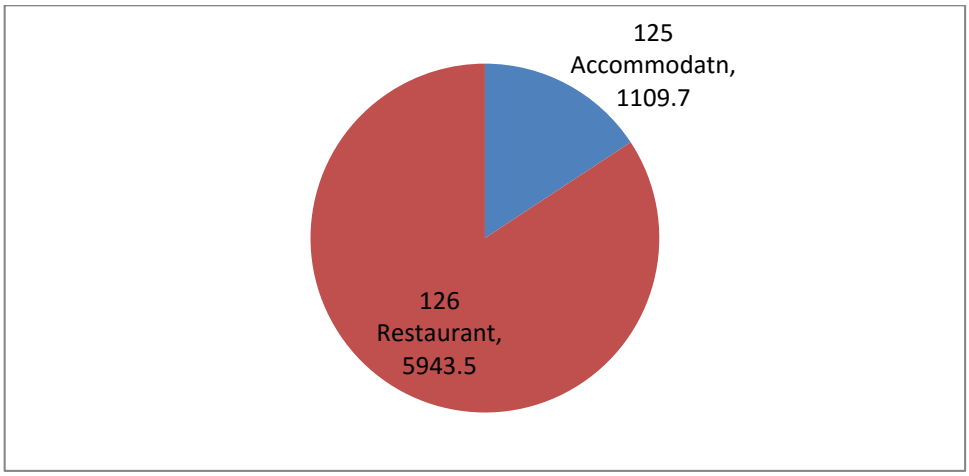

FIGURE 47: ACCOMMODATION AND FOOD SERVICES GROUPS OF VICTORIA STATE INCOME ($MILLION)

4.9.1 Accommodation and Food Services Vulnerability

The areas identified as being affected most by bushfires and floods are the snowfields and coastal regions. Much of the capital value in these regions is invested in coastal properties involved in tourist accommodation that are at the vulnerability of sea level rise or flooding. For the state, the breakdown of moderate, low and negligible sensitivity for bushfire is 2.5%, 7.4% and 90.1% while for flood it is 1.6%, 6.3% and 92.1% as shown in Figure 48 and Figure 49.

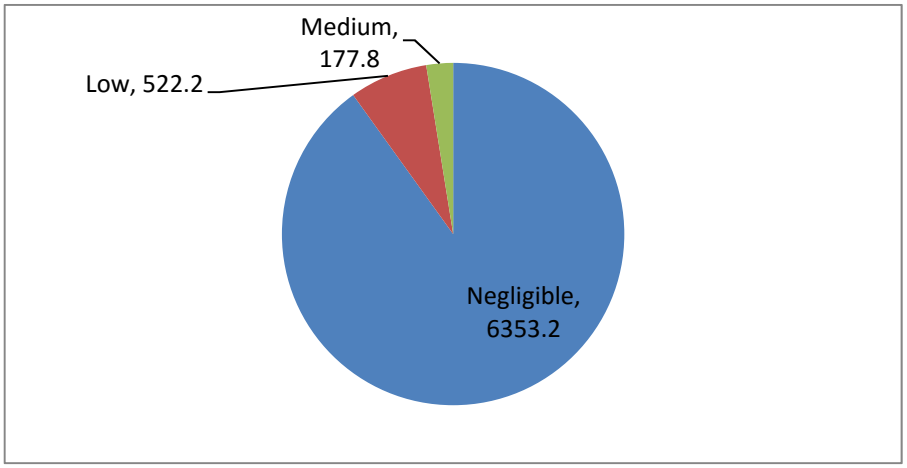

FIGURE 48: ACCOMMODATION AND FOOD SERVICES BUSHFIRE VULNERABILITY ($MILLION)

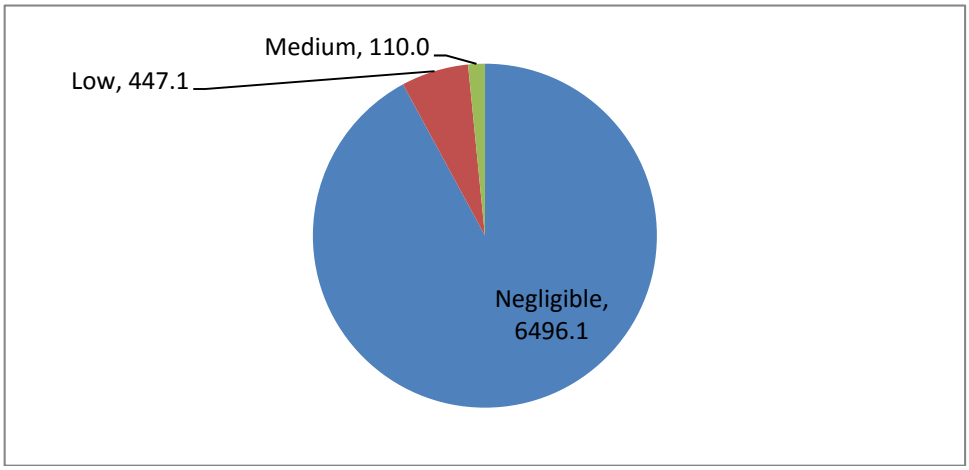

FIGURE 49: ACCOMMODATION AND FOOD SERVICES FLOOD VULNERABILITY ($MILLION)

4.10 Transport, Postal and Warehousing

The transport, postal and warehousing sector generated $14 billion or 2.7% of Victoria's income (2011). The largest groups in the sector were transport services (37.2%), road freight (27.9%) and air transport (10.4%) as shown in Figure 52. In absolute terms this division is largest in the west and north of Melbourne in Wyndham (North) ($569 million), Brimbank (Keilor) ($452 million) and Brimbank (Sunshine) ($426 million) (Figure 50). This sector is largest in relative terms in tourist based SLAs of Falls Creek (34%) and (14%) as well as the city SLA of Hume Broadmeadows (13%) and Melton (12%) as shown in Figure 51.

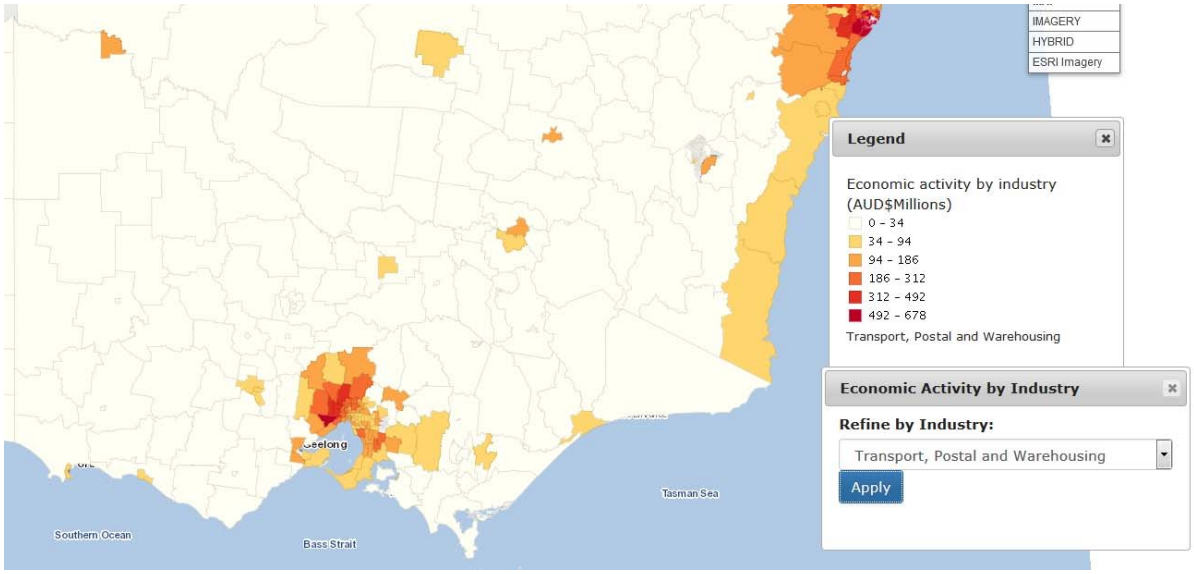

FIGURE 50: MAP OF SLA TRANSPORT, POSTAL AND WAREHOUSING ABSOLUTE INCOME ($MILLION)

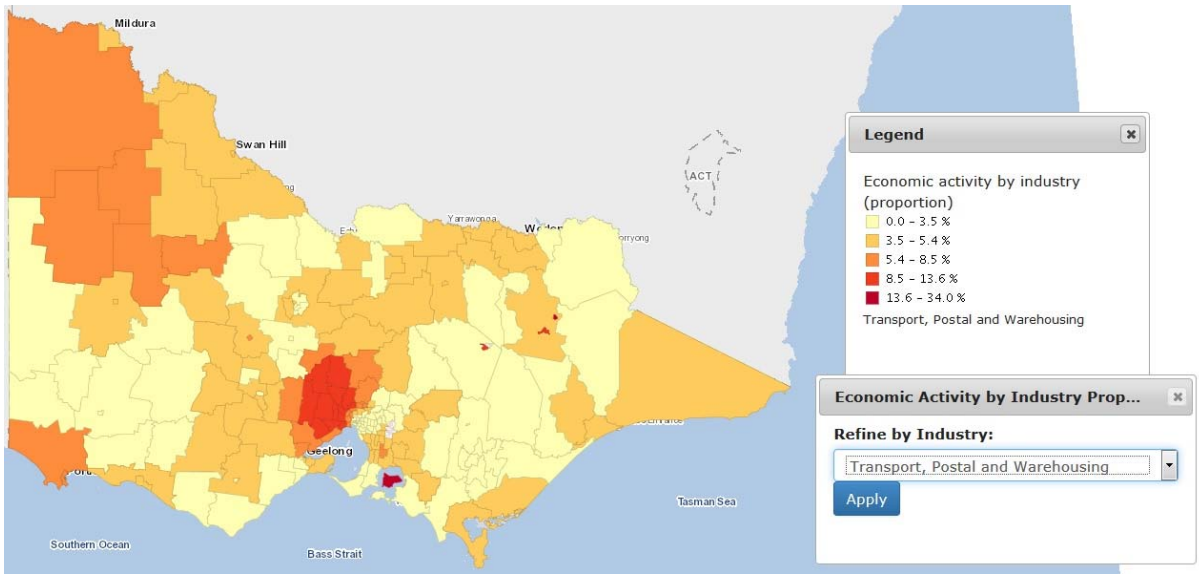

FIGURE 51: MAP OF SLA TRANSPORT, POSTAL AND WAREHOUSING RELATIVE INCOME (%)

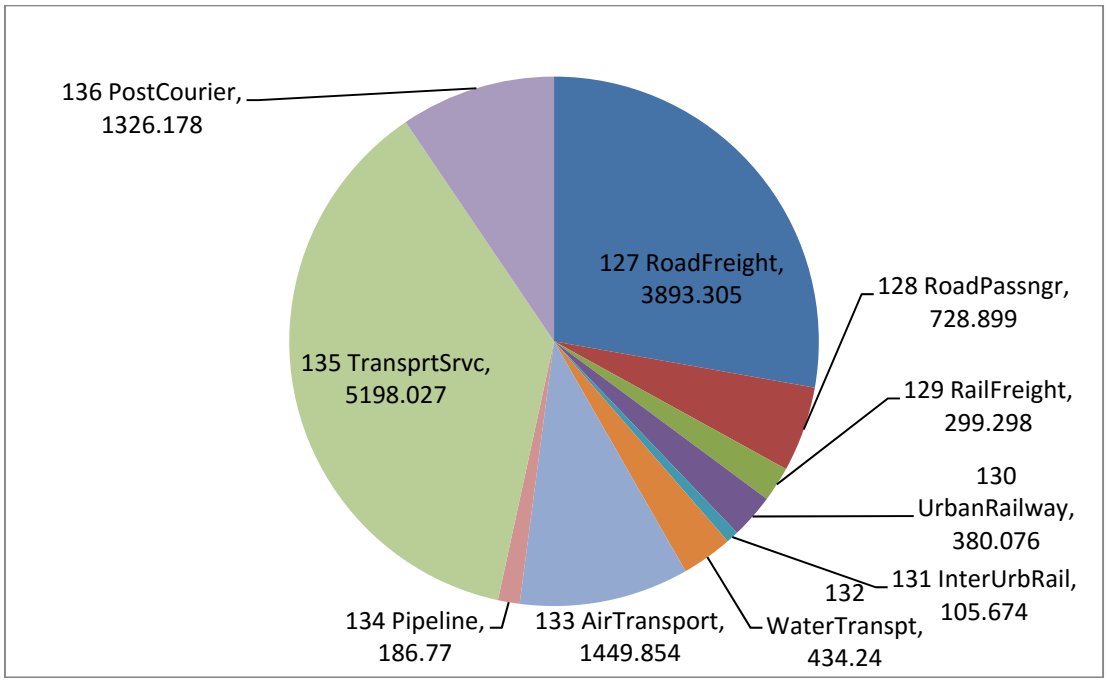

FIGURE 52: TRANSPORT, POSTAL AND WAREHOUSING GROUPS OF VICTORIA STATE INCOME ($MILLION)

4.10.1 Transport, Postal and Warehousing Vulnerability

Transport services are affected by weather-related phenomena, mostly extreme events. Road and rail are affected by fire, flood and storm surge. Fire vulnerability may become more frequent, requiring road and rail closure. If average rainfall decreases, flood events may be expected to be rarer but perhaps more severe. Large-scale riverine flooding, which causes the longest running service interruptions is likely to become less frequent, except perhaps in Gippsland, if East Coast Lows become more intense. Overall, many groups in the sector have a low or moderate vulnerability rating. For the state, the breakdown of high, moderate, low and negligible sensitivity for bushfire is 0.1%, 6.1%, 13.9% and 79.9% while for flood it is 0.1%, 3.5%, 10.1% and 86.3% as shown in Figure 53 and Figure 54.

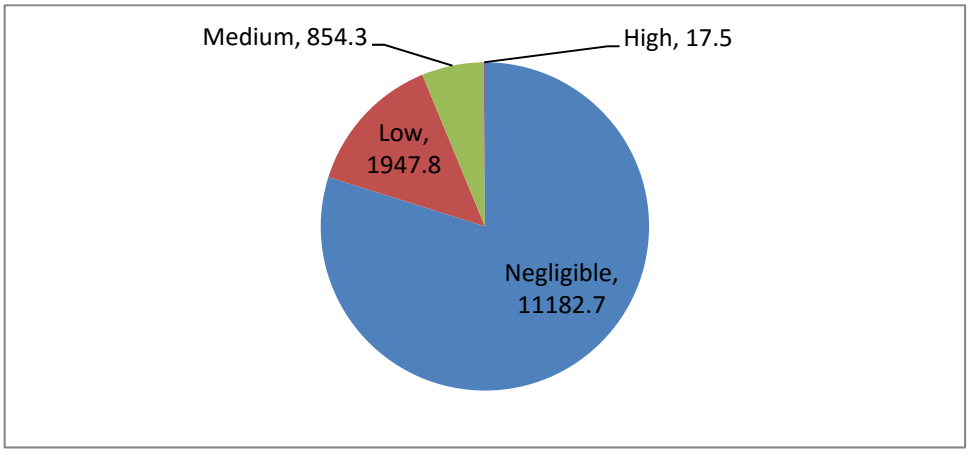

FIGURE 53: TRANSPORT, POSTAL AND WAREHOUSING BUSHFIRE VULNERABILITY ($MILLION)

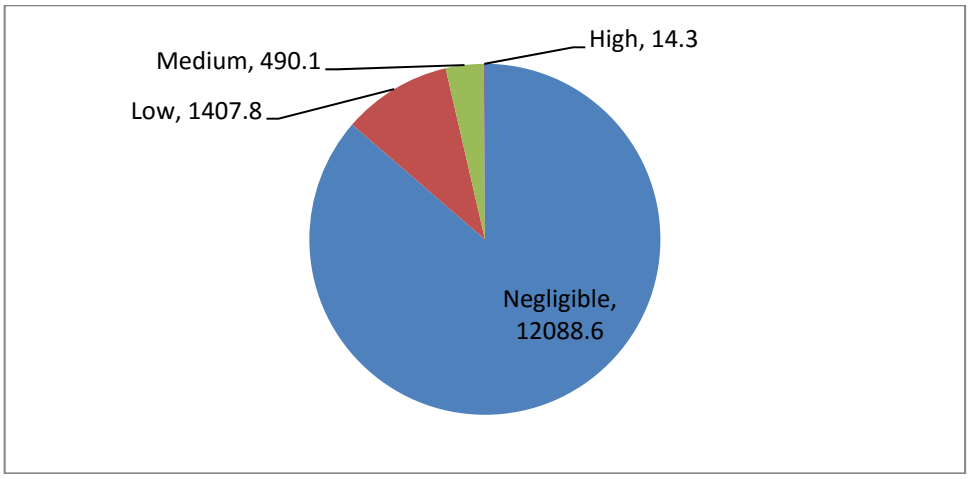

FIGURE 54: TRANSPORT, POSTAL AND WAREHOUSING FLOOD VULNERABILITY ($MILLION)

4.11 Information Media and Telecommunications

The information, media and telecommunications sector generated $11.1 billion or 3.7% of Victoria's income (2011) with the largest values found in the Melbourne SLAs of Port Phillip (St Kilda) ($309 million), Glen Eira (Caulfield) ($284 million) and Kingston (North) ($237 million) (Figure 57). In relative terms this sector is large in inner Melbourne SLAs of Port Phillip – St Kilda (7%) and Yarra North (7%), Moreland Brunswick, Melbourne Inner, Yarra Richmond, Stonnington Prahran and Darebin Northcote (all 6%) (Figure 56). The largest groups in the sector were telecommunications (50.2%), communication services (24%) and internet (10%) as shown in Figure 57.

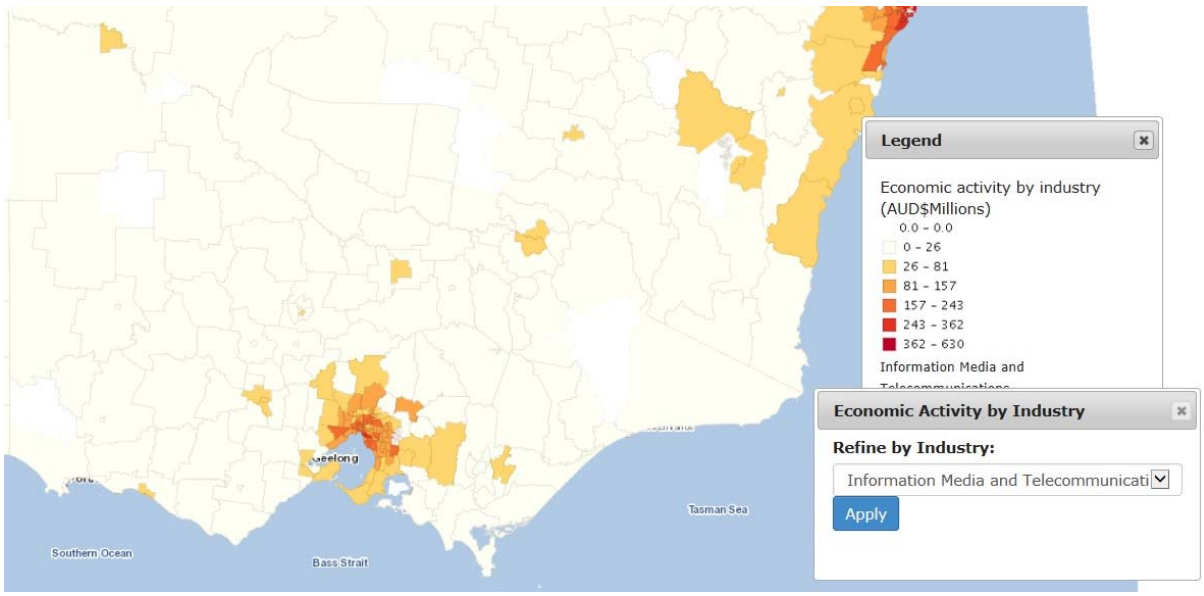

FIGURE 55: MAP OF SLA INFORMATION, MEDIA AND TELECOMMUNICATIONS ABSOLUTE INCOME ($MILLION)

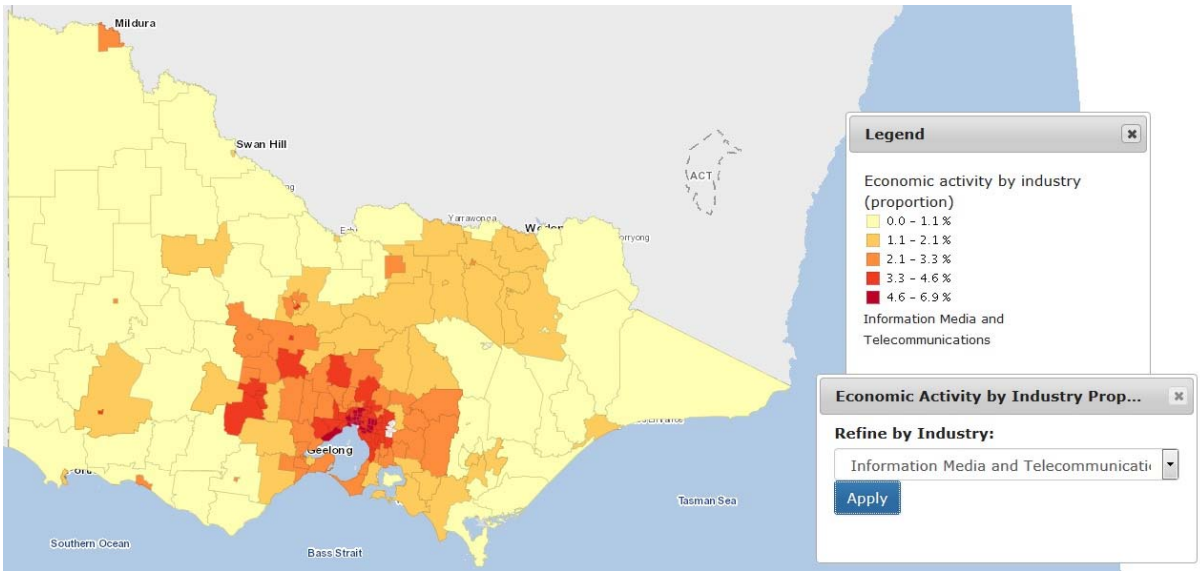

FIGURE 56: MAP OF SLA INFORMATION, MEDIA AND TELECOMMUNICATIONS RELATIVE INCOME (%)

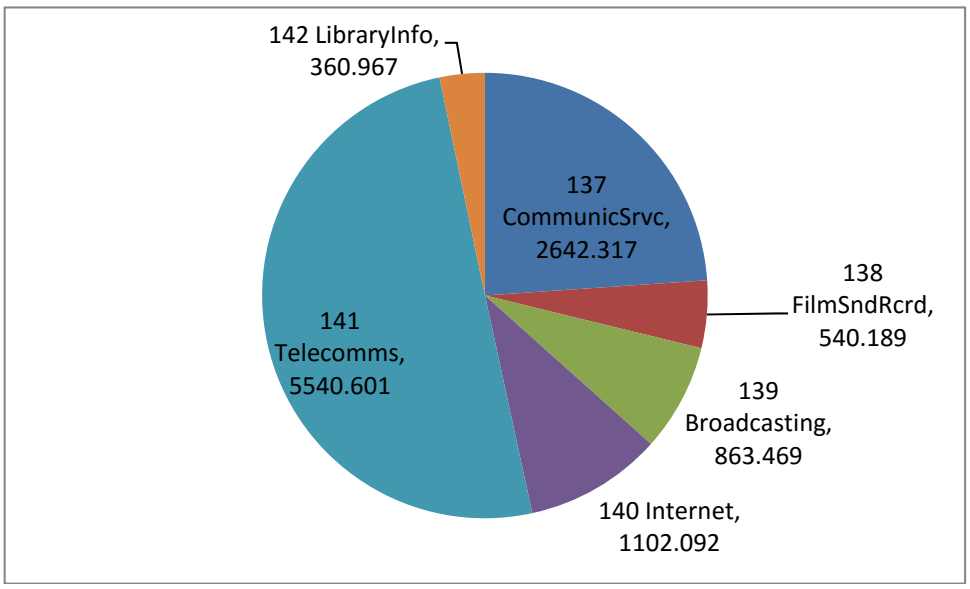

FIGURE 57: INFORMATION, MEDIA AND TELECOMMUNICATIONS GROUPS OF VICTORIA STATE INCOME ($MILLION)

4.11.1 Information Media and Telecommunications Vulnerability

Increased storm and bushfire events may damage above-ground transmission infrastructure and service. Increased extreme rainfall events are likely to affect underground telecommunications facilities. Telecommunication services are critical to manage emergency responses to such events, so the integrity of the infrastructure is essential. For this reason, telecommunications and internet services were rated as having a moderate vulnerability to bushfire and flood. For the state, the breakdown of high, moderate, low and negligible sensitivity for bushfire 2.1%, 2.8%, 26.8% and 68.3% while for flood it is 0.8%, 3.5%, 10.1% and 86.3% as shown in Figure 58 and Figure 59.

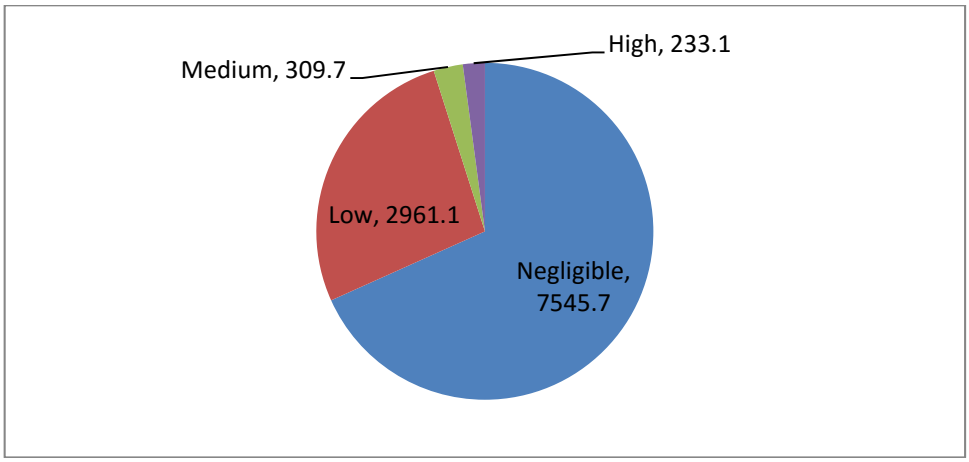

FIGURE 58: INFORMATION MEDIA AND TELECOMMUNICATIONS BUSHFIRE VULNERABILITY ($MILLION)

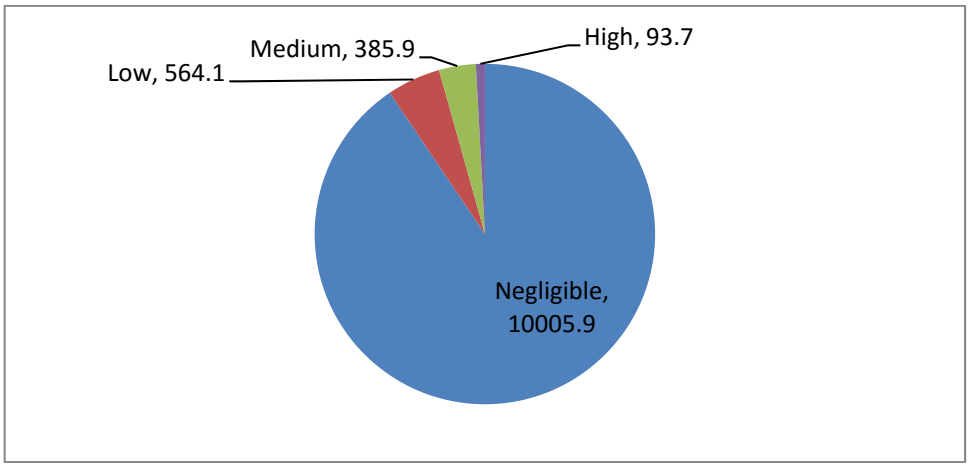

FIGURE 59: INFORMATION MEDIA AND TELECOMMUNICATIONS FLOOD VULNERABILITY ($MILLION)

4.12 Financial and Insurance Services

The financial and insurance services sector generated $31 billion or 10.5% of Victoria's income (2011) with the largest income in absolute terms found in the SLAs of Manningham (West) ($810 million), Glen Eira (Caulfield) ($777 million) and Kingston (North) ($703 million). This sector is largest in relative terms in the inner Melbourne SLAs of Melbourne Southbank Docklands (22%) and Melbourne Inner (21%) (Figure 61). The largest groups in the sector were banking (54.8%) and financial services (22.7%) with insurance being the smallest group with 6.5% as shown in Figure 62.

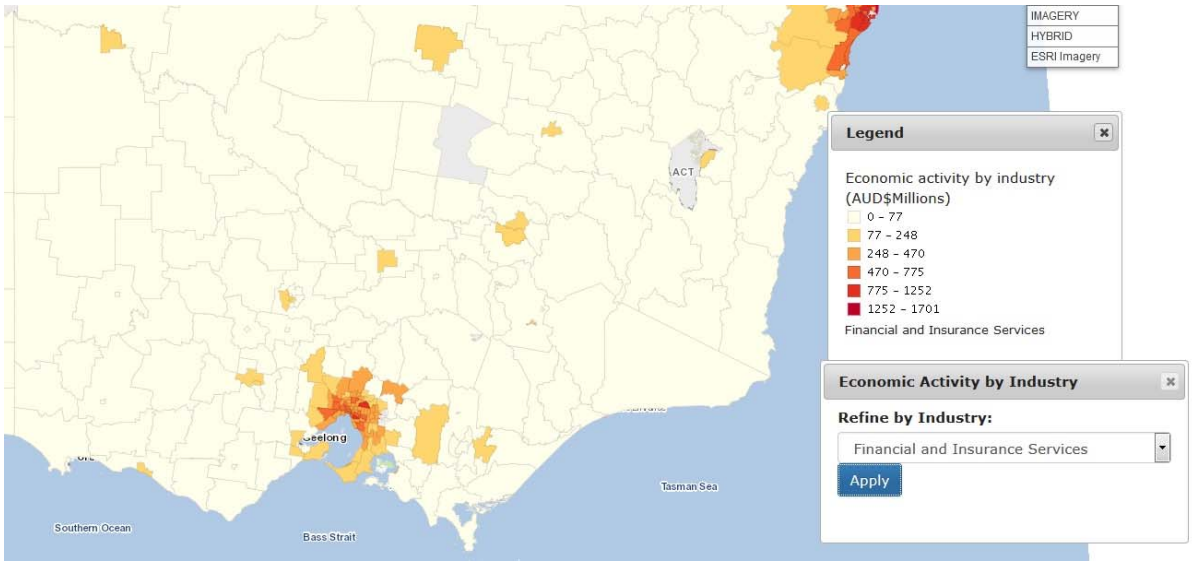

FIGURE 60: MAP OF SLA FINANCIAL AND INSURANCE SERVICES ABSOLUTE INCOME ($MILLION)

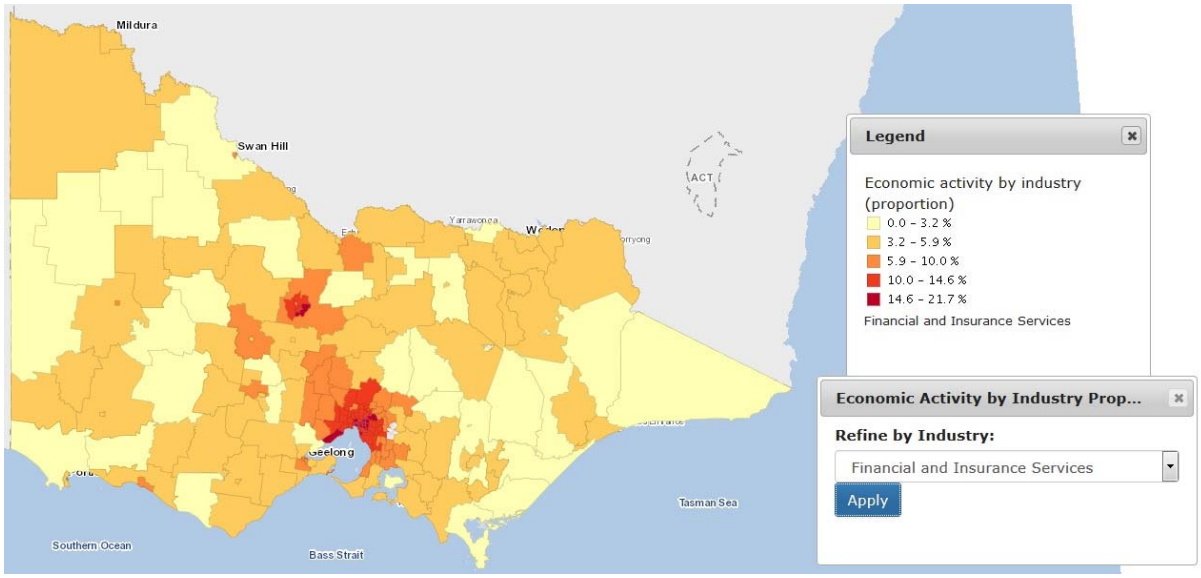

FIGURE 61: MAP OF SLA FINANCIAL AND INSURANCE SERVICES RELATIVE INCOME (%)

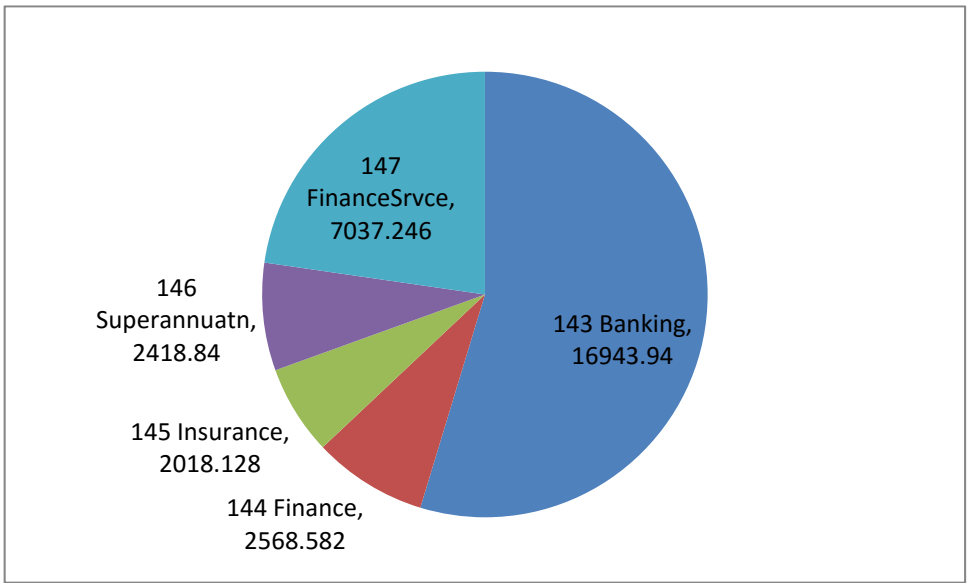

FIGURE 62: FINANCIAL AND INSURANCE SERVICES GROUPS OF VICTORIA STATE INCOME ($MILLION)

4.12.1 Financial and Insurance Services Vulnerability

Financial services exposed to bushfire and flood impacts include finance providers to business involved in bushfire and flood sensitive activities, especially banks operating in rural regions. Access to finance, or to debt relief, can be critical for primary producers during periods of bushfire and flood stress. Debt and income offsetting instruments for managing climate variability and extremes such as forward contracts, future options and others are not highly used at present but may become so in the future.

Insurance costs in Australia are greatest for damages to property from extreme events such as storms, floods and fire. Flood insurance is often not offered and as flash flooding is likely to increase; the vulnerability for widespread floods is likely to increase. Bushfire vulnerability is projected to increase, as are the numbers of people and property in at vulnerability regions, but many more properties are being saved during wild fires of the last few decades. Insurance was rated as having a moderate vulnerability to bushfire and flood.

For the state, the breakdown of high, moderate, low and negligible sensitivity for bushfire 0.2%, 0.3%, 6.4% and 93.1% while for flood it is 0.1%, 0.5%, 2.7% and 96.7% as shown in Figure 63 and Figure 64.

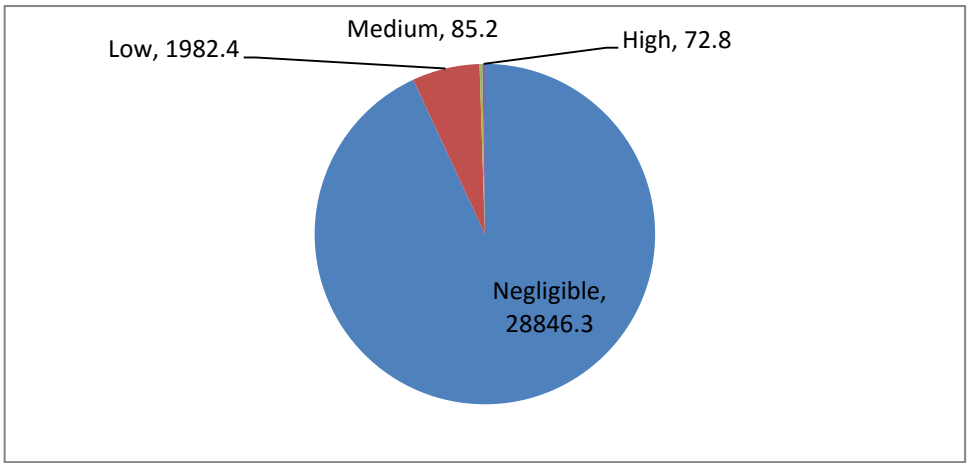

FIGURE 63: FINANCIAL AND INSURANCE SERVICES BUSHFIRE VULNERABILITY ($MILLION)

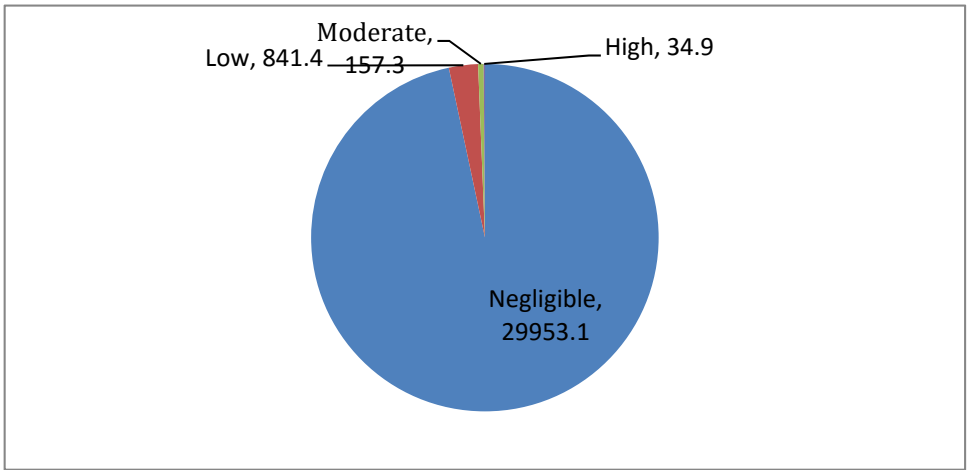

FIGURE 64: FINANCIAL AND INSURANCE SERVICES FLOOD VULNERABILITY ($MILLION)

4.13 Rental, Hiring and Real Estate Services

The Rental, Hiring and Real Estate Services sector generated $33.5 billion or 11.3% of Victoria's income (2011) with the largest values found in Manningham (West) ($681 million), Glen Eira (Caulfield) ($655 million) and Wyndham (North) ($621 million) (Figure 65). This sector makes up the largest proportion in the tourist focused SLAs of Mt Baw Baw (74%), Mt Hotham (44%), Falls Creek (20%) and Mt Buller (17%). Queenscliffe (15%) and Mornington Peninsula South (15%) were also highly represented (Figure 66). This sector is a significant sector as it is represented in all SLAs with the lowest value still being 6% in Loddon and Mildura. The largest groups in the sector were owner dwellings (69.9%) and other property services (22.2%) as shown in Figure 67.

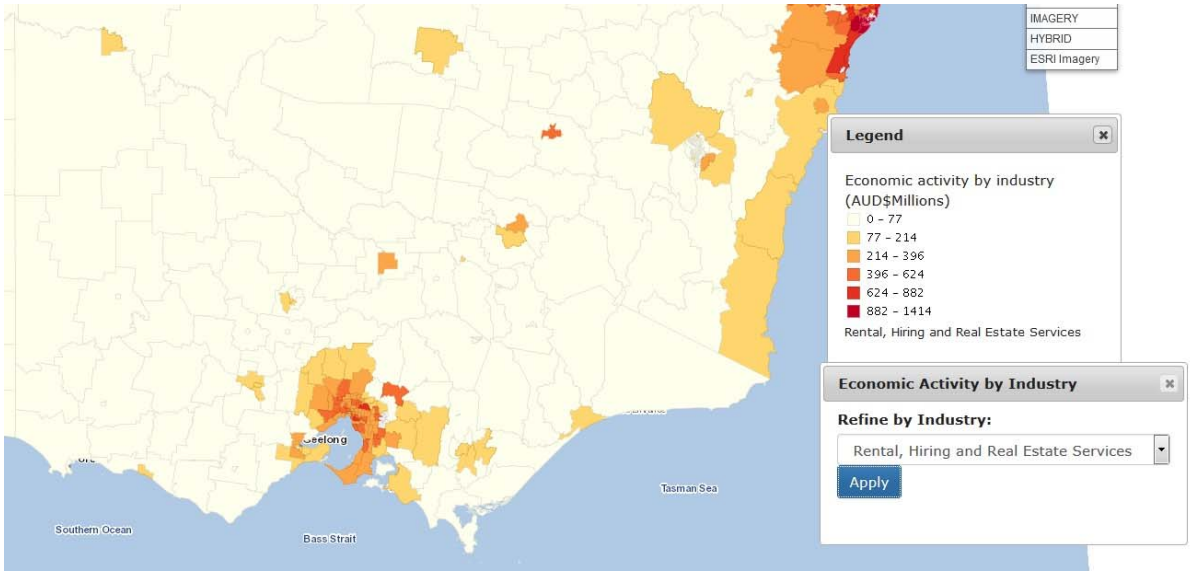

FIGURE 65: MAP OF SLA RENTAL, HIRING AND REAL ESTATE SERVICES ABSOLUTE INCOME ($MILLION)

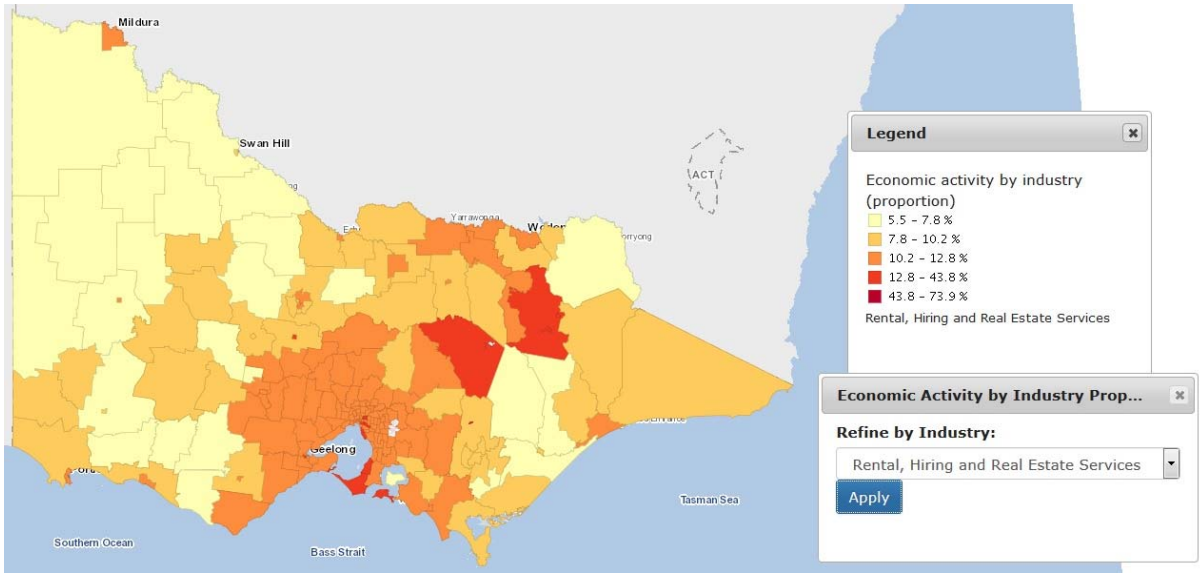

FIGURE 66: MAP OF SLA RENTAL, HIRING AND REAL ESTATE SERVICES RELATIVE INCOME (%)

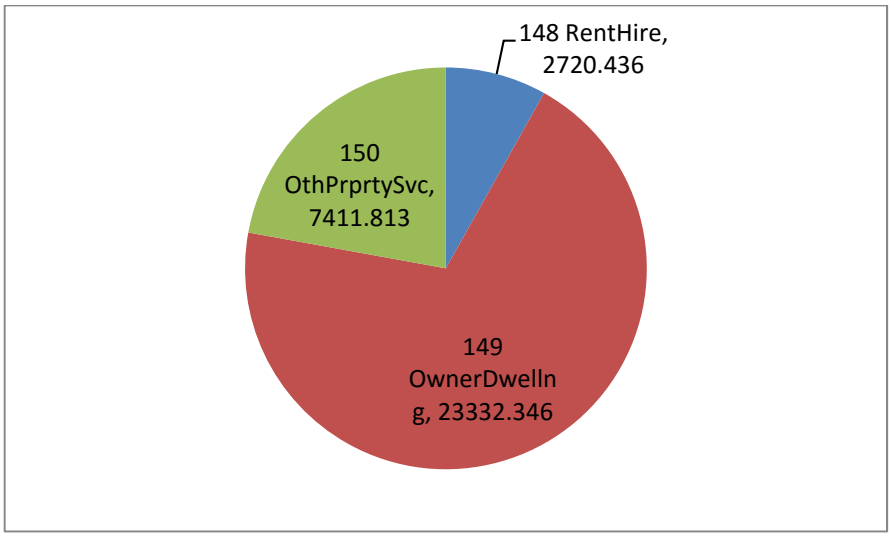

FIGURE 67: RENTAL, HIRING AND REAL ESTATE SERVICES GROUPS OF VICTORIA STATE INCOME ($MILLION)

4.13.1 Rental, Hiring and Real Estate Services Vulnerability

Rental, hiring and real estate services were rated as having negligible vulnerability to bushfire and flood. For the state, the breakdown of low and negligible sensitivity for bushfire 7.4% and 92.6% while for flood it is 4.7% and 95.3% as shown in Figure 68 and Figure 69.

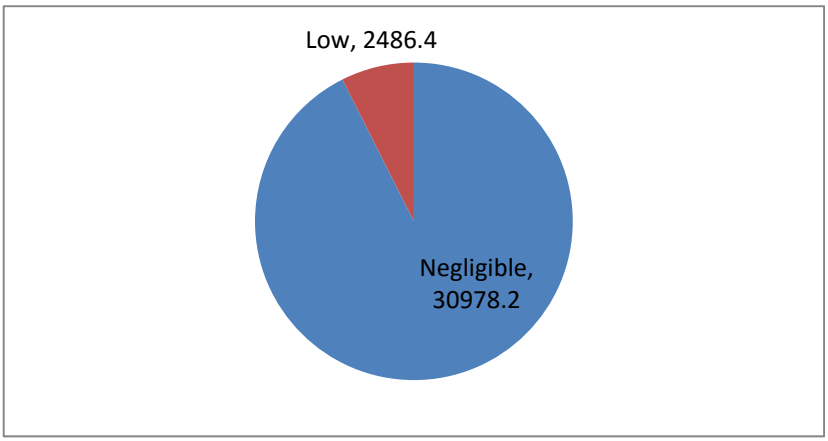

FIGURE 68: RENTAL, HIRING AND REAL ESTATE SERVICES BUSHFIRE VULNERABILITY ($MILLION)

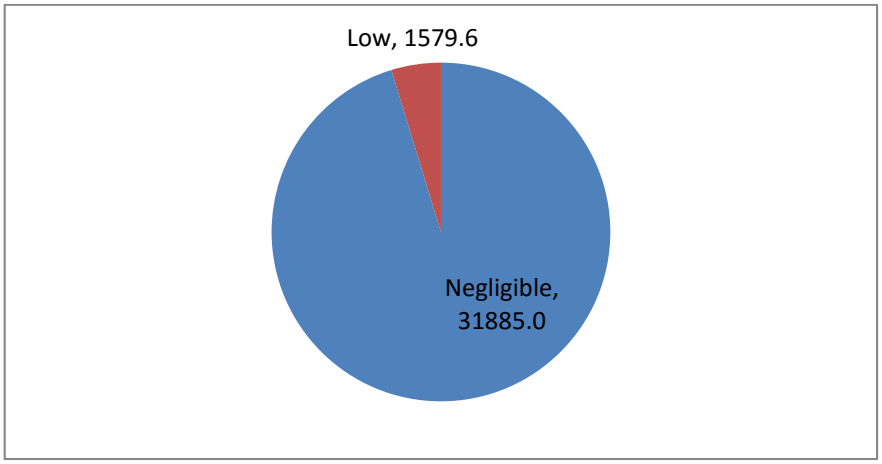

FIGURE 69: RENTAL, HIRING AND REAL ESTATE SERVICES FLOOD VULNERABILITY ($MILLION)

4.14 Professional, Scientific and Technical Services

The Professional, scientific and Technical Services sector generated $32.8 billion or 11.1% of Victoria's income (2011) with Glen Eira (Caulfield) ($993 million), Port Phillip (St Kilda) ($931 million) and Melbourne (Remainder) ($903 million) having the largest values (Figure 70). This sector is largest in relative terms in the inner Melbourne SLAs of Melbourne Inner (26%) and Melbourne Southbank Docklands (23%) which demonstrates the concentration of professional, scientific and technical services around Melbourne (Figure 71). The largest groups in the sector were professional services (31.7%), computer services (25.9%) and architecture and engineering services (25.1%) as shown in Figure 72.

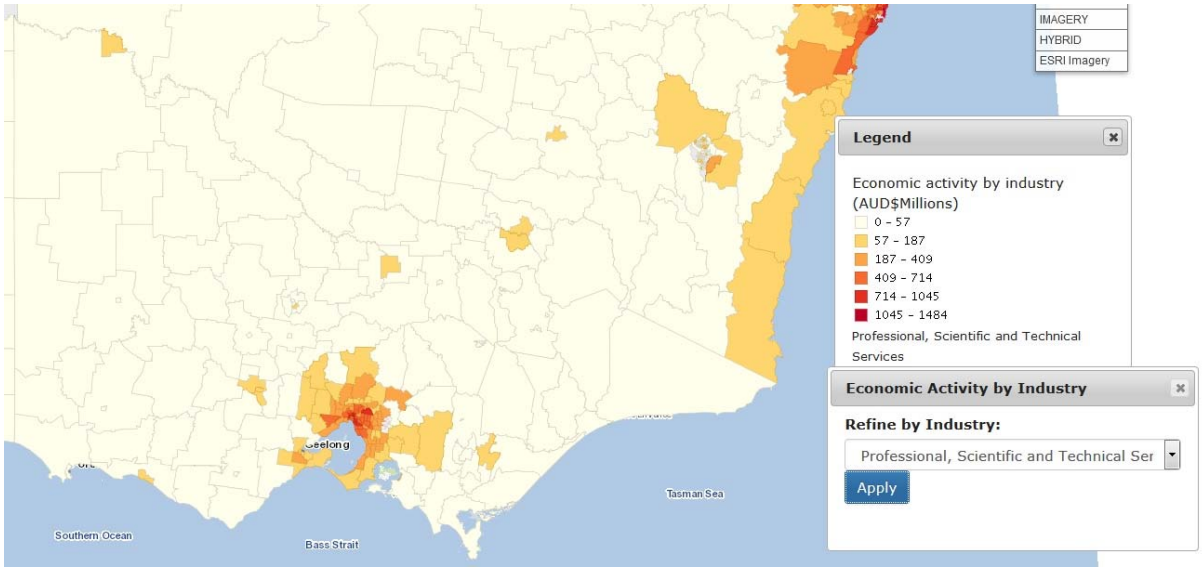

FIGURE 70: MAP OF SLA PROFESSIONAL, SCIENTIFIC AND TECHNICAL SERVICES ABSOLUTE INCOME ($MILLION)

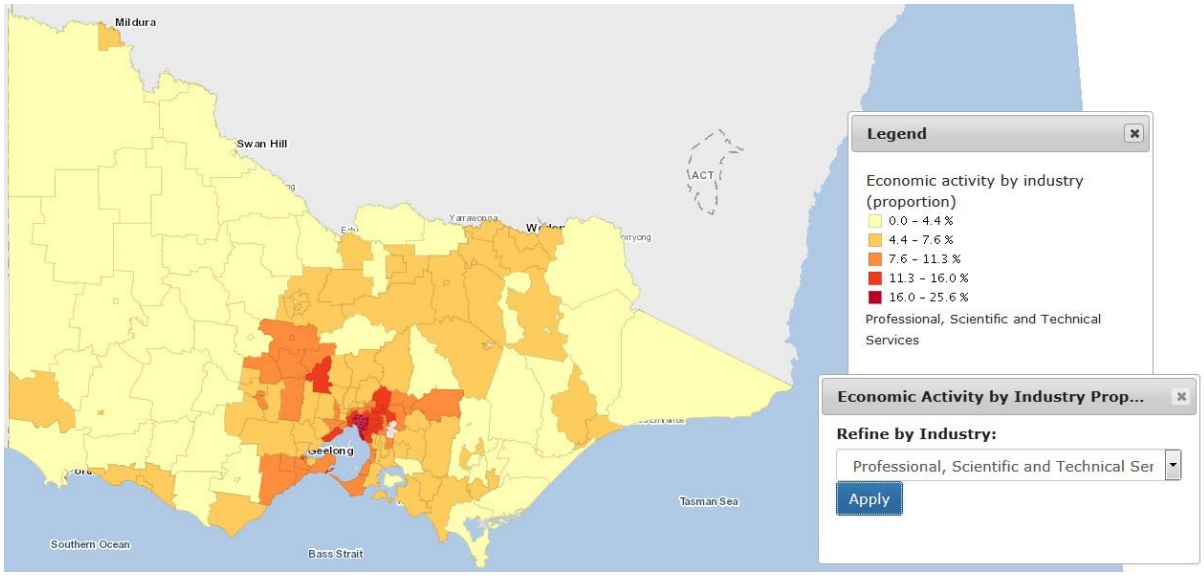

FIGURE 71: MAP OF SLA PROFESSIONAL, SCIENTIFIC AND TECHNICAL SERVICES RELATIVE INCOME (%)

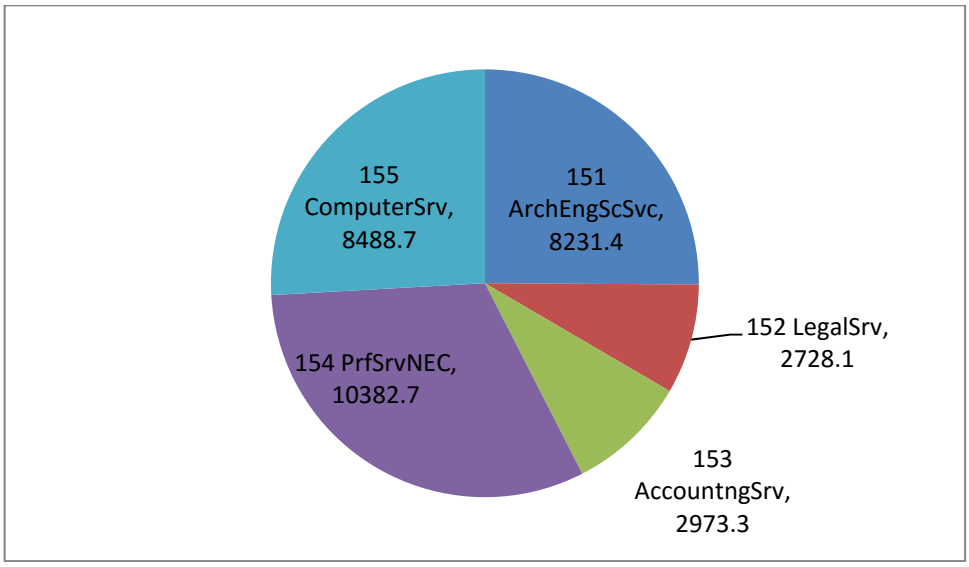

FIGURE 72: PROFESSIONAL, SCIENTIFIC AND TECHNICAL SERVICES GROUPS OF VICTORIA STATE INCOME ($MILLION)

4.14.1 Professional, Scientific and Technical Services Vulnerability

A small number of service activities are considered to have low sensitivity to bushfire and flood. For the state, the breakdown of low and negligible sensitivity for bushfire 4.6% and 95.4% while for flood it is 2.1% and 97.9% as shown in Figure 73 and Figure 74.

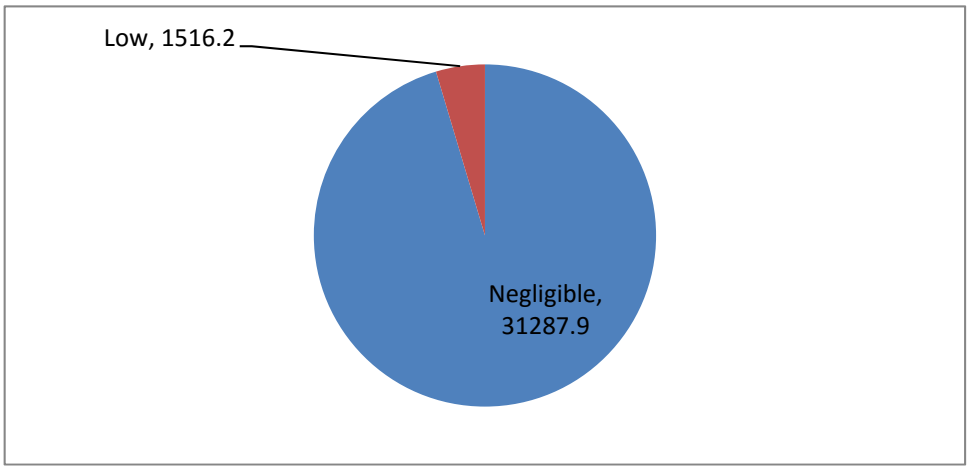

FIGURE 73: PROFESSIONAL, SCIENTIFIC AND TECHNICAL SERVICES BUSHFIRE VULNERABILITY ($MILLION)

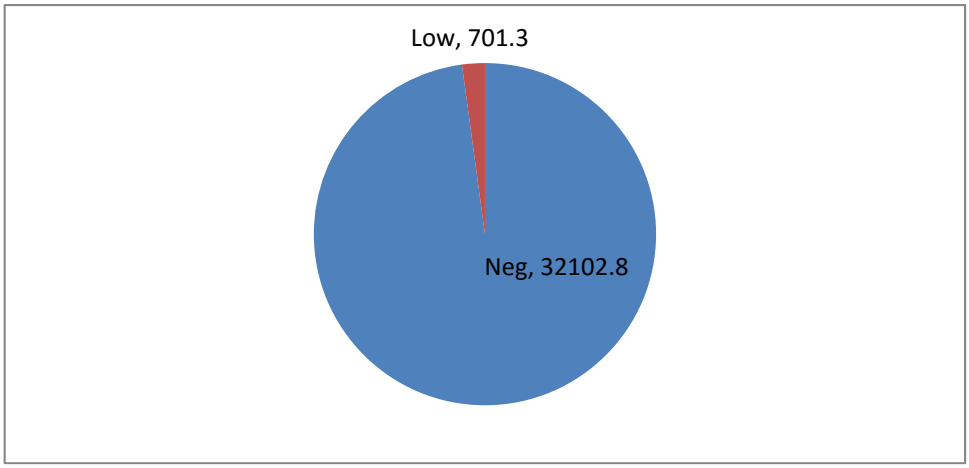

FIGURE 74: PROFESSIONAL, SCIENTIFIC AND TECHNICAL SERVICES FLOOD VULNERABILITY ($MILLION)

4.15 Administrative and Support Services

The Administrative and Support Services sector generated $9.2 billion or 3.1% of Victoria's income (2011). This sector is largest in Wyndham (North) ($219 million), Port Phillip (St Kilda) ($215 million) and Glen Eira (Caulfield) ($199 million) (Figure 75). This sector is largest in relative terms in Colac Otway –Colac (8%), Yarra Ranges Pt B (7%), Colac Otway South (6%) and Port Phillip – St Kilda (5%) (Figure 76). The two groups in the sector are employment, travel and other administrative services (81.8%) and support services (18.4%) as shown in Figure 77.

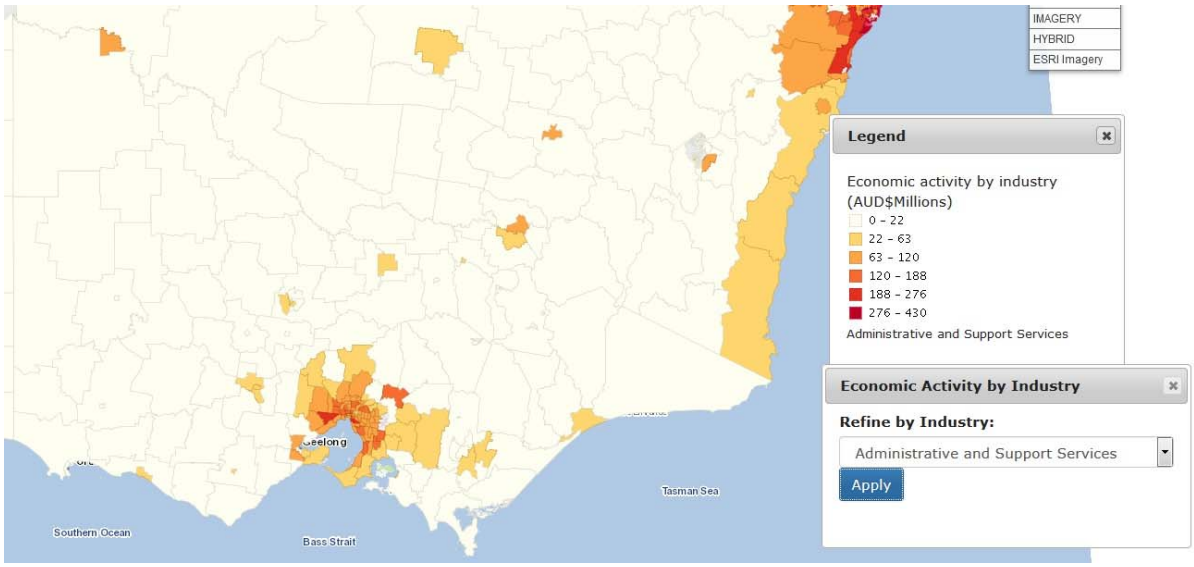

FIGURE 75: MAP OF SLA ADMINISTRATION AND SUPPORT SERVICES ABSOLUTE INCOME ($MILLION)

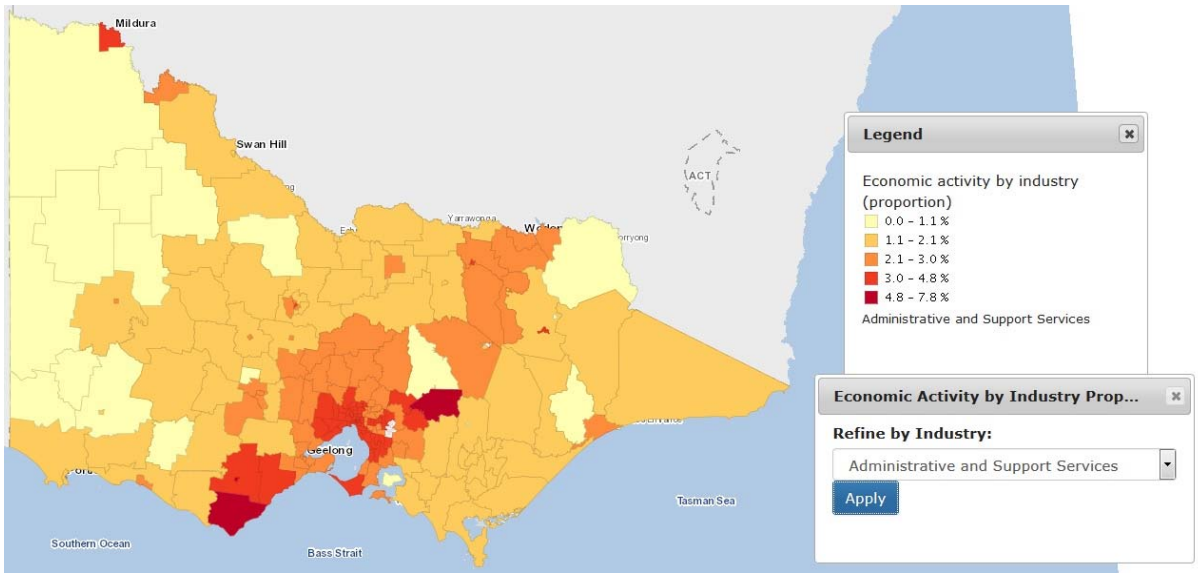

FIGURE 76: MAP OF SLA ADMINISTRATION AND SUPPORT SERVICES RELATIVE INCOME (%)

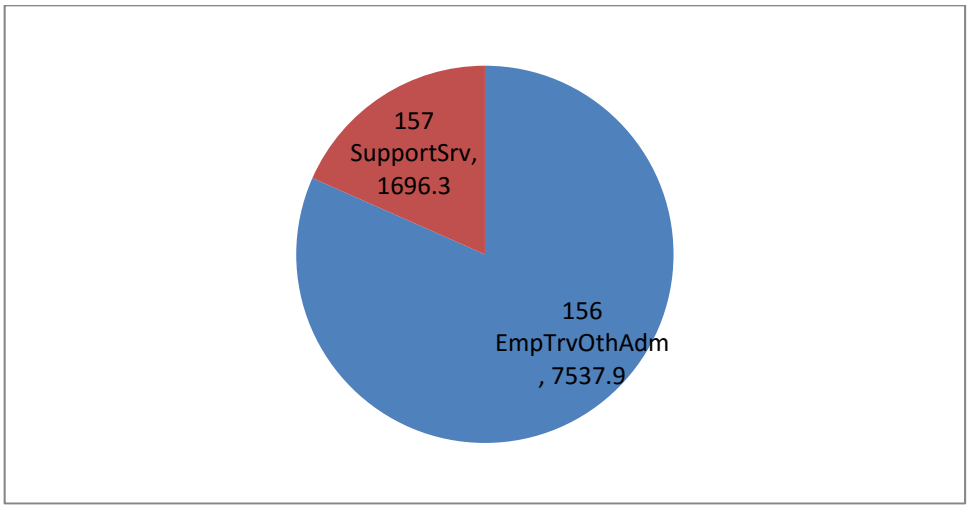

FIGURE 77: ADMINISTRATIVE AND SUPPORT SERVICES GROUPS OF VICTORIA STATE INCOME ($MILLION)

4.15.1 Administrative and Support Services Vulnerability

Administrative and support services are considered to have negligible to low sensitivity to bushfire and flood. For the state, the breakdown of low and negligible sensitivity for bushfire 5.9% and 94.1% while for flood it is 3.4% and 96.6% as shown in Figure 78 and Figure 79.

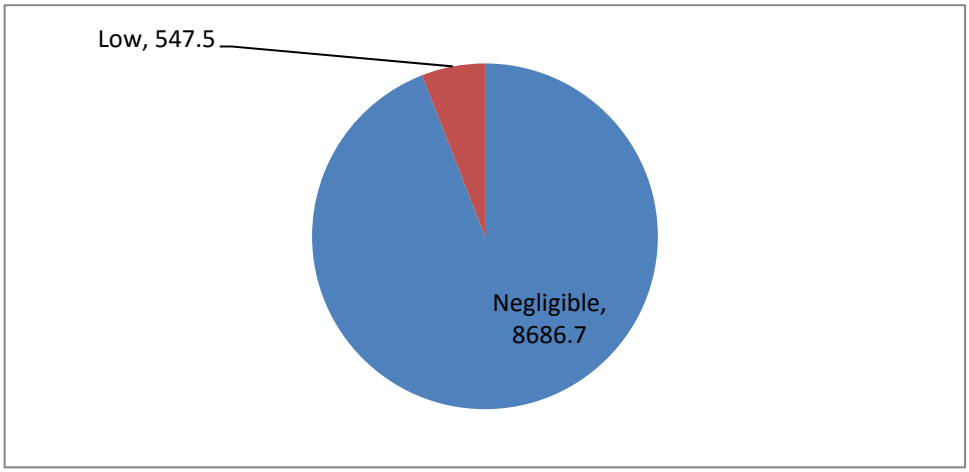

FIGURE 78: ADMINISTRATIVE AND SUPPORT SERVICES BUSHFIRE VULNERABILITY ($MILLION)

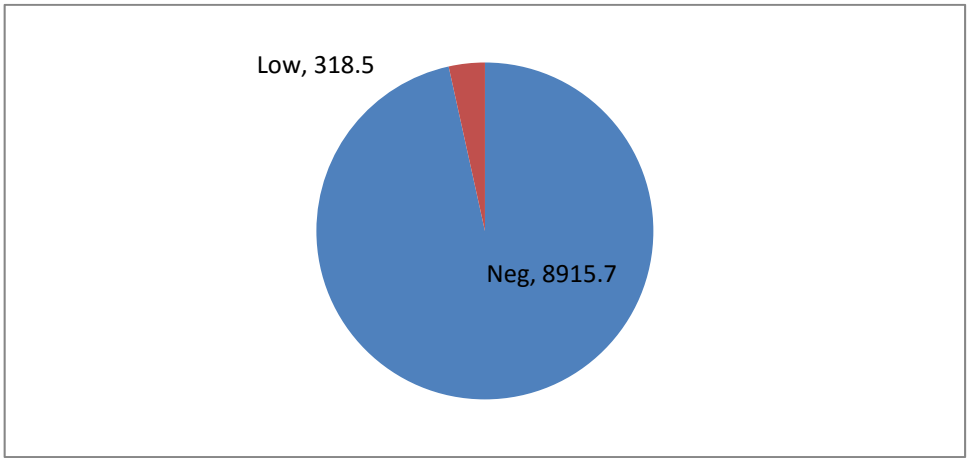

FIGURE 79: ADMINISTRATIVE AND SUPPORT SERVICES FLOOD VULNERABILITY ($MILLION)

4.16 Public Administration and Safety

The public administration and safety sector generated $13 billion or 4.4% of Victoria's income (2011). The largest absolute values for this sector are found in the SLAs of Wodonga ($291 million), Wyndham (North) ($267 million) and Banyule (Heidelberg) ($247 million) (Figure 80). This sector makes up the largest proportion in Mitchell North (22%), Wodonga (16%), Mornington Peninsula East (10%) and Queenscliff (10%) (Figure 81). The largest groups in the sector are Federal Government Administrative services (43.7%), local government administrative services (16.1%) and state government administrative services (10.3%) in Figure 82.

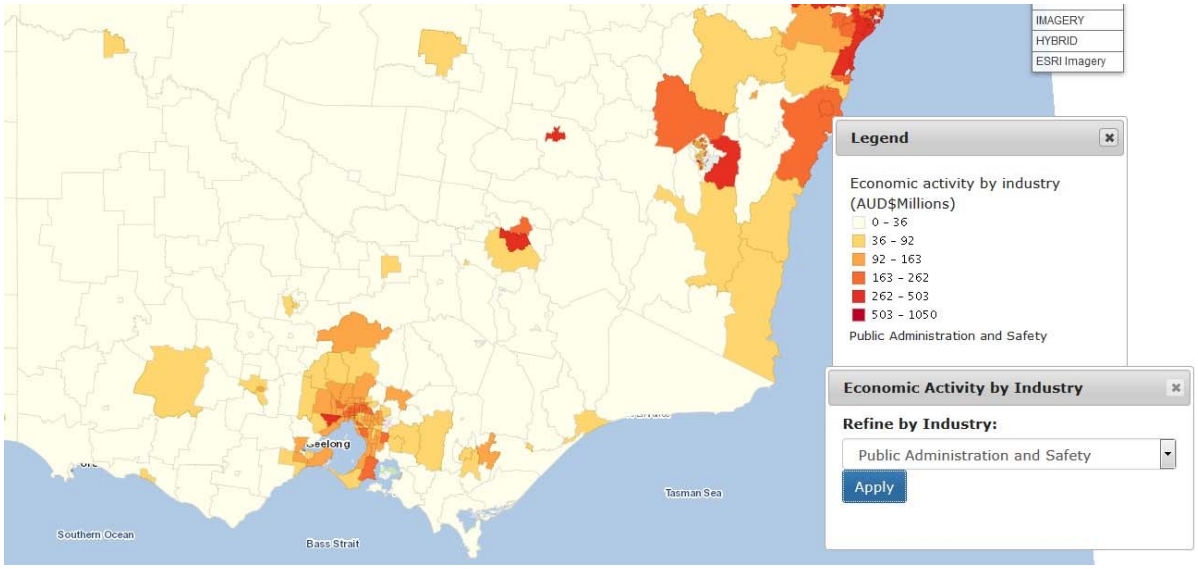

FIGURE 80: MAP OF SLA PUBLIC ADMINISTRATION AND SAFETY ABSOLUTE INCOME ($MILLION)

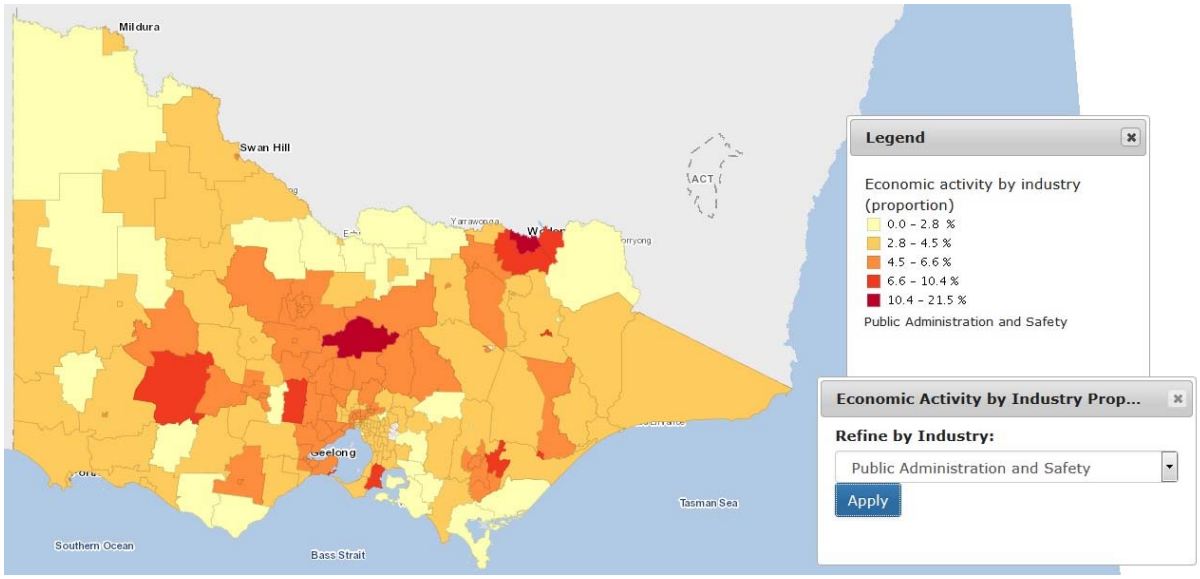

FIGURE 81: MAP OF SLA PUBLIC ADMINISTRATION AND SAFETY RELATIVE INCOME (%)

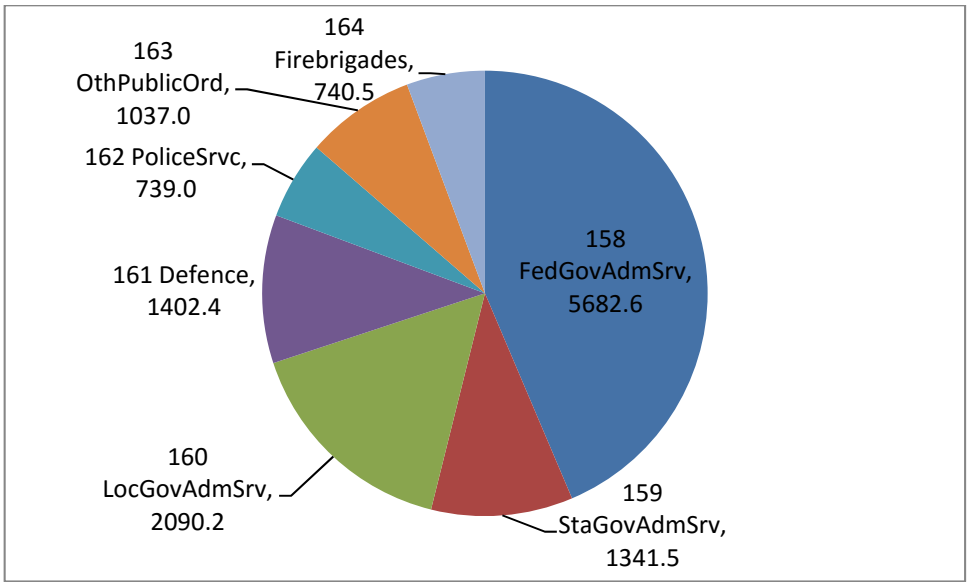

FIGURE 82: PUBLIC ADMINISTRATION AND SAFETY GROUPS OF VICTORIA STATE INCOME ($MILLION)

4.16.1 Public Administration and Safety Vulnerability

This economic division includes the three levels of government which are usually directly or indirectly affected by bushfire and flood and therefore are considered to have a low sensitivity. However, fire and police services are heavily and directly involved and hence have a moderate sensitivity. For the state, the breakdown of high, moderate, low and negligible sensitivity for bushfire is 1.2%, 7.3%, 11.6 and 79.9% while for flood it is 0.6%, 5.1%, 9.3% and 85% as shown in Figure 83 and Figure 84.

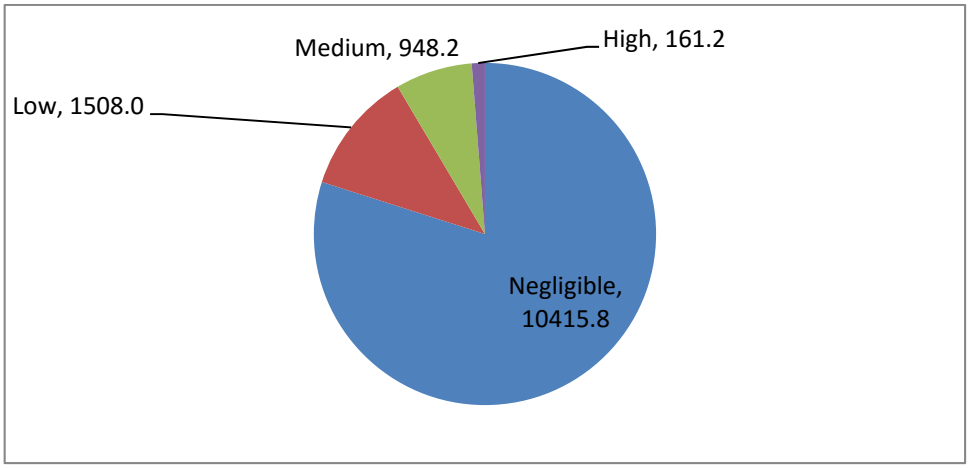

FIGURE 83: PUBLIC ADMINISTRATION AND SAFETY BUSHFIRE VULNERABILITY ($MILLION)

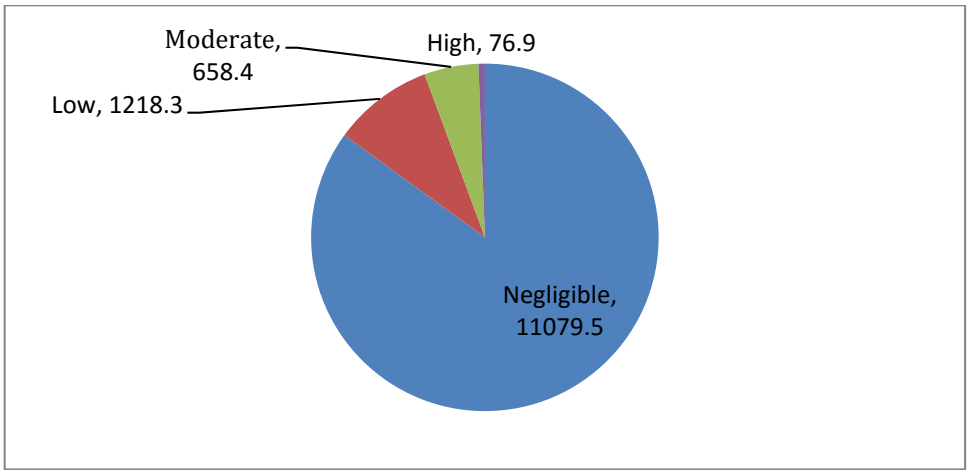

FIGURE 84: PUBLIC ADMINISTRATION AND SAFETY FLOOD VULNERABILITY ($MILLION)

4.17 Education and Training

This economic division includes all levels of education from preschool to vocational education and university and generated $17.9 billion (6%) of Victoria's income (2011) with the largest values found in Glen Eira (Caulfield) ($394 million), Manningham (West) ($337 million) and Kingston (North) ($325 million) (Figure 85). This sector constitutes the large proportion in Mt Buller Alpine Resort (25%), Mansfield (10%) and Queenscliffe (10%) (Figure 86). The largest group is Secondary Schools (22.8%), followed by Tertiary education (24.3%) and primary schools (18.3%) (Figure 87).

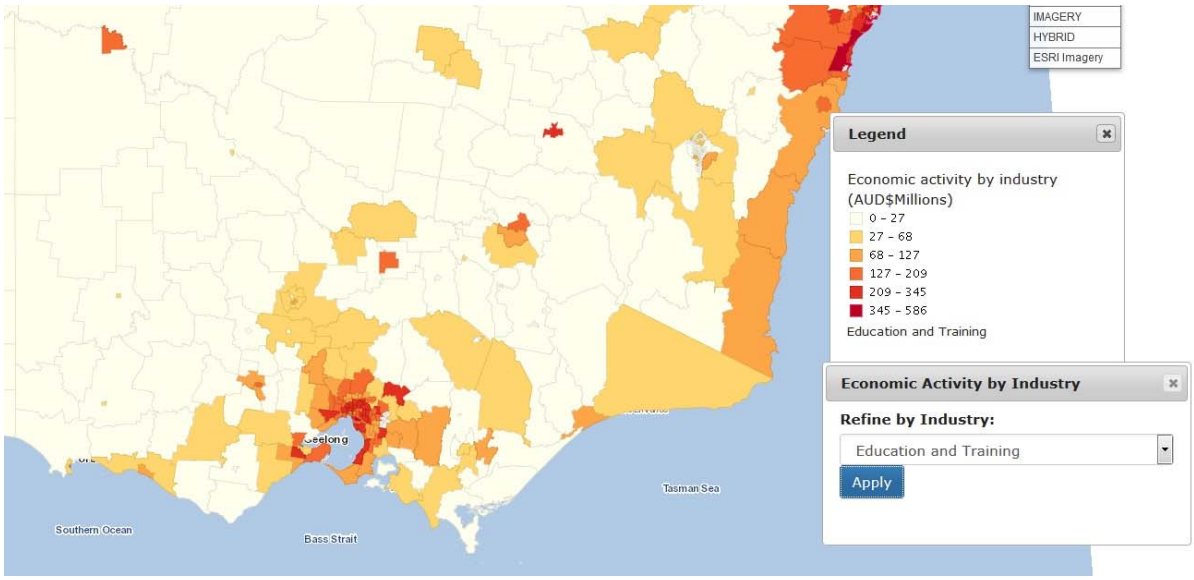

FIGURE 85: MAP OF SLA EDUCATION AND TRAINING ABSOLUTE INCOME ($MILLION)

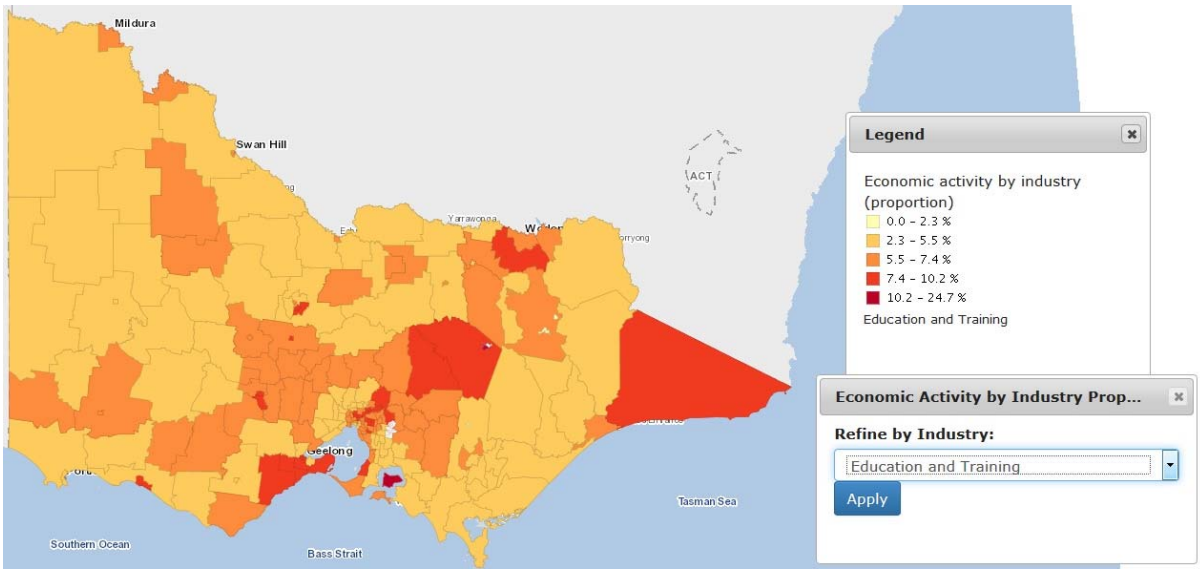

FIGURE 86: MAP OF SLA EDUCATION AND TRAINING RELATIVE INCOME (%)

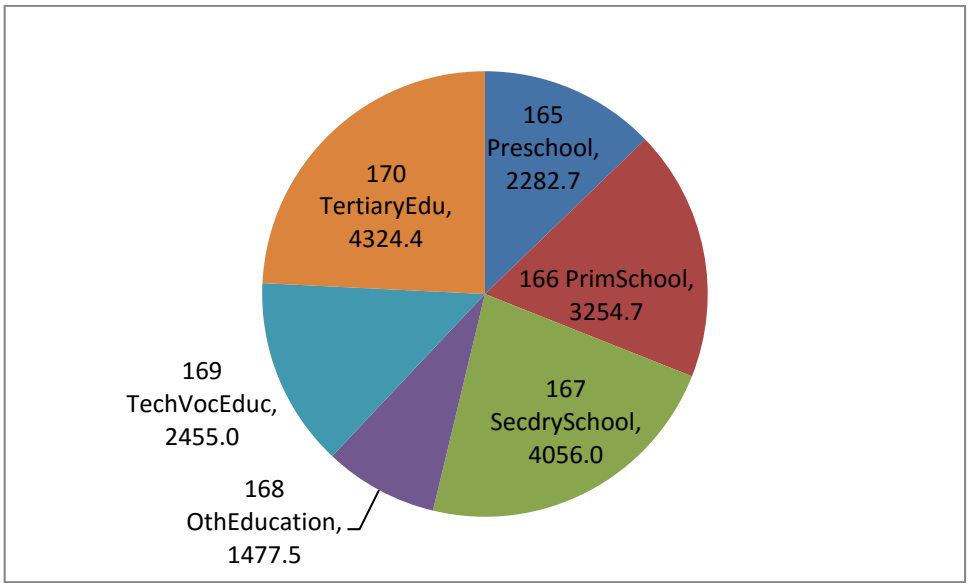

FIGURE 87: EDUCATION AND TRAINING GROUPS OF VICTORIA STATE INCOME ($MILLION)

4.17.1 Education and Training Vulnerability

Given the direct and indirect links educational institutions have in most communities, the sensitivity for all was rated as moderate. For the state, the breakdown of high, moderate, low and negligible sensitivity for bushfire is 1.2%, 7.3%, 11.6% and 79.9% while for flood it is 0.6%, 5.1%, 9.3% and 85% as shown in Figure 88 and Figure 89.

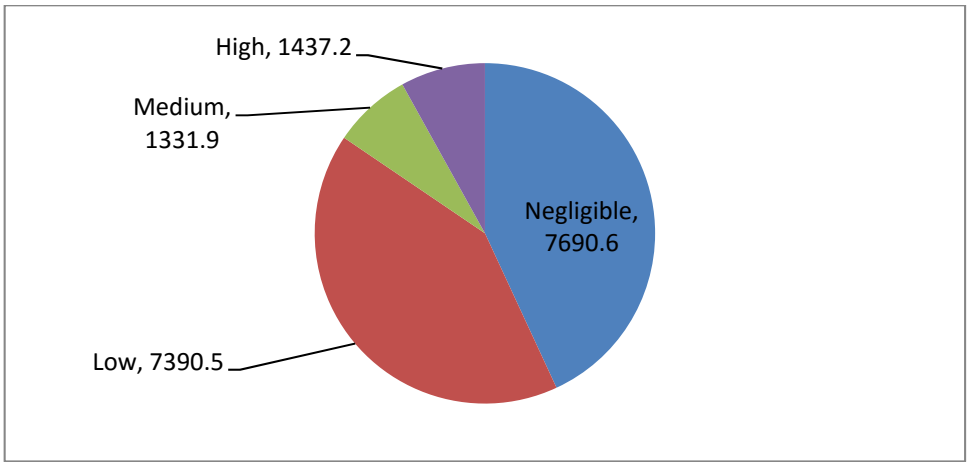

FIGURE 88: EDUCATION AND TRAINING BUSHFIRE VULNERABILITY ($MILLION)

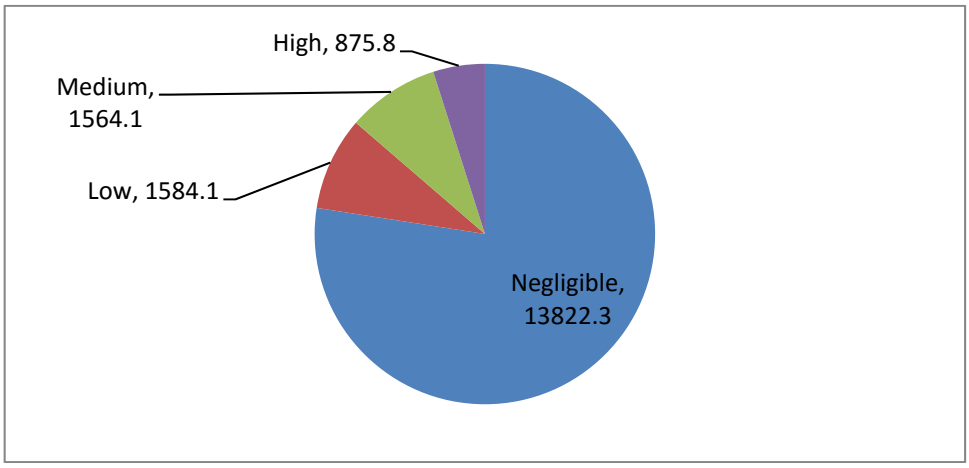

FIGURE 89: EDUCATION AND TRAINING FLOOD VULNERABILITY ($MILLION)

4.18 Health Care and Social Assistance

The health sector has income of about $22.5 billion or 7.6% of state income with the largest values found in Manningham (West) ($419 million), Kingston (North) ($389 million) and Glen Eira (Caulfield) ($371 million) (Figure 90). In individual SLAs, this proportion ranges from 1% (tourist-based SLAs such as the ski resorts of Mt Buller, Falls Creek etc.) to 14% in Wangaratta (Figure 91). The SLAs with a proportion greater than 10% are all rural or regional centres. The largest groups in this economic division are community health (19.3%), child care services (16.2%) and hospital nursing (13.1%) as shown in Figure 92.

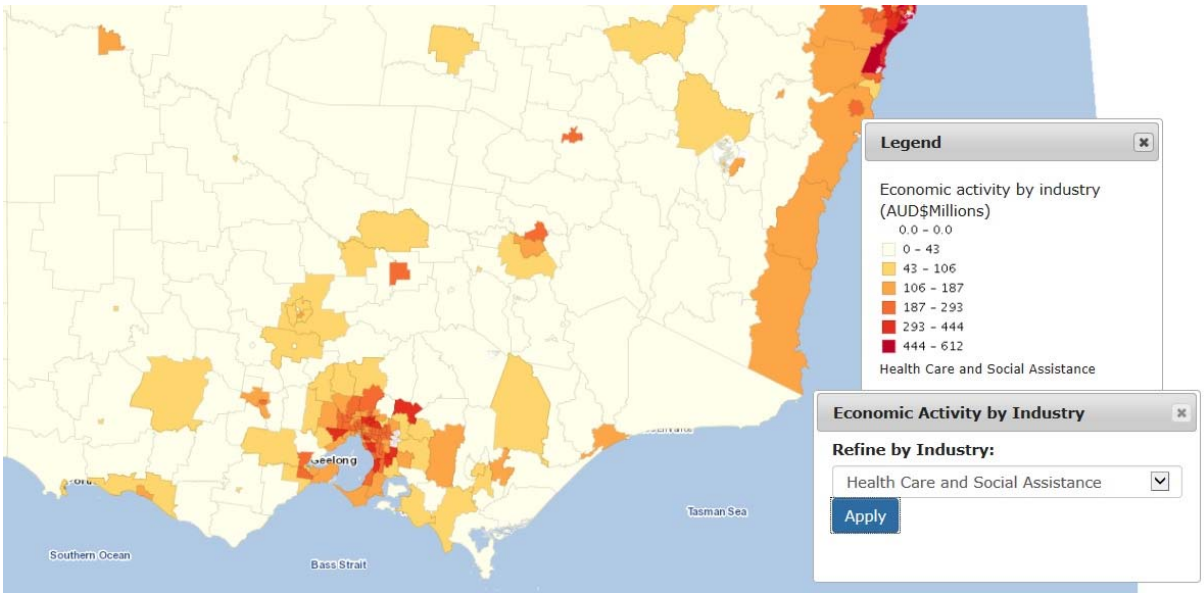

FIGURE 90: MAP OF SLA HEALTHCARE AND SOCIAL ASSISTANCE ABSOLUTE INCOME ($MILLION)

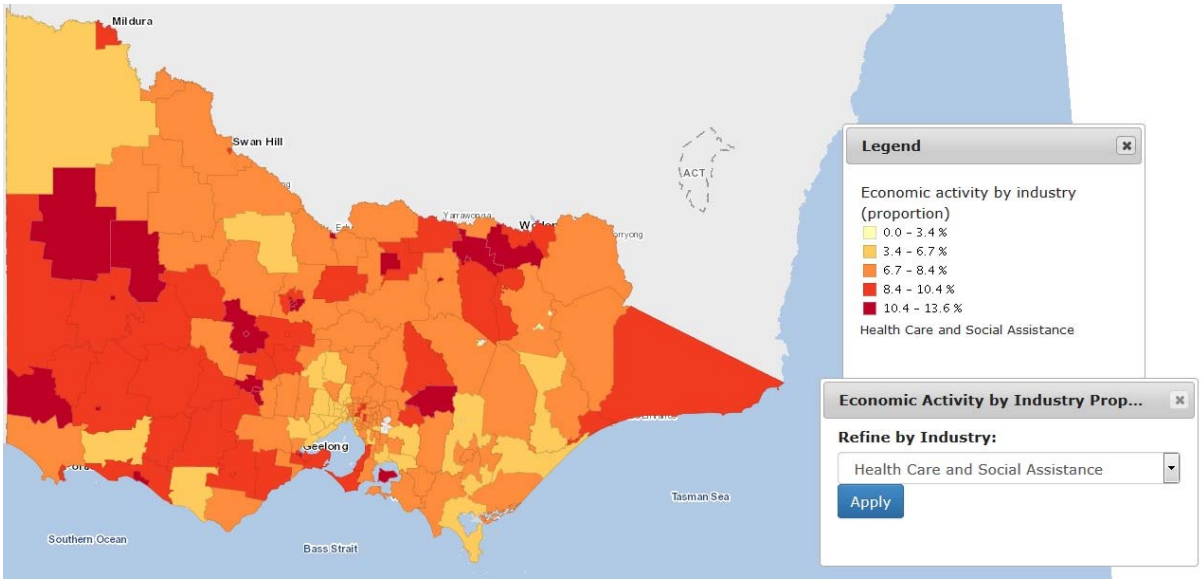

FIGURE 91: MAP OF SLA HEALTHCARE AND SOCIAL ASSISTANCE RELATIVE INCOME (%)

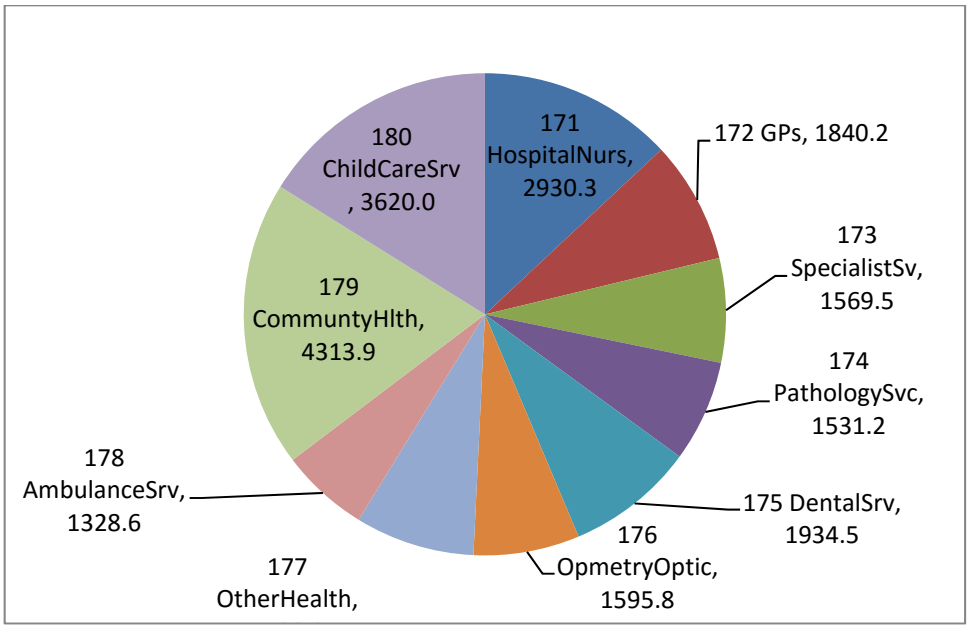

FIGURE 92: HEALTHCARE AND SOCIAL ASSISTANCE GROUPS OF VICTORIA STATE INCOME ($MILLION)

4.18.1 Health Care and Social Assistance Vulnerability

The aspects of health sensitive to bushfires and floods include heat stress, cold stress and vector-borne disease. Trauma can come through death and injury from these extreme events. Stress and mental illness is associated with the aftermath of such events and to chronic extremes such as drought. Ambulance and community services are rated as having moderate sensitivity, as the front line. Hospital and medical services are rated as having low sensitivity. For the state, the breakdown of high, moderate, low and negligible sensitivity for bushfire is 1.4%, 2.7%, 12.8% and 83.1% while for flood it is 1.2%, 2.3%, 7.3% and 89.3% as shown in Figure 93 and Figure 94.

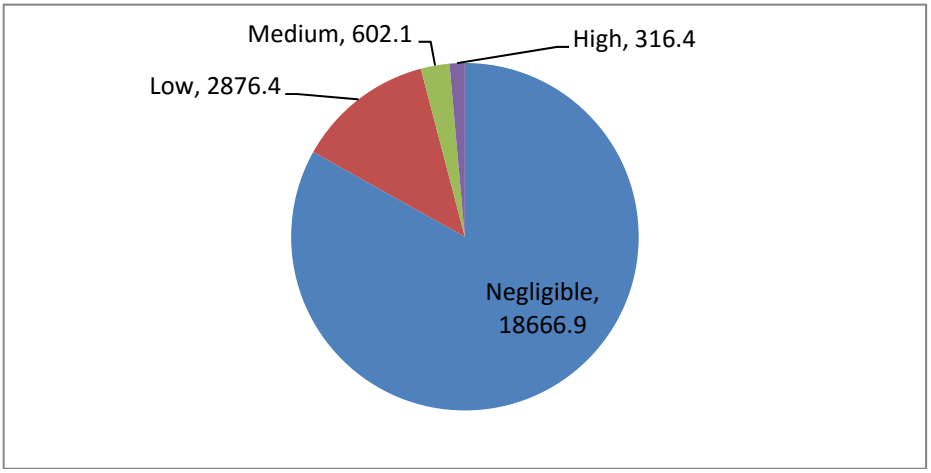

FIGURE 93: HEALTHCARE AND SOCIAL ASSISTANCE BUSHFIRE VULNERABILITY ($MILLION)

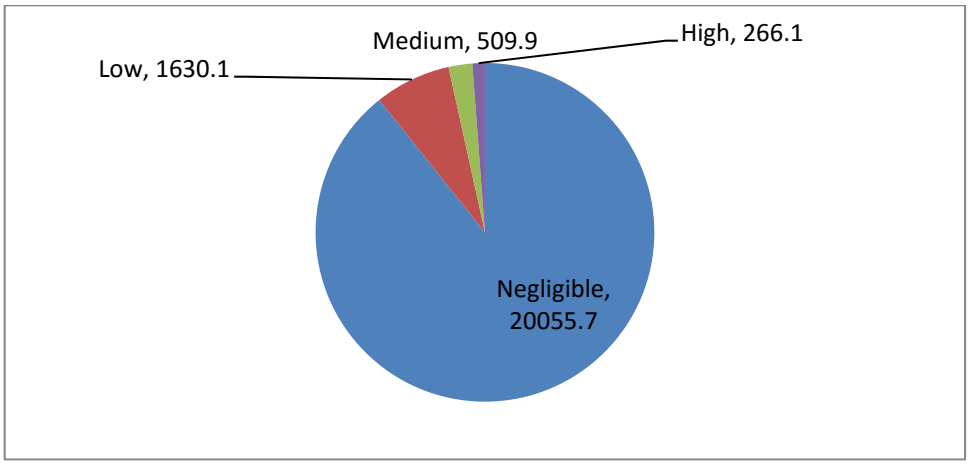

FIGURE 94: HEALTHCARE AND SOCIAL ASSISTANCE FLOOD VULNERABILITY ($MILLION)

4.19 Arts and Recreation Services

The arts and recreation services sector generates $3 billion or 1% of Victoria's income (2011) with Maribyrnong ($75.2 million), Port Phillip (St Kilda) ($73.7 million) and Wyndham (North) ($70.3 million) having the largest values (Figure 95). The SLAs with a higher proportion of this economic division are diverse ranging from Falls Creek Alpine resort (4%) to Bass Coast Phillip Island (3%) to Melbourne Docklands (2%) (Figure 96). Overall, however, this division is small in all SLAs. It consists of three groups, sport and recreation (42.4%), gambling (31.6%) and libraries, museums and art galleries (26.2%) as shown in Figure 97.

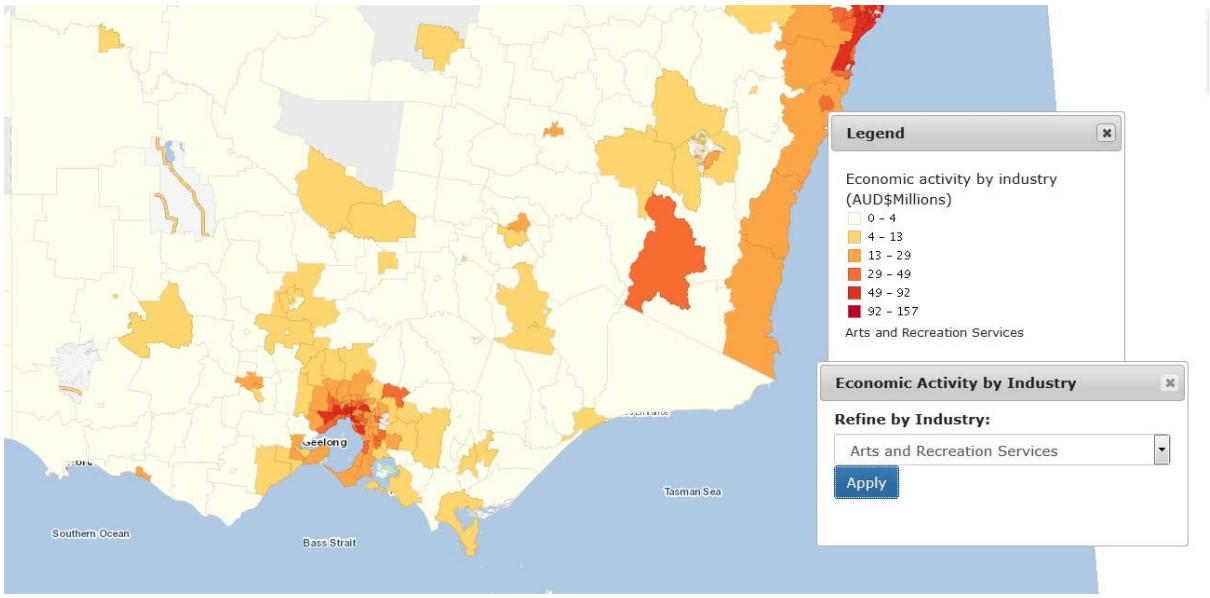

FIGURE 95: MAP OF SLA ARTS AND RECREATION SERVICES ABSOLUTE INCOME ($MILLION)

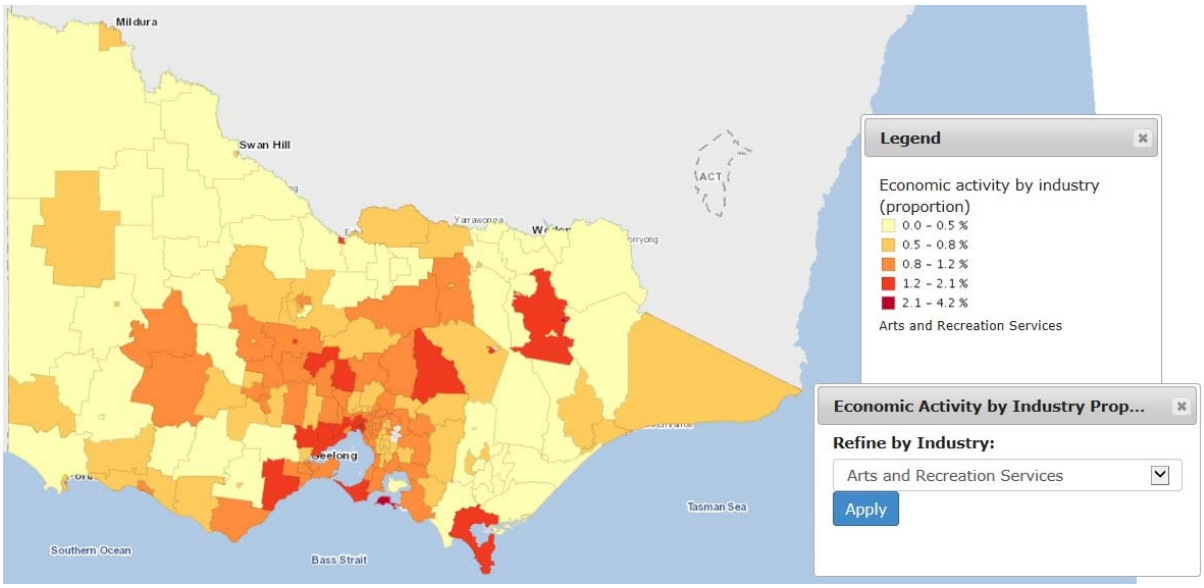

FIGURE 96: MAP OF SLA ARTS AND RECREATION SERVICES RELATIVE INCOME (%)

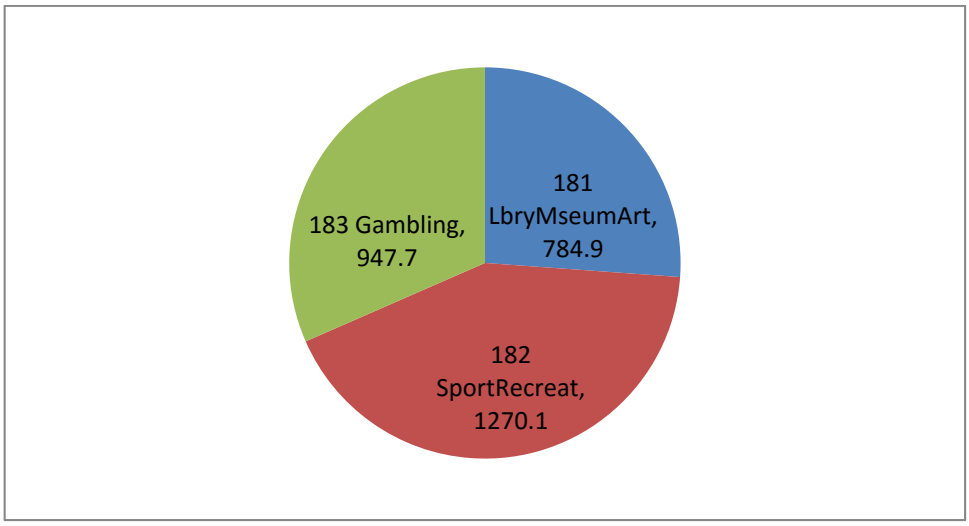

FIGURE 97: ARTS AND RECREATION GROUPS OF VICTORIA STATE INCOME ($MILLION)

4.19.1 Arts and Recreation Services Vulnerability

Service activities considered having a low sensitivity to bushfires and floods include sport and recreation and negligible for the others. Impacts on this sector are both direct and indirect. For the state, the breakdown of low and negligible sensitivity for bushfire is 5.9%, 94.1% while for flood it is 3% and 97% as shown in Figure 98 and Figure 99.

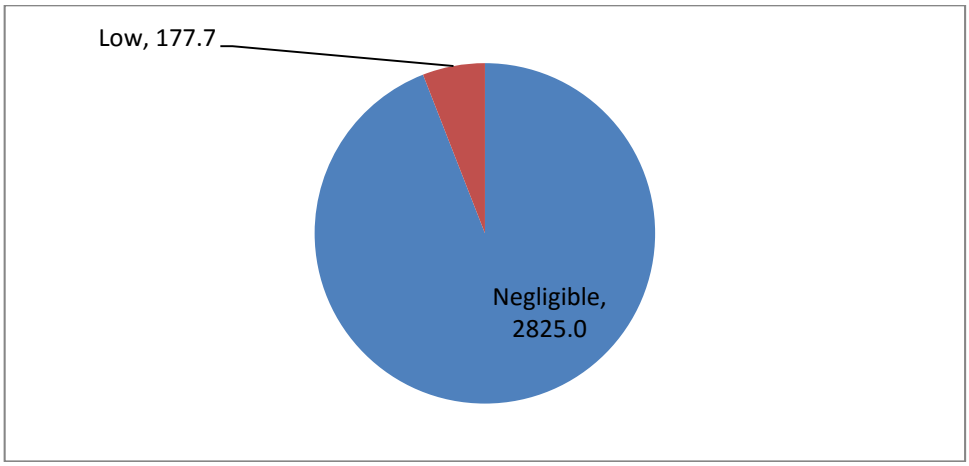

FIGURE 98: ARTS AND RECREATION BUSHFIRE VULNERABILITY ($MILLION)

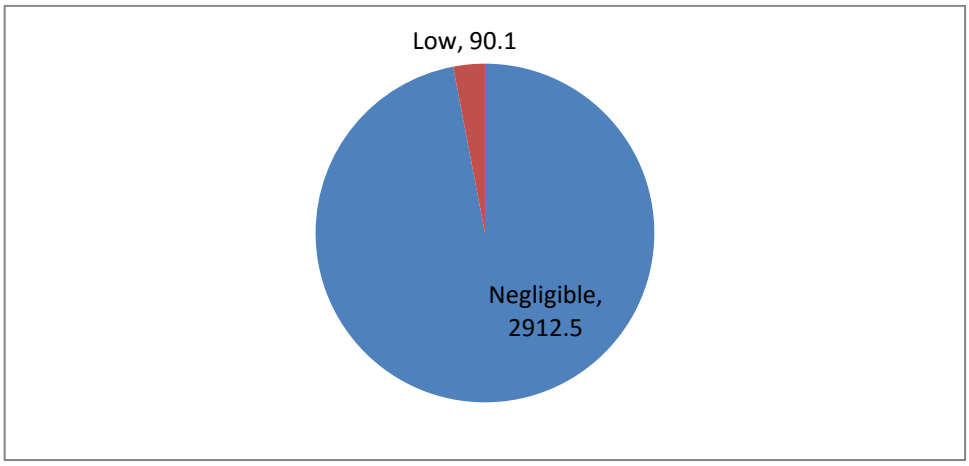

FIGURE 99: ARTS AND RECREATION FLOOD VULNERABILITY ($MILLION)

4.20 Other Services

The other services sector generates $7.8 billion or 2.6% of Victoria's income (2011) with the largest values found in Casey (Berwick) ($169 million), Kingston (North) ($160 million) and Yarra Ranges (North) ($151 million). This division is extremely diverse, with services ranging from religious organisations to automotive repairs to hair dressing and beauty salons, generating $7.8 billion or 2.6% of the state's income in 2011. The largest group in this division is automotive repairs (36.2%) as shown in Figure 100.

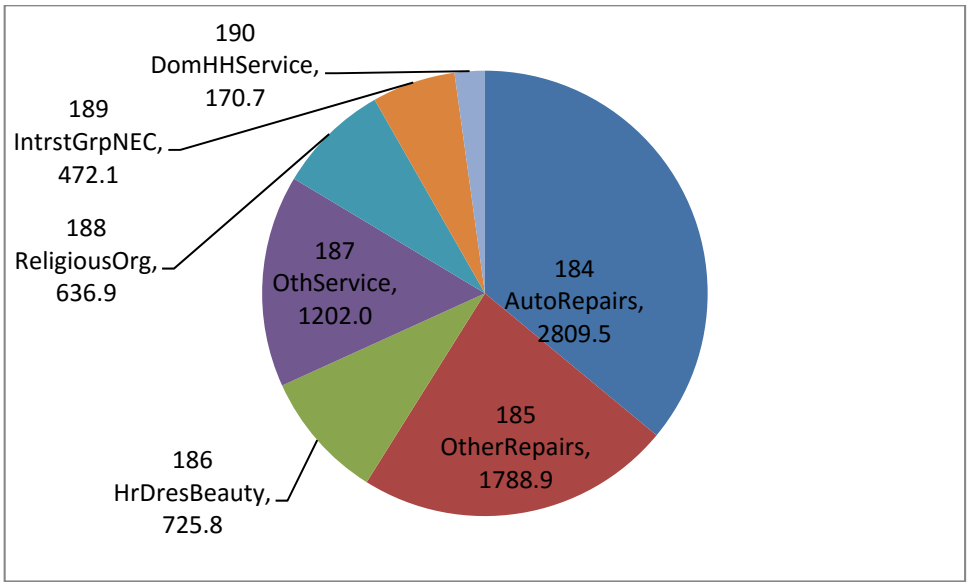

FIGURE 100: OTHER SERVICES GROUPS OF VICTORIA STATE INCOME ($MILLION)

4.20.1 Other Services Vulnerability

Nearly all of these services were rated as having negligible sensitivity to bushfire and flood. For the state, the breakdown of low and negligible sensitivity for bushfire is 8.9%, 91.1% while for flood it is 6.1% and 93.9% as shown in Figure 101 and Figure 102.

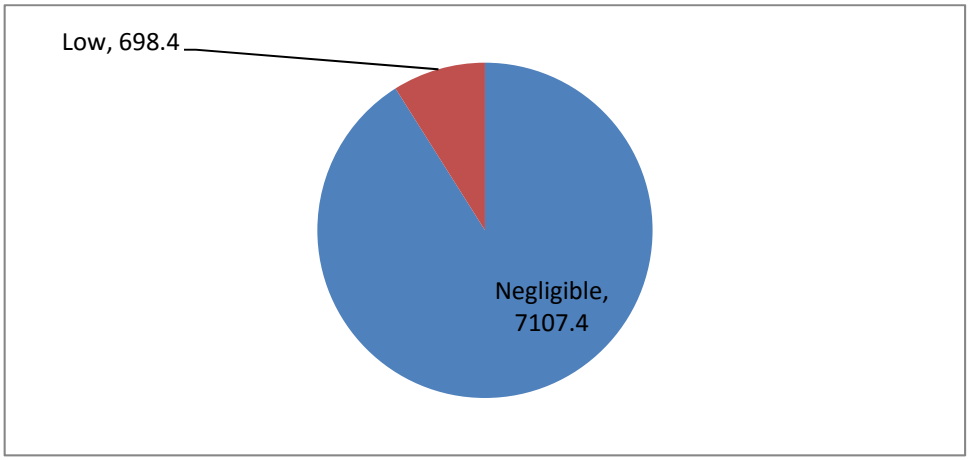

FIGURE 101: OTHER SERVICES BUSHFIRE VULNERABILITY ($MILLION)

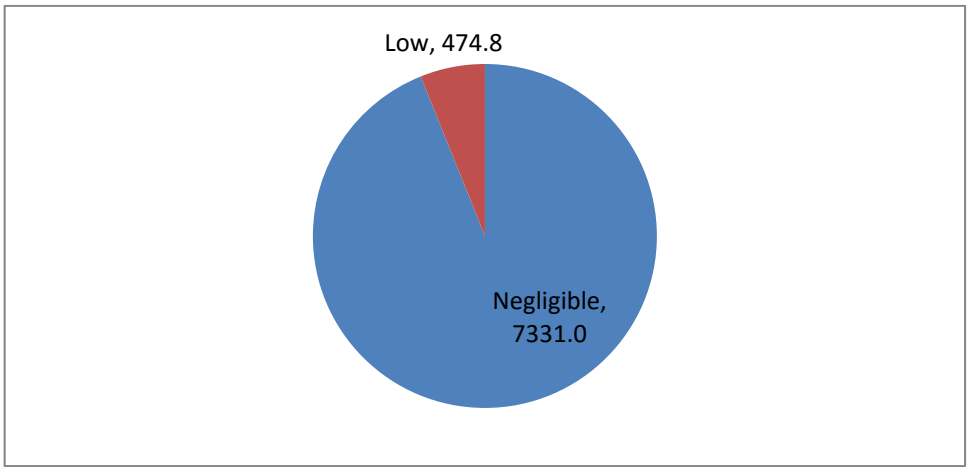

FIGURE 102: OTHER SERVICES FLOOD VULNERABILITY ($MILLION)

5 SLA ECONOMIC DIVERSITY DISTRIBUTION

In theory, a more diverse economy will have less variation in economic activity over time, all other factors remaining constant, as well as having less vulnerability and greater resilience to natural disasters such as bushfires or floods (Xiao and Drucker, 2013). The extent of economic diversification varies from state to state as well as from one SLA to another within a state. Mapping of such economic diversity highlights areas with greater and lesser economic vulnerability.

The approach used here is the economic diversification index, or Hachman Index (Moore, 2001, BEBR, 2000), to measure the extent of economic diversity of Victoria's 205 SLAs. In its most general form, the Hachman Index measures how closely the economic distribution of a subject region (e.g., SLA) resembles that of a reference region (e.g., the country as a whole) at a point in time. The more closely a subject region's economy reflects the reference region's economic mix, the higher the value of the Hachman Index. It has a maximum value of one (meaning a subject region's employment mix is exactly the same as the reference region's economic mix), while the lowest score is 0, meaning the economic diversity is completely different to the reference case.

The spatial distribution of the Hachman Index or economic diversity scores per SLA in Victoria is shown in Figure 103. As a point of comparison, the level of economic activity in Victoria per SLA is shown in Figure 104.

This highlights the significant differences between size of economic activity and economic diversity. The numerical distribution of Economic Diversity Index scores for the 205 SLAs in Victoria is shown in Figure 105. The lowest diversity score in Victoria is Loddon North with a score of 0.07, whilst the highest score is 0.93 in Greater Bendigo Inner West. Not surprisingly, rural regions have much lower diversity scores than metropolitan regions. The distribution of economic diversity scores for Victoria is shown in Figure 105. As this figure shows there are a significant number of SLAs with very low economic diversity, with 60 SLAs having an economic diversity index score of less than 0.5.

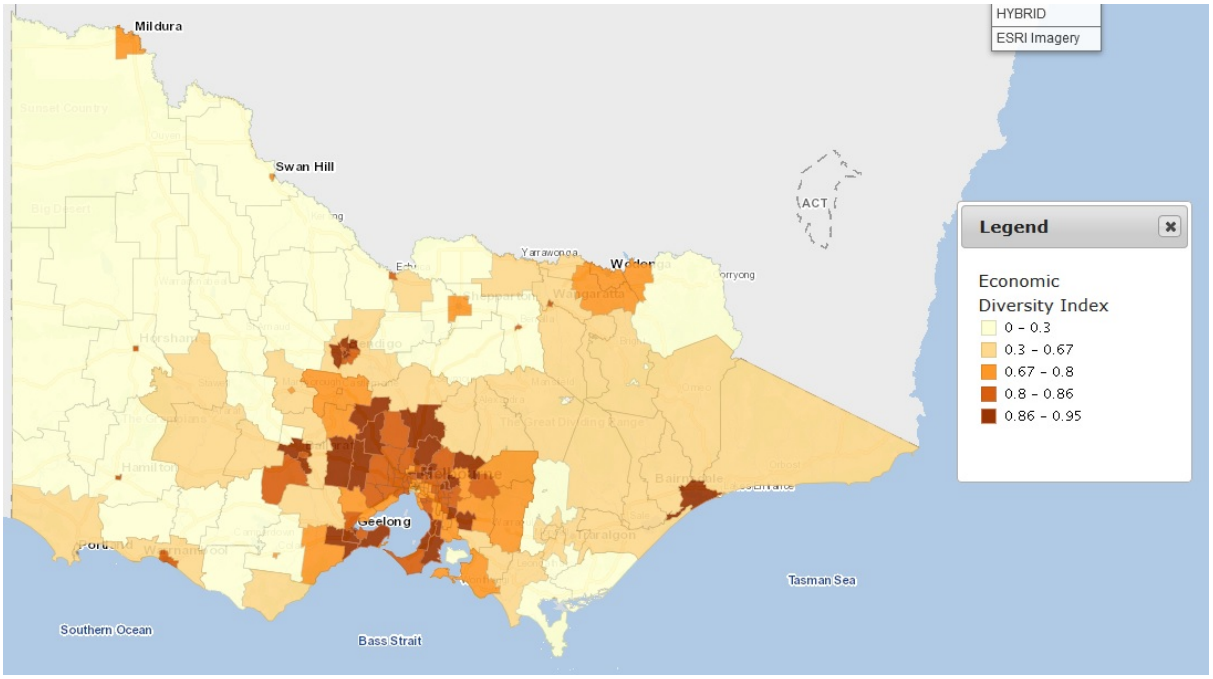

FIGURE 103: SPATIAL DISTRIBUTION OF ECONOMIC DIVERSITY - VICTORIA

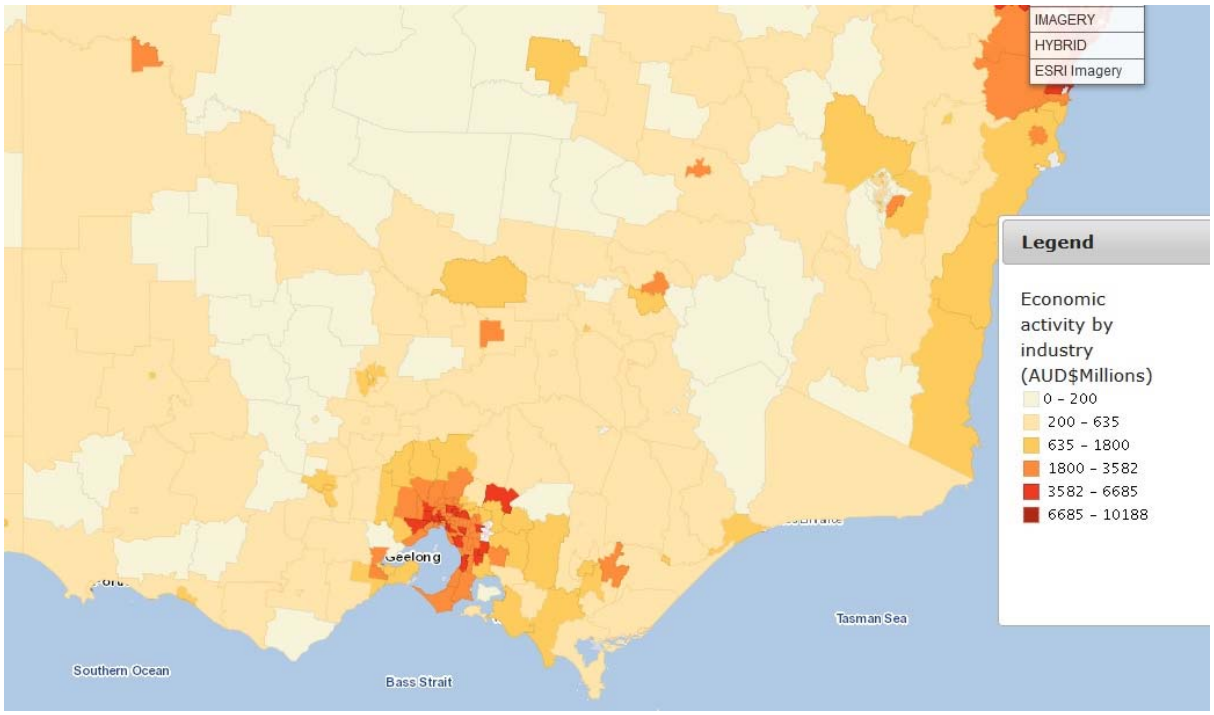

FIGURE 104: ECONOMIC ACTIVITY PER SLA IN VICTORIA

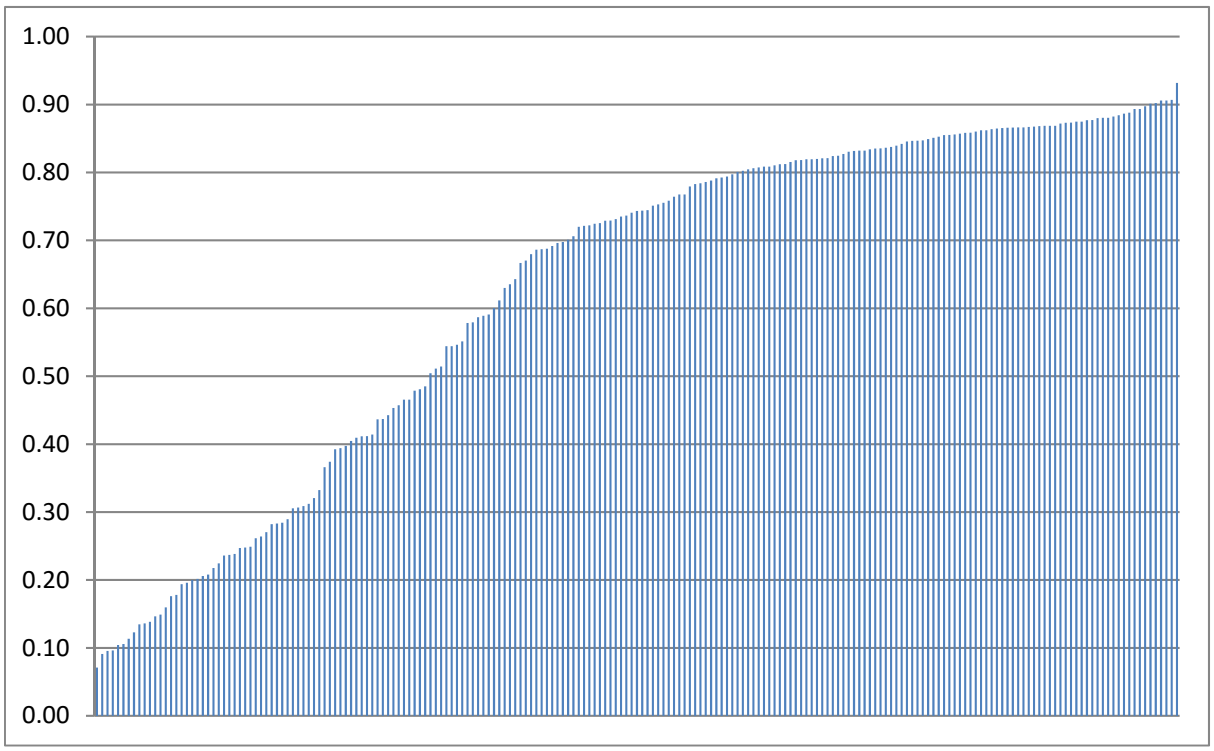

FIGURE 105: VICTORIAN SLA ECONOMIC DIVERSITY

Figure 106, Figure 107 and Figure 108 illustrate the economic group breakdown of Loddon (S) – North, an SLA with low (0.07) economic diversity, Murrindindi (S) – West moderate (0.5) economic diversity, and Gr Bendigo (C) – Inner West high diversity (0.93).

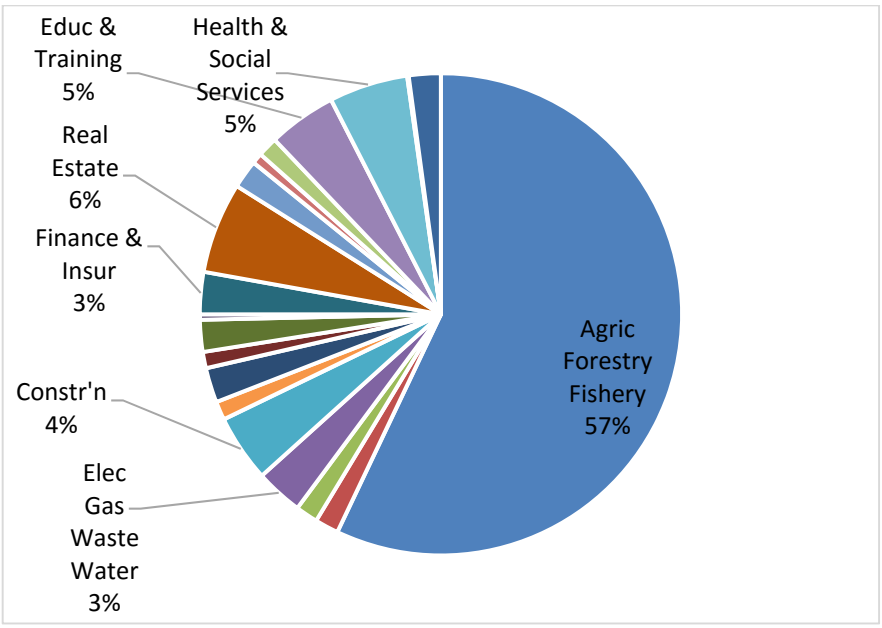

FIGURE 106: LODDON (S) – NORTH ECONOMIC DIVISIONS

Loddon (S) – North	% of max SLA income	2%	Economic Diversity	0.07

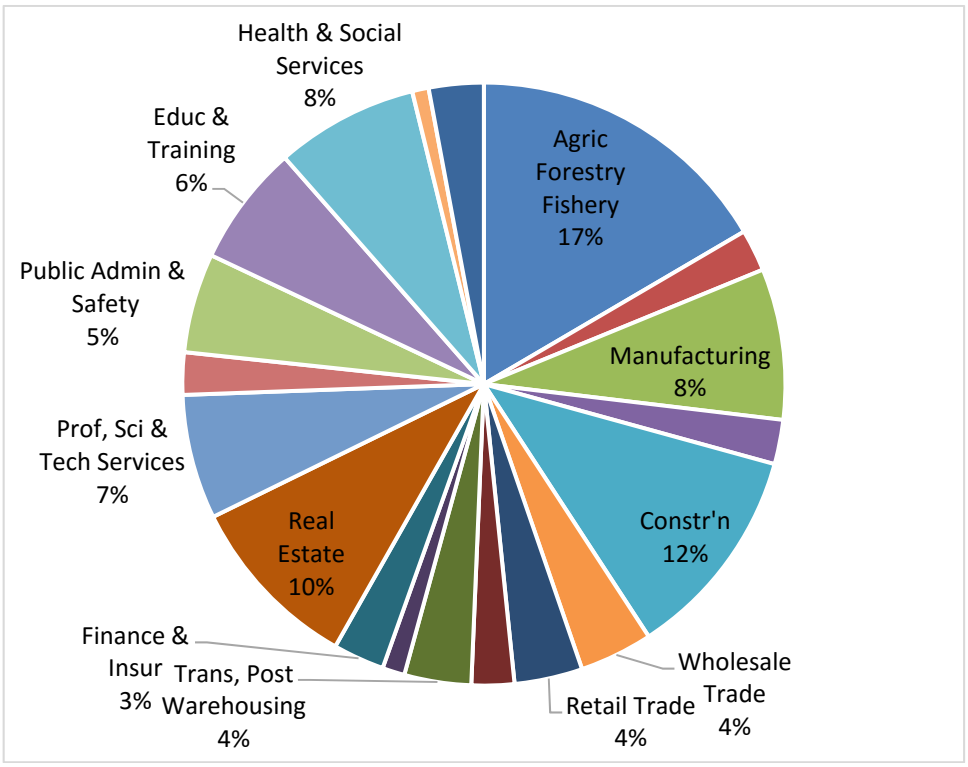

FIGURE 107: MURRINDINDI (S) – WEST ECONOMIC DIVISIONS

Murrindindi (S) – West	% of max SLA income	4%	Economic Diversity	0.50

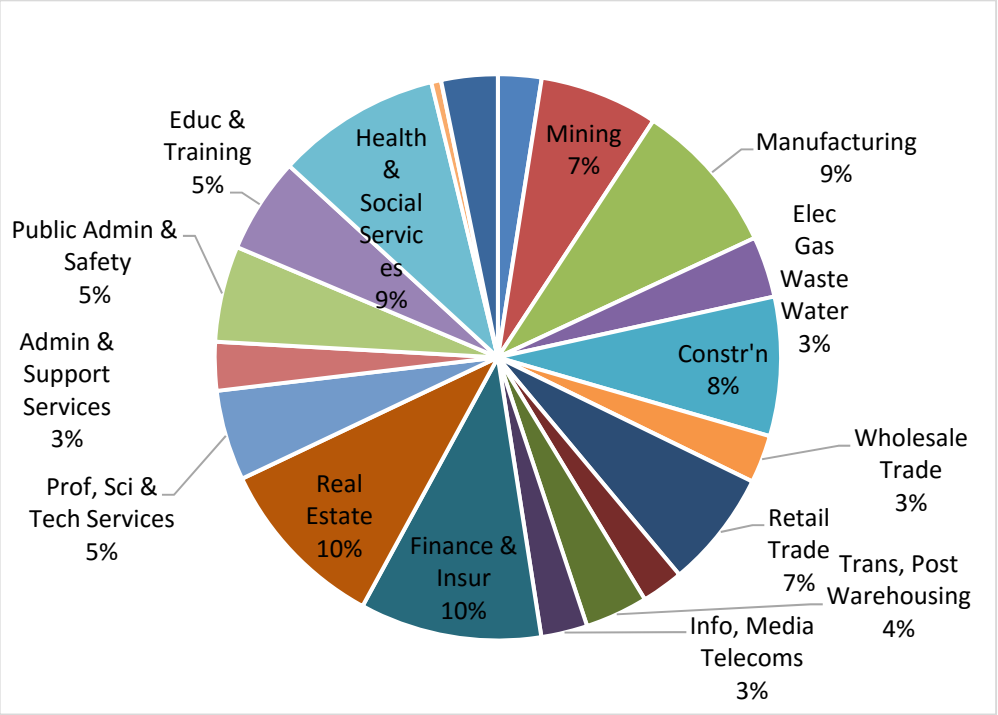

FIGURE 108: GR. BENDIGO (C) - INNER WEST ECONOMIC DIVISIONS

Gr. Bendigo (C) – Inner West	% of max SLA income 9%	Economic Diversity 0.93	

However, the size of the economic resources available also influence an SLA's vulnerability. As shown in Figure 109, over half of SLAs in Victoria have less than 10% of the maximum SLA economic output. When low economic diversity is combined with low economic output, the vulnerability of an area increases dramatically. However, per cent of maximum SLA economic output must be interpreted with care, as some SLAs are small urban areas with high socio-economic characteristics, for example Boroondara (C) – Kew has a 19% of maximum SLA economic output but is nevertheless a well-off area close to other resources.

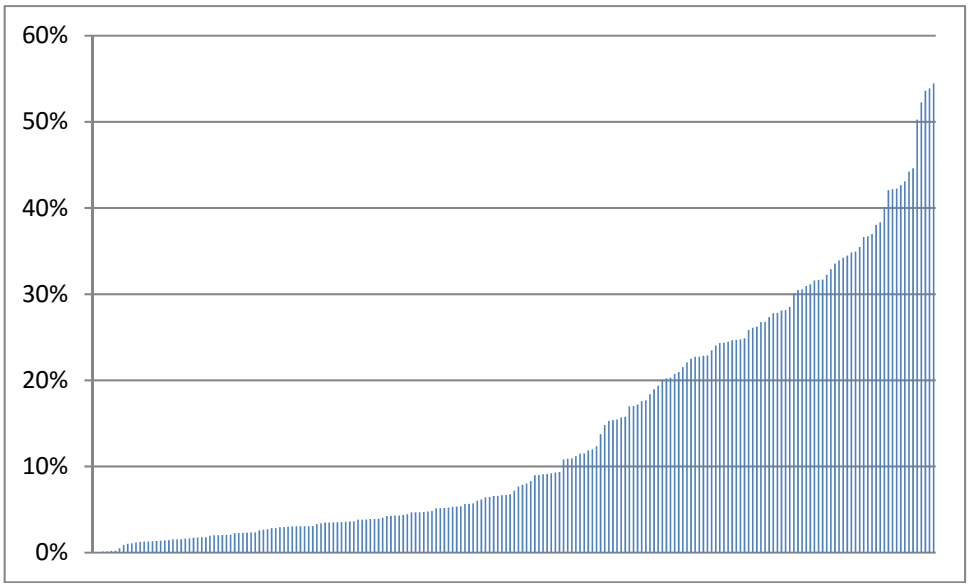

FIGURE 109: VICTORIAN SLA ECONOMIC OUTPUT % OF MAXIMUM AUSTRALIAN SLA OUTPUT

At the other end of the scale, Loddon (S) – North has a very low diversity score, 0.07, and only 2% of the maximum SLA economic output. Whilst this suggests the Loddon (S) – North is extremely vulnerable, however, the neighbouring SLA of Loddon (S) – South has a higher economic diversity but is more vulnerable as Figure 110, Figure 111, Figure 113 and Figure 114 indicate. Loddon North is a higher exposure to flood but a much lower exposure to bushfire than Loddon South which has a high exposure to both bushfire and flood combined with a low economic diversity, 0.18 and the same level of economic output as Loddon North.

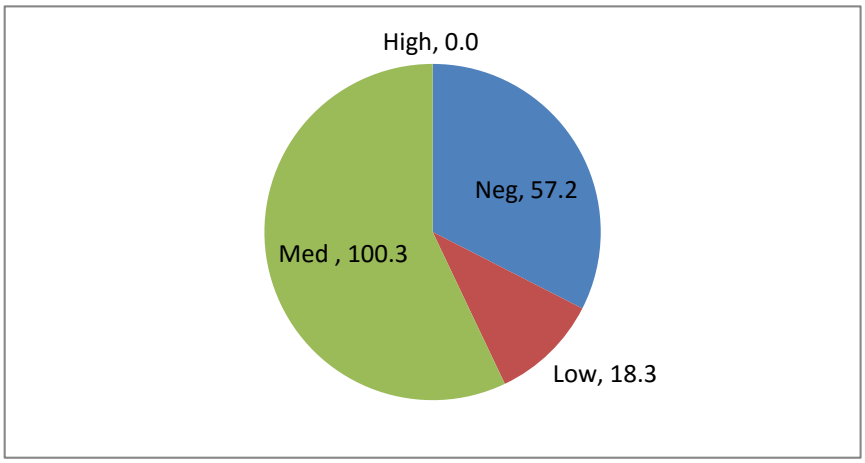

FIGURE 110: LODDON (S) - NORTH INCOME VULNERABILITY TO BUSHFIRE ($MILLION)

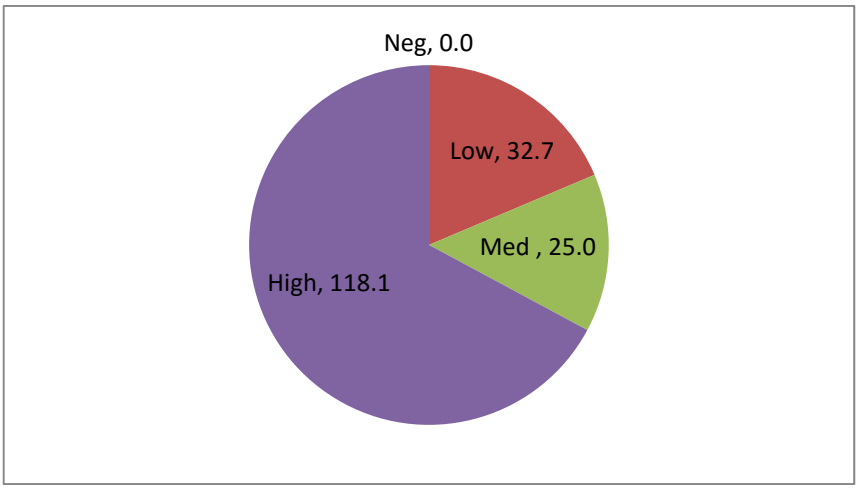

FIGURE 111: LODDON (S) - NORTH INCOME VULNERABILITY TO FLOOD ($MILLION)

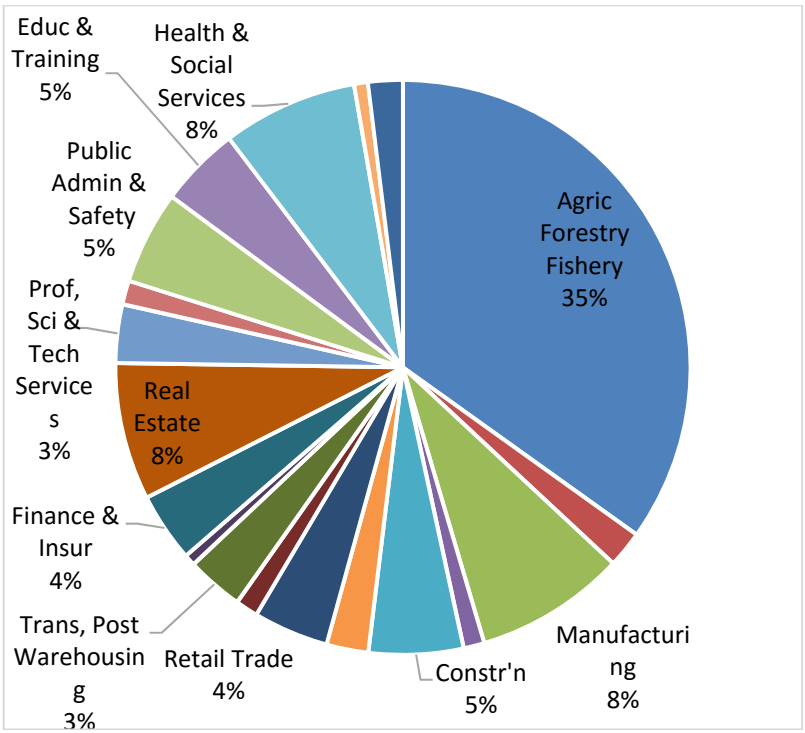

FIGURE 112: LODDON (S) – SOUTH ECONOMIC DIVISIONS

Loddon (S) - South % of max SLA income 2% Economic Diversity 0.18

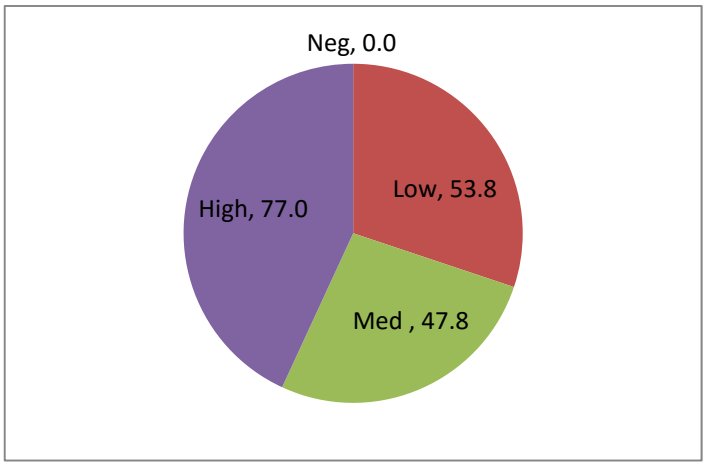

FIGURE 113: LODDON (S) – SOUTH INCOME VULNERABILITY TO BUSHFIRE ($MILLION)

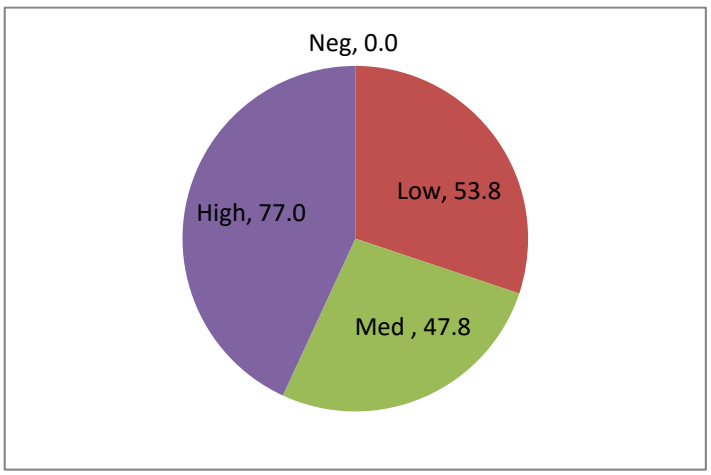

FIGURE 114: LODDON (S) – SOUTH INCOME VULNERABILITY TO FLOOD ($MILLION)

5.1.1 Economic Magnitude, Diversity and Hazards

The relative vulnerability of all the SLAs can be visualised in a 3D scatter plot. The x, y, and z axes represent, economic magnitude (% of maximum SLA economic output, X value), economic diversity (Y value) and bushfire (or flood) rating (Z value; i.e., vertical axis). This places the economic variables on the horizontal plane of the x–y axes with the lowest at the left rear and the highest at the right front. Hazard rating is on the vertical axis, so the most vulnerable SLAs will be situated on the left rear near the intersection of the red and green axes. The hazard rating for each SLA was based on the relative percentage each area was rated at negligible, low, moderate and high with each rating given ordinal ranking of 0, 1, 2 and 3.

The SLAs divided into urban, peri-urban and rural SLAs are shown in Figure 115, Figure 116 and Figure 117, respectively. As expected, the urban SLAs have a very low exposure to bushfires, with a few peri-urban SLAs with moderate to high bushfire rating. Many rural SLAs have a much higher bushfire rating as well as a low economic income and low economic diversity (top left corner), thereby heightening their vulnerability to the effects of a bushfire. There are numerous SLAs with a low economic magnitude, low economic diversity and high bushfire rating (found in the top left hand corner of the graph). These are the SLAs with the highest economic vulnerability to bushfires.

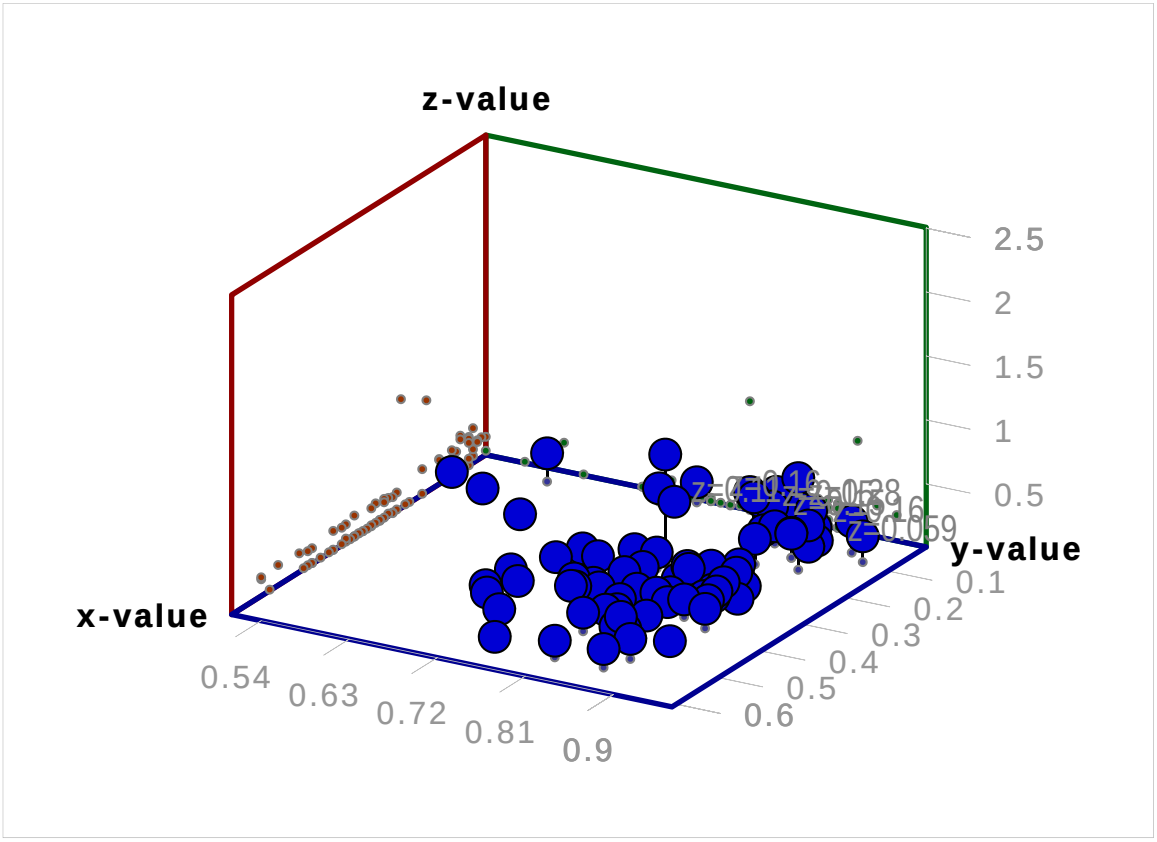

FIGURE 115: URBAN SLAS ECONOMIC MAGNITUDE, DIVERSITY AND BUSHFIRE RATING

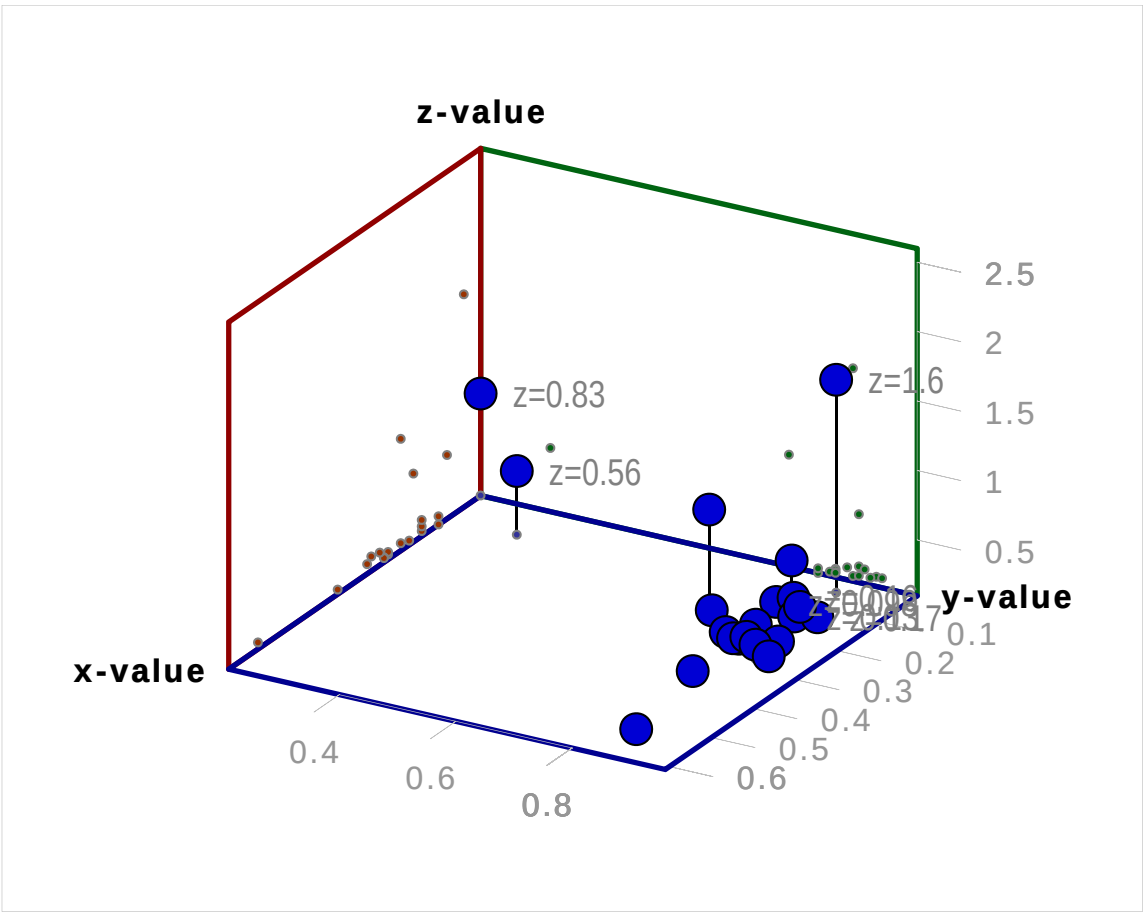

FIGURE 116: PERI URBAN SLAS ECONOMIC MAGNITUDE, DIVERSITY AND BUSHFIRE RATING

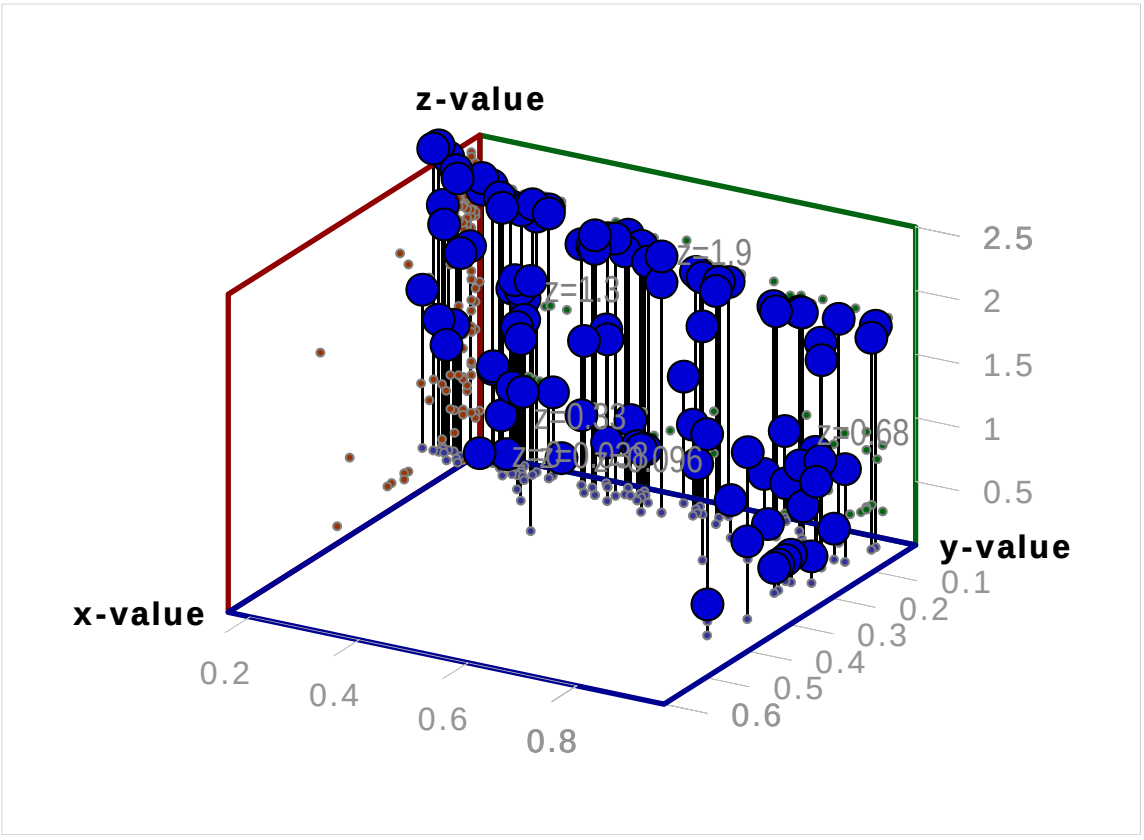

FIGURE 117: RURAL SLAS ECONOMIC MAGNITUDE, DIVERSITY AND BUSHFIRE RATING

Flood ratings were developed in the same way and plotted against economic magnitude and diversity as shown in Figure 118, Figure 119 and Figure 120. They follow a similar pattern to the bushfire figures, except that more urban SLAs are exposed to flood than bushfire. As with bushfires, the SLAS with the highest flood rating are found in the top left hand corner.

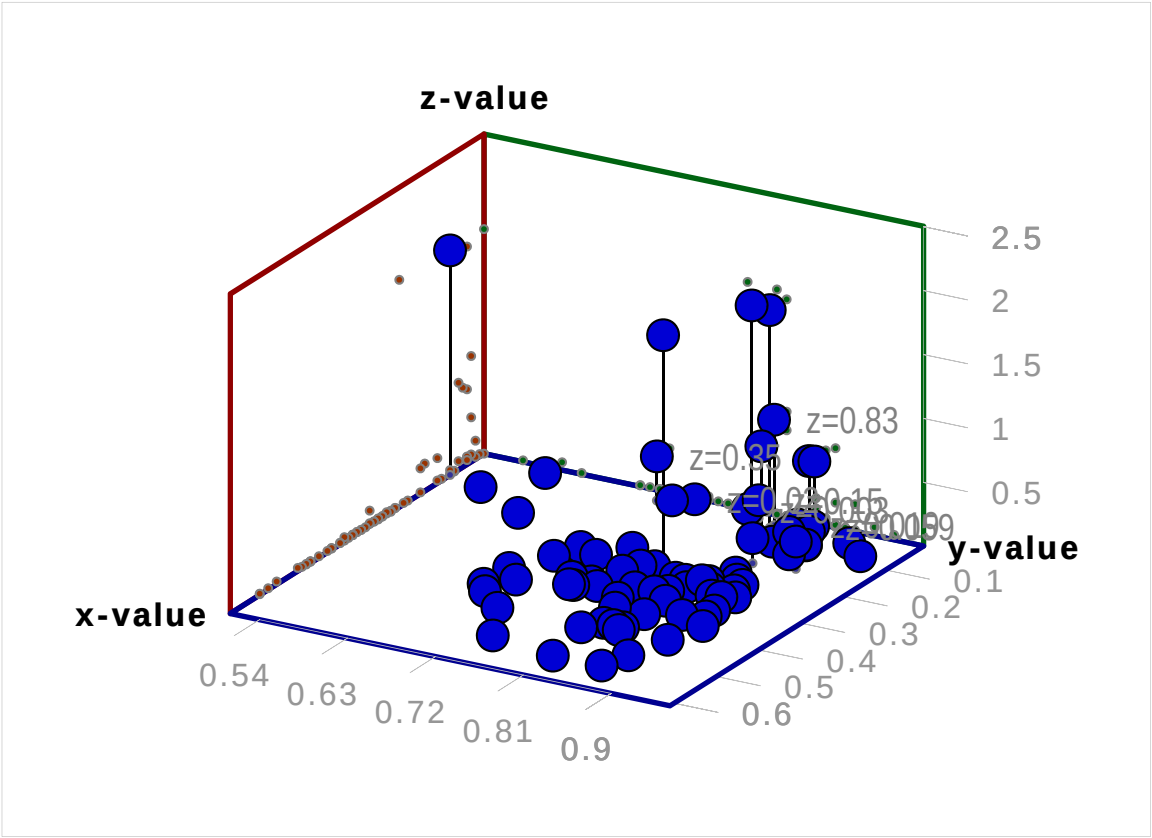

FIGURE 118: URBAN SLAS ECONOMIC MAGNITUDE, DIVERSITY AND FLOOD RATING

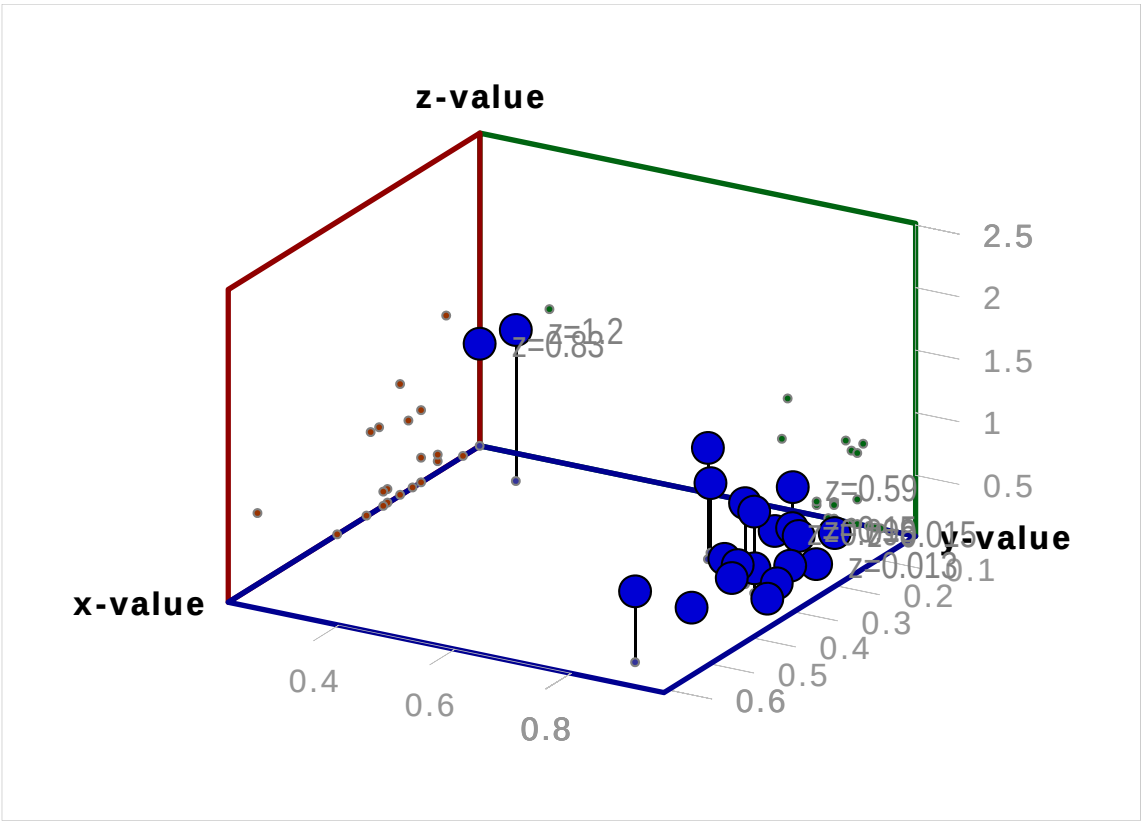

FIGURE 119: PERI URBAN SLAS ECONOMIC MAGNITUDE, DIVERSITY AND FLOOD RATING

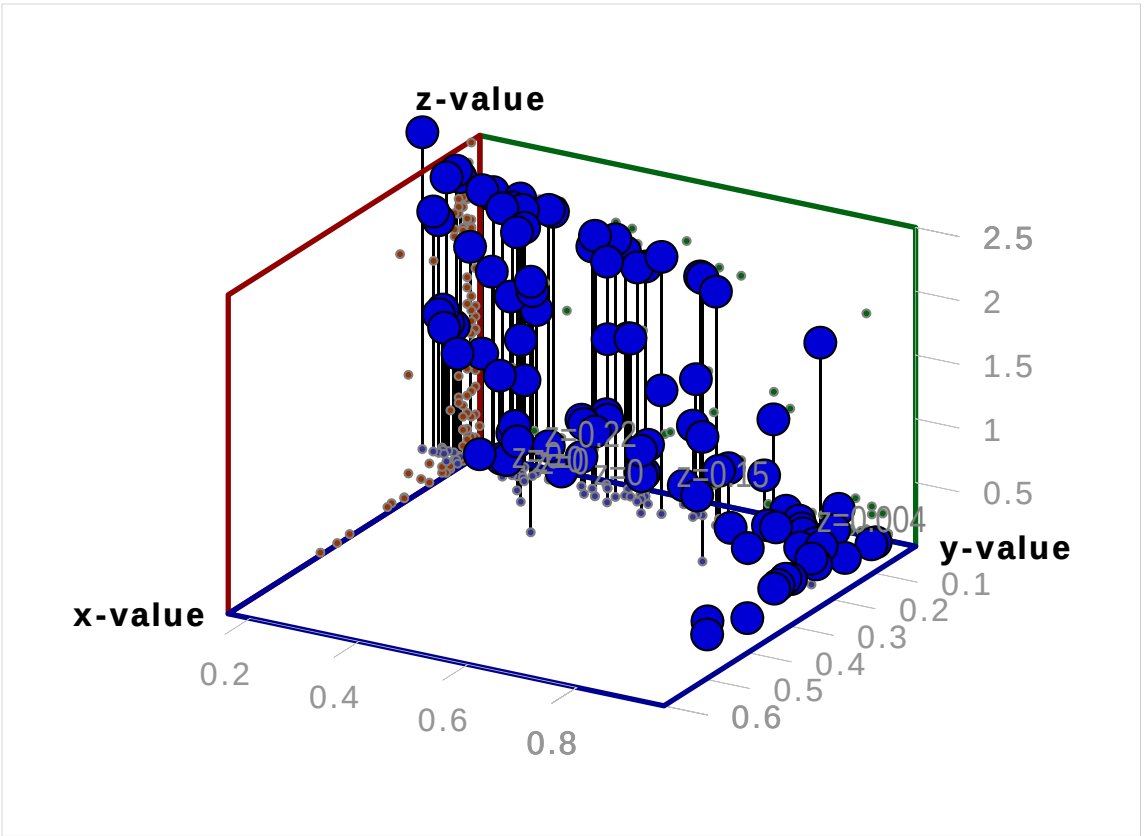

FIGURE 120: RURAL SLAS ECONOMIC MAGNITUDE, DIVERSITY AND FLOOD RATING

A combined rating for both bushfire and flood was used to produce Figure 121, Figure 122 and Figure 123 which produces a similarly shaped plot with more SLAs found in the top left corner due to the combined effect of bushfire and flood.

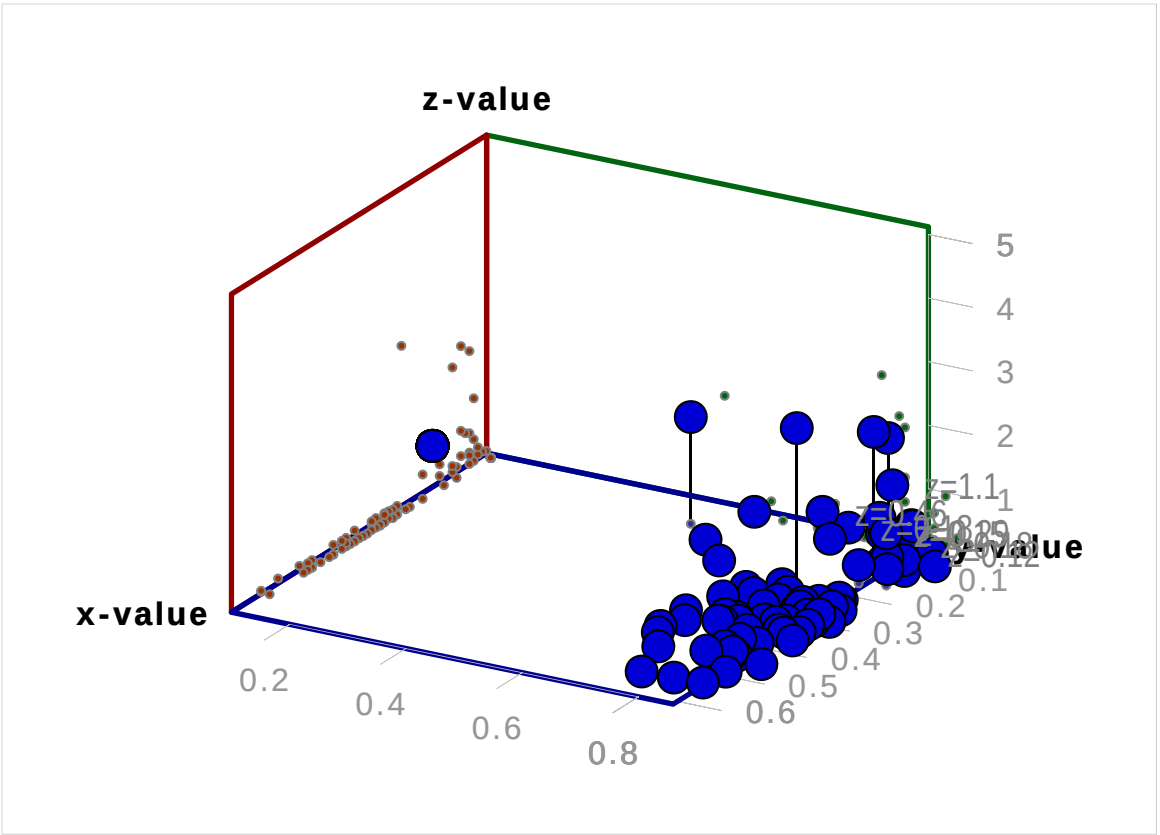

FIGURE 121: URBAN SLAS ECONOMIC MAGNITUDE, DIVERSITY AND COMBINED BUSHFIRE AND FLOOD RATING

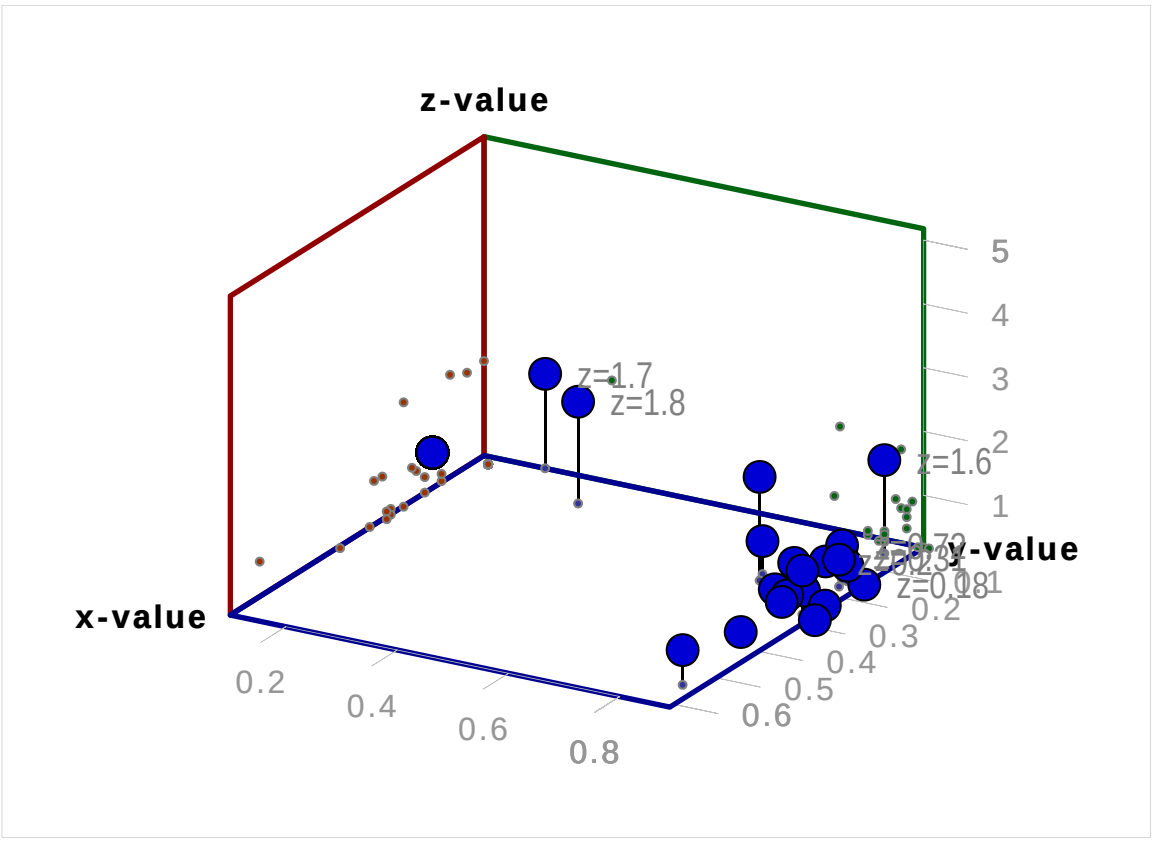

FIGURE 122: PERI URBAN SLAS ECONOMIC MAGNITUDE, DIVERSITY AND COMBINED BUSHFIRE AND FLOOD RATING

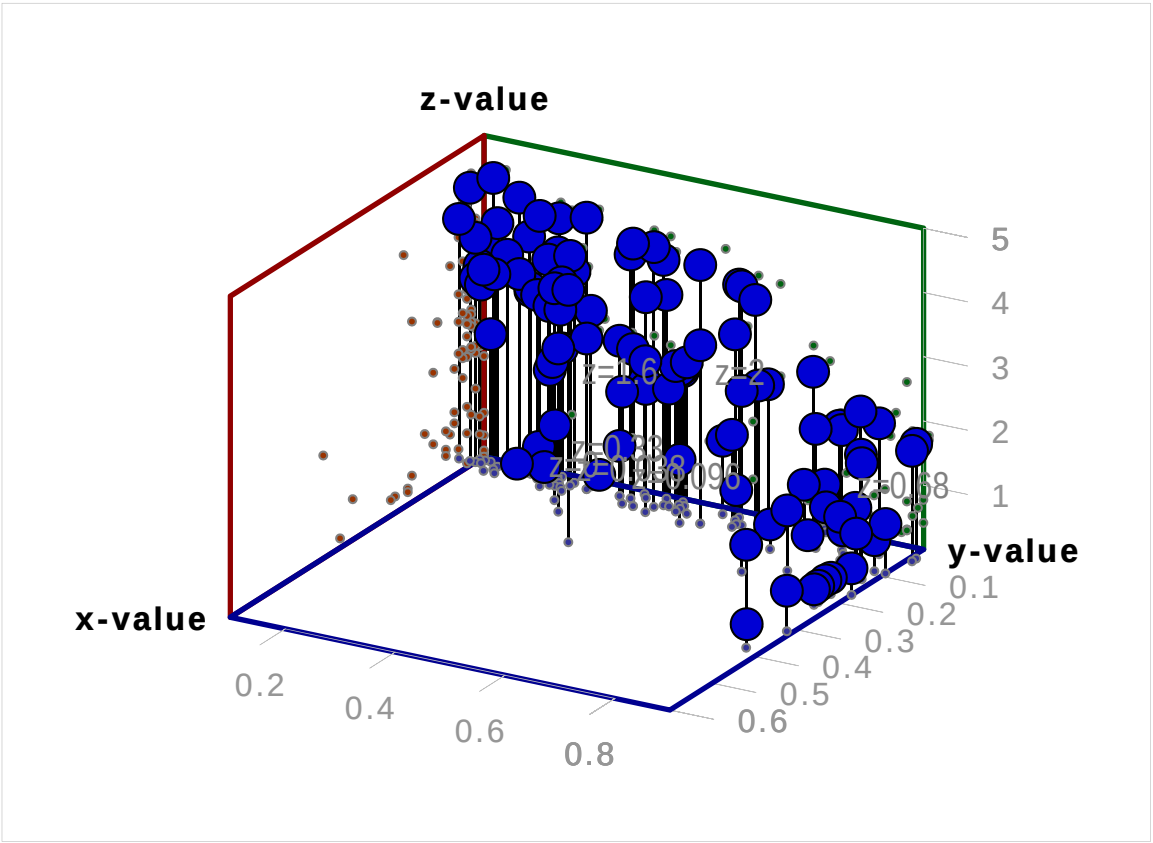

FIGURE 123: RURAL SLAS ECONOMIC MAGNITUDE, DIVERSITY AND COMBINED BUSHFIRE AND FLOOD RATING

6 ECOSYSTEM SERVICES VALUE

Ecosystems provide a range of services that are of fundamental importance to human well-being, health, livelihoods, and survival. A better understanding of the role of ecosystem services emphasises natural assets as critical components of wealth, well-being, and sustainability. Estimating the relative magnitude of the contributions of ecosystem services has been an important part of changing this framing. The value of ecosystem services was not included in the ABS figures. The concepts of ecosystem services flows and natural capital stocks are increasingly useful ways to highlight, measure, and value the degree of interdependence between humans and the rest of nature. This approach is complementary with other approaches to nature conservation, but provides conceptual and empirical tools that the others lack and it communicates with different audiences for different purposes. Estimates of the global accounting value of ecosystem services expressed in monetary units, are mainly useful to raise awareness about the magnitude of these services relative to other services provided by human-built capital at the current point in time. Costanza et al. (2014) estimates show that global ecosystem services have a value of approximately US $124 trillion (2011 values) and these estimates are considered conservative.

The unit values used by Costanza et al. (2014) can be applied in the Victoria setting through the use of the Victorian Land Use Information System which allocates each land parcel into one of 10 categories as listed in Table 4. The value Costanza et al. (2014) assign to agricultural land is based on the work of Wratten et al. (2013) who assign an ecosystem value to this land use separate to that of the market value of products grown on this land.

Land Use Type
Residential
Commercial
Industrial
Extractive Industries
Primary Production
Infrastructure and utilities
Community services
Sport Heritage and Culture
National parks, conservation areas, forest reserves and natural water reserves
Unclassified

TABLE 4: VICTORIAN LAND USE INFORMATION SYSTEM LAND USE CATEGORIES

VLUIS data is aggregated to Local Government Area (LGA) level which is often comprised of two or three SLAs and shares the same external boundaries. The Costanza et al. values are applied to the VLUIS data and aggregated to the LGA level the result is shown in Figure 124.

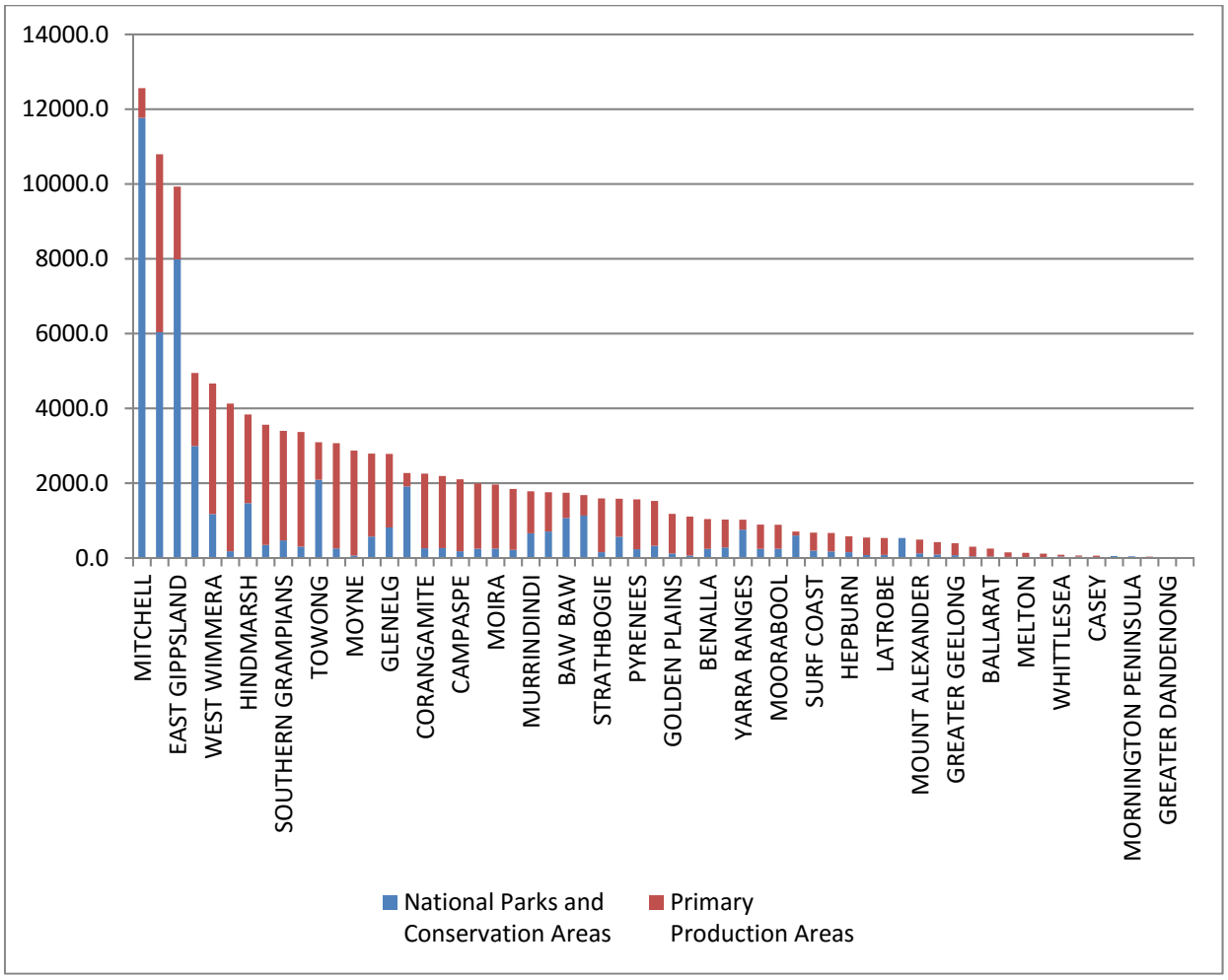

FIGURE 124: ECOSYSTEM VALUES FOR PRIMARY PRODUCTION AREAS AND NATIONAL PARKS AND CONSERVATION AREAS

The combined ecosystem value for primary production and conservation areas is $117.7 billion. This is a substantial figure and represents 40% of the economic activity reported by the ABS in their GSP for Victoria.

The ecosystem value for primary production areas was $68.6 billion and for National Parks and conservation areas it was $49.1 billion. Over 80% of the ecosystem value for National Parks is found in just 12 LGAs as shown in Figure 125, whereas the ecosystem value of primary production areas is more widely spread with 24 LGAs making up 80% of the value as shown in Figure 126 with some areas such as East Gippsland having substantial ecosystem value for both National Parks and Primary Production areas.

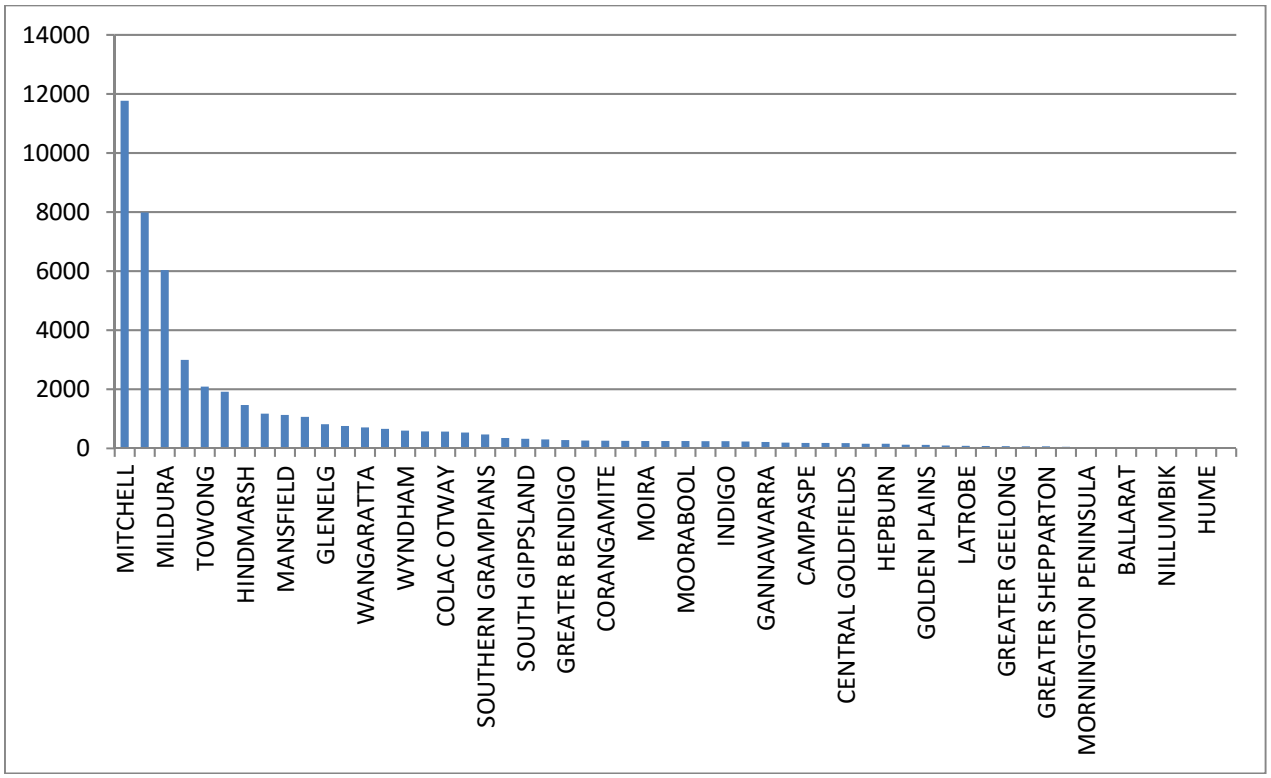

FIGURE 125: ECOSYSTEM VALUE OF NATIONAL PARKS AND CONSERVATION AREAS ($MILLIONS)

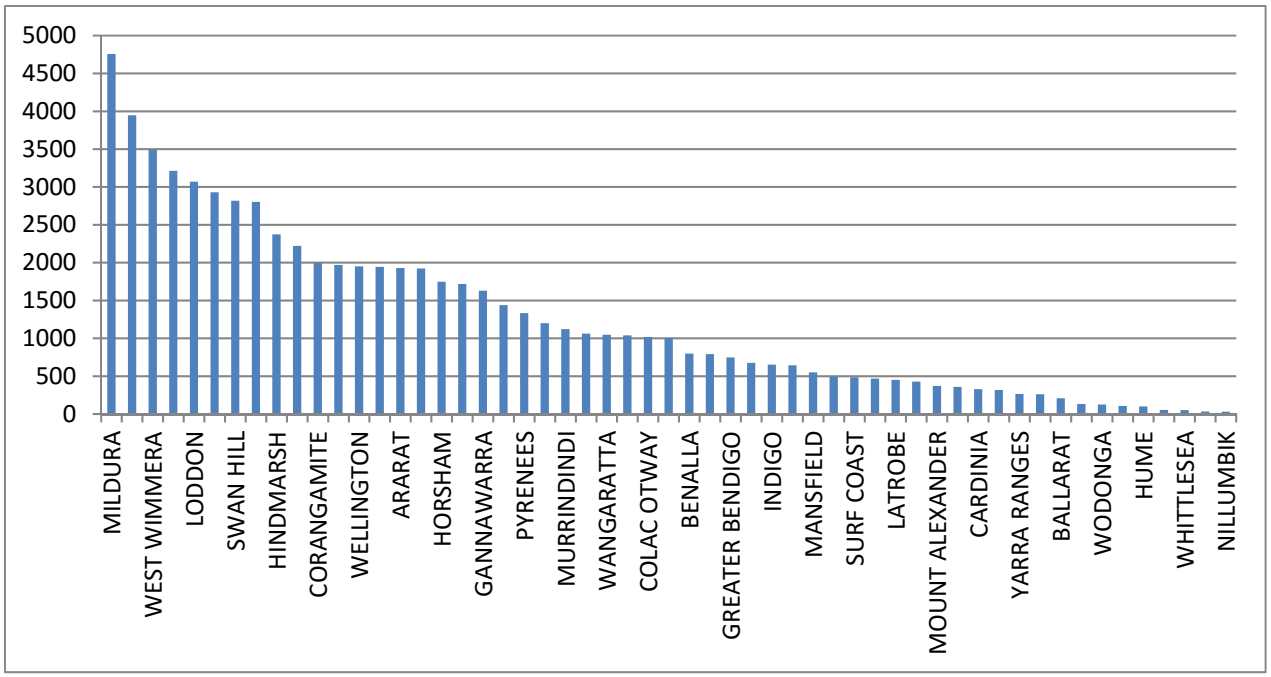

FIGURE 126: ECOSYSTEM VALUE OF PRIMARY PRODUCTION AREAS ($MILLIONS)

The implications of such of large figures are substantial however this does not imply that they should be treated as private commodities that can be traded in private markets. Many ecosystem services are public goods or the product of common assets that cannot (or should not) be privatized. Their value in monetary units is an estimate of their benefits to society expressed in units that are understandable by a broader audience. This can help to raise awareness of the importance of ecosystem services to society and serve as a powerful and essential communication tool to inform better, more balanced decisions regarding trade-offs with policies that enhance GDP but damage ecosystem services.

6.1 Ecosystem Value and Bushfires and Flood Vulnerability

Ecosystem value vulnerability to bushfires and floods is complicated by the reliance of some ecosystems on bushfire and flood for their health and regeneration. No assessment has been made here regarding this aspect, however, the historical number of bushfires and flood is compared with the ecosystem value for each LGA in Figure 127 and Figure 128.

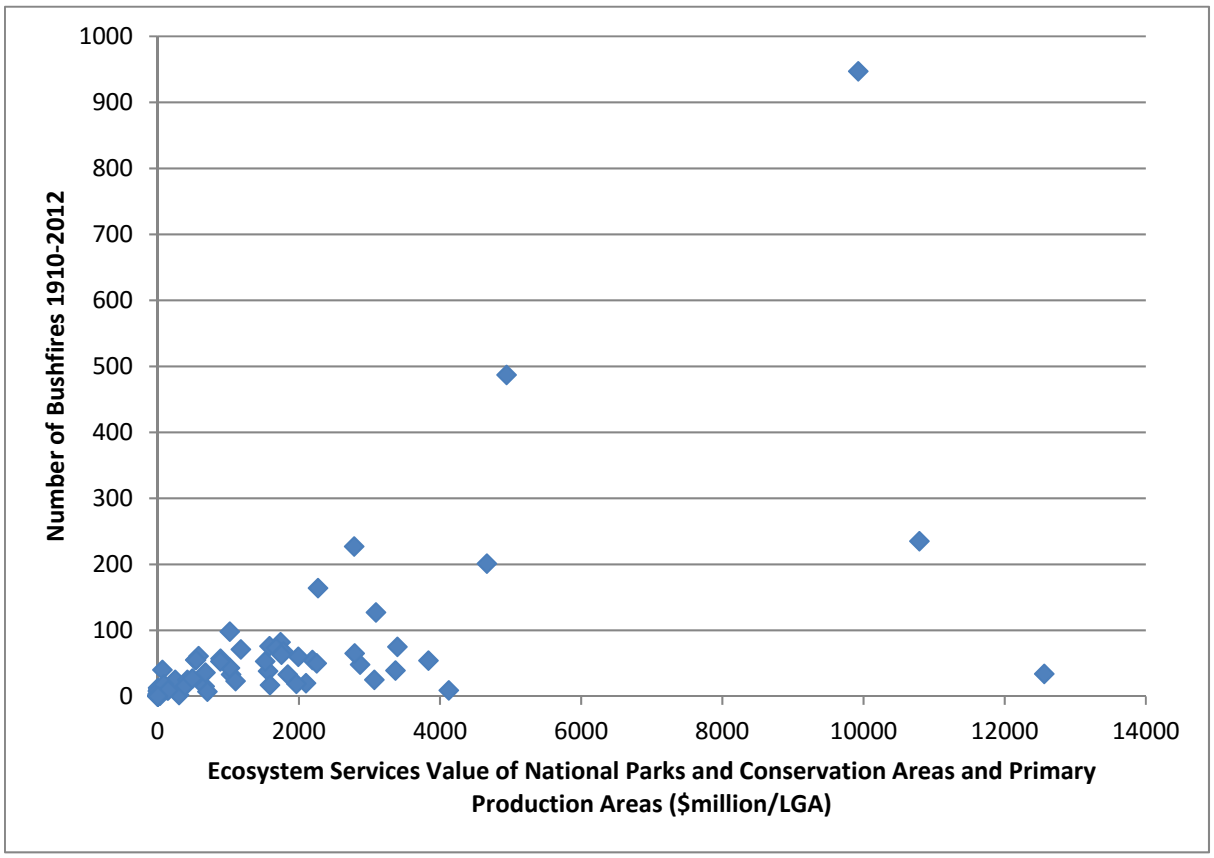

FIGURE 127: ECOSYSTEM VALUE AND NUMBER OF BUSHFIRES 1910–2012 PER LGA

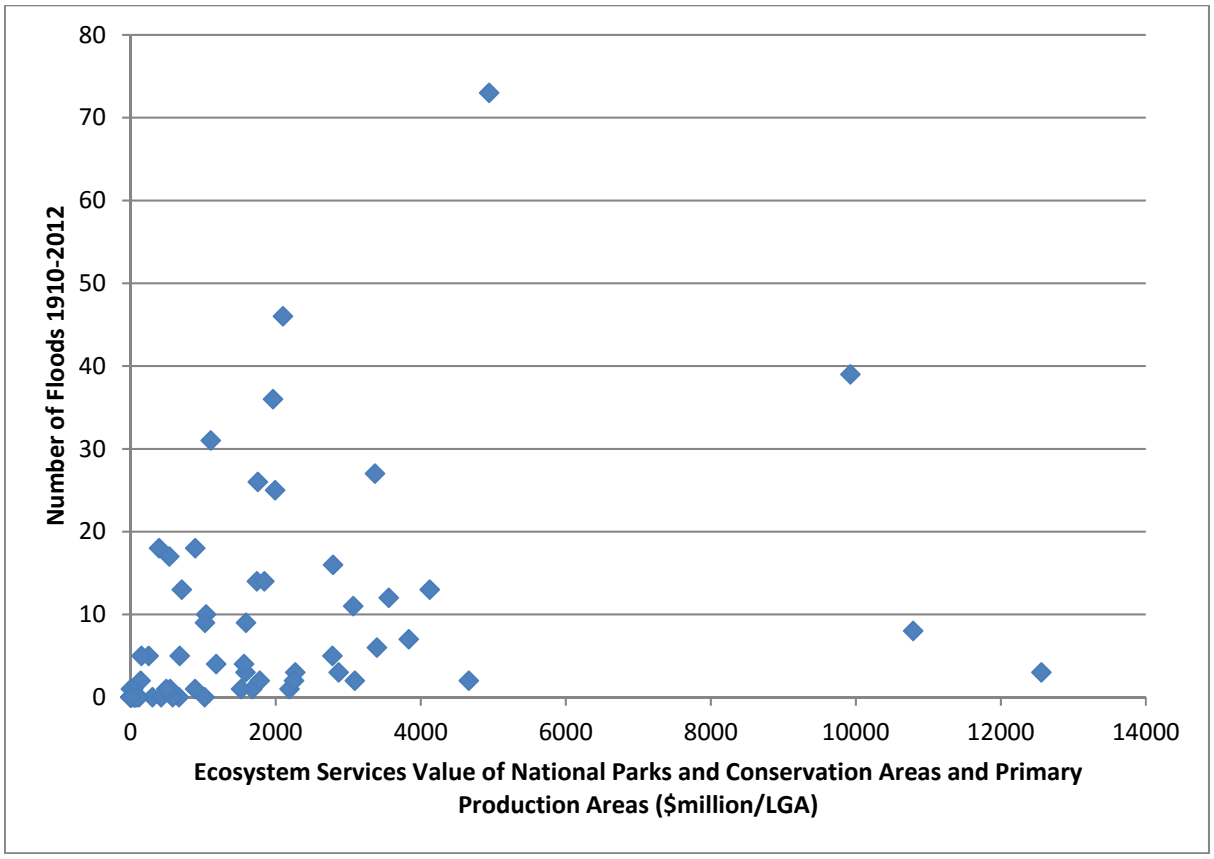

FIGURE 128: ECOSYSTEM VALUE AND NUMBER OF FLOODS 1910–2012 PER LGA

7 SUMMARY AND CONCLUSION

This report constructs a geography of economic vulnerability to bushfire and flood hazards by combining exposure and sensitivity to estimate potential impact. Although adaptive capacity is not explicitly included in the analysis, the inclusion of economic magnitude and diversity can be combined with impact to provide a broad-brush outlook on economic vulnerability at a Statistical Local Area (SLA) scale.

Exposure has been based on historical fire and riverine flood data for each SLA. While historical events are not necessarily an accurate guide to future events, they do give a reasonable indication of exposure for a particular SLA. Sensitivity for each of the 190 economic classes was based on expert judgement and previous work done by Jones and Webb (2008). The sensitivity rankings and exposure were used to form a vulnerability matrix for the 205 SLAs and 190 economic groups. These are summarised in Table 5, Table 6, Table 7 and Table 8.

Exposure	Sensitivity			
	negligible	low	moderate	high
negligible	74331.0	28241.7	14411.4	1827.0
low	70514.6	41526.3	14812.6	4189.3
moderate	9974.8	7252.8	2553.4	2134.2
high	9982.7	8091.0	2704.8	3660.3

TABLE 5: VICTORIA ABSOLUTE INCOME ACCORDING TO FIRE SENSITIVITY AND EXPOSURE

Exposure	Sensitivity			
	negligible	low	moderate	high
negligible	25.1%	9.5%	4.9%	0.6%
low	23.8%	14.0%	5.0%	1.4%
moderate	3.4%	2.4%	0.9%	0.7%
high	3.4%	2.7%	0.9%	1.2%

TABLE 6: VICTORIA PERCENTAGE INCOME ACCORDING TO FIRE SENSITIVITY AND EXPOSURE

Exposure	Sensitivity			
	negligible	low	moderate	high
negligible	133343.1	62201.6	26570.5	4639.7
low	12355.3	8221.7	3041.3	1823.2
moderate	13021.6	8617.8	3026.2	2280.7
high	6083.1	6070.0	1844.1	3067.1

TABLE 7: VICTORIA TOTAL INCOME ACCORDING TO FLOOD SENSITIVITY AND EXPOSURE

Exposure	Sensitivity			
	negligible	low	moderate	high
negligible	45.0%	21.0%	9.0%	1.6%
low	4.2%	2.8%	1.0%	0.6%
moderate	4.4%	2.9%	1.0%	0.8%
high	2.1%	2.0%	0.6%	1.0%

TABLE 8: VICTORIA PERCENTAGE INCOME ACCORDING TO FLOOD SENSITIVITY AND EXPOSURE

Although in percentage terms, the vulnerability of Victoria's economy to bushfires and floods appears relatively low, in dollar terms the numbers run to $8.5 billion and $7.1 billion highly vulnerable, and $14.9 billion and $10.8 billion moderately vulnerable. At present, we can provide a picture as to which sectors, using limited expert opinion, are considered to be the most vulnerable and indicate the relative vulnerabilities between sectors.

As expected, economic income is centred on Melbourne, which has a negligible exposure to bushfires and similar exposure to floods. This leads the overall bushfire vulnerability for the state's income to have relatively low vulnerability to bushfire (high 2.9%, moderate 5% and low 11.7%) as well as flood (high 2.4%, moderate 3.6% and low 7.5%). However, these low figures mask enormous regional variation with some places have over 50% of their income rated as high vulnerability to bushfire and flood. Not surprisingly this occurs in rural areas and the agriculture, forestry and fishery sector being the most highly vulnerable.

This indicates the importance of examining each SLA not just in terms of the size of the economic income but also the percentage each economic sector contributes to the regional economy, for example manufacturing has a relatively low absolute figure in Wodonga and Warrnambool but makes up a very high percentage of the area's economy which indicates its local importance.

This led to analysis of each SLA in terms of its economic diversity and the relationship to vulnerability and bushfires and natural disasters. Greater economic diversity has been shown to boost employment growth and hasten income recovery after natural disasters. An economic diversity index was constructed based on the Hachman Index from 0–1 for each SLA with numbers closer to 1 being more diverse. In Victoria the economic diversity ranged from 0.07 in Loddon North to 0.93 in Bendigo Inner West.

Economic diversity, economic income and an ordinal scale of bushfire and flood vulnerability were then combined to produce 3D scatter plots showing how the three aspects interacted for each SLA. Low economic diversity combined with low economic income and high vulnerability to natural hazards indicates areas with high overall economic vulnerability as these the scatter plots show. Not surprisingly, it is SLAs in rural areas that display these three characteristics. This is particularly true for bushfires and to a lesser extent, floods, as a few urban areas are highly vulnerability to flood.

This report has also assessed ecosystem value for Victoria based on values from Costanza et al. (2014) applied to conservation areas and croplands from the Victorian Land Use Information Service. This information is not aggregated to SLA level but rather Local Government Areas (LGA). Nevertheless, this initial analysis suggests that ecosystem services represents approximately 40% of the Gross State Product as measured by the ABS and hence is a significant figure. No attempt was made to rate the vulnerability of ecosystem services, but these values were plotted vs bushfire and flood per LGA in Figures 122 and 123, which highlights that a comparatively small number of LGAs make up a large percentage of the ecosystem services value.

Overall, this report suggests that analysing vulnerability to bushfires and floods through the lens of economic diversity as well as economic income adds new insight into overall vulnerability of areas on SLA scale.

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