



## Climate Change Adaptation Gap Analysis

### Part Two

#### Document Control

<b>Version</b>	2.2 FINAL
<b>Date</b>	22 January 2018
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<b>Notes</b>	Changes since v2.0 DRAFT (19 January 2018): <ul style="list-style-type: none"><li>- Index page inserted</li><li>- Minor wording change for various statistics</li><li>- Updated formatting</li></ul> May 2021 – hyperlink to appendices added (final page)



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## 1. Introduction

The Department of Environment, Land, Water and Planning (DELWP) is conducting a climate change adaptation regional gap analysis to develop regional priorities for adaptation based on the climate change impacts the region is likely to experience, the needs and values of regional communities, and work undertaken to date. The DELWP Port Phillip Region team have asked the Northern Alliance for Greenhouse Action (NAGA), working with the other metropolitan Alliances (WAGA, SECCCA and EAGA), to deliver part of this analysis by February 2018.

## 2. Scope

### 2.1 Reports

The gap analysis to be delivered by NAGA consists of the following defined pieces of work:

#### Part One

- Regional Snapshot
- Stakeholder Analysis
- Climate Change Impact Assessment

#### Part Two

- Vulnerability Mapping

#### Part Three

- Existing Adaptation Responses

Part One was delivered on 22 December 2017. This report forms the output from Part Two of this work.

### 2.2 Vulnerability Mapping

*Vulnerability Mapping* brings together the outcomes from the *Regional Snapshot* and the *Climate Change Impact Assessment*, to identify populations and assets that are particularly vulnerable to climate change. This is in the form of desktop analysis drawing on the data gathered in the previous sections and based upon the approach to vulnerability assessment mapping used by NAGA in its regional adaptation strategy, *Adaptation in the North*.

## 3. Overview



The Port Phillip region consists of 31 LGAs. This diverse region includes the state capital central business district, growing inner city and suburban urban areas, growth regions, green wedge areas and protected landscapes.

The main climate change impacts for this region will be increased temperatures, rising sea levels and increased extreme weather events. These impacts will play out differently in different geographical areas, such as flooding and tidal inundation from higher sea level rises in coastal areas and higher risk of bushfire on the urban fringe and in rural areas.

The report also identifies communities that are more vulnerable to projected impacts whether they are likely to suffer more due to existing stressors such as poor health, lower socio-economic status or poor housing. Finally, assets that are vital for the functioning of the city, including transport, agriculture, industry and Victoria's unique biodiversity.

#### **4. Populations & Social Factors**

In the context of climate change 'vulnerability is the degree to which a community or an individual is susceptible to, or unable to cope with, the adverse effects of climatic changes. As such, vulnerability is a function of a community or individual's exposure to extreme heat and other climatic variables, their sensitivity to such changes and their ability to adapt.'<sup>1</sup>

Climate change shocks and stresses can create and exacerbate social vulnerability.<sup>2</sup> As such, some communities may be disproportionately impacted by climate change. The following populations, communities and social factors have been identified as being adversely affected by, or affecting vulnerability to climate change. It is important to note that the following communities and populations are heterogeneous, and will not be uniformly impacted by climate change or its outcomes. Further, within each population there may be interactions with other factors (such as socio-economic status) which could make an individual more or less vulnerable to climate change impacts and outcomes.

The distribution and more detailed information for many of the populations discussed below were referred to as demographic data in Report 1 – Regional Snapshot. Where this is the case, it is noted. Due to the potential of climate change to exacerbate or create social vulnerability, several other populations have been included in this report, who have been identified as potentially vulnerable to the impacts of climate change.

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<sup>1</sup> Department of Health and Human Services (DHHS) (2015), Heat Health Plan for Victoria: Protecting health and reducing harm from extreme heat and heatwave, Victorian State Government, Melbourne.

<sup>2</sup> H. Fünfgeld & D. McEvoy (2013), Framing Climate Change Adaptation in Policy Development and Implementation. Available at: <http://www.vcccar.org.au/publication/policy-brief/framing-climate-change-adaptation-in-policy-development-and-implementation>



#### **4.1 Aboriginal and Torres Strait Islander Peoples**

*Refer to Report 1 – Regional Snapshot, section 4.3 for more detail. Population of ATSI peoples by LGA, taken from the 2016 ABS Census, is provided as an Appendices for Report 1.*

Aboriginal and Torres Strait Islander (ATSI) peoples have a higher number of risk factors on average, which contribute to social vulnerability to climate change, than non-Indigenous Victorians. These include higher instances of health conditions, including preventable chronic health conditions; higher instances of mental illness, typically linked to grief, trauma and loss; lower incomes; and less access to quality housing.<sup>3</sup> During emergency management, the higher proportion of ATSI peoples living in remote areas can also increase vulnerability to climate change<sup>4</sup>.

Areas in the Port Phillip region, with a higher proportion of ATSI peoples by LGA when compared to the Victorian average (0.8%), are Frankston (1.0%), Melton (0.9%) and the Yarra Ranges (0.9%)<sup>5</sup>.

#### **4.2 Culturally and Linguistically Diverse Communities**

*Refer to Report 1 – Regional Snapshot, section 4.3 for more detail. Percentage of main language spoken other than English, and English proficiency is provided by LGA, taken from the 2016 ABS Census is provided at Appendix C from Report 1.*

Culturally and linguistically diverse communities (CALD) may be more vulnerable to climate shocks and stressors, as they proportionally may be more likely to lack support networks, and lack an understanding of risk (for example, to extreme heat, or in emergency events).<sup>6</sup> This could be due to a lack of exposure to particular events, and a lack of understanding as to how to manage risks (for example, during extreme heat). Refugees and newly arrived migrants are also more likely to be in poor quality housing and have low socioeconomic status, contributing to vulnerability to climate change.<sup>7</sup>

Emergency communications, and communications of risk, are also a consideration for people who speak another language at home, and English not well or not at all. The five LGAs with

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<sup>3</sup> VicHealth (2013), Aboriginal Health in Victoria Research Summary: Identifying the determinants of physical and mental health.

<sup>4</sup> VCOSS (2014), Disaster and Disadvantage: Social Vulnerability in Emergency Management, Melbourne

<sup>5</sup> ABS Quickstats 2016

<sup>6</sup> Hansen, A, Bi, P, Saniotis, A, Nitschke, M, Benson, J, Tan, Y, Smyth, V, Wilson, L & Han, G-S (2013), Extreme heat and climate change: Adaptation in culturally and linguistically diverse (CALD) communities, National Climate Change Adaptation Research Facility, Gold Coast, 101 pp.

<sup>7</sup> VCOSS (2014), Disaster and Disadvantage: Social Vulnerability in Emergency Management, Melbourne.

the highest proportion of residents who speak another language, and English not well or not at all, are listed below. The Victorian average is 4.5%.

- Greater Dandenong 25, 541 persons (16.8%)
- Brimbank: 25,989 persons (13.4%)
- Maribyrnong: 7,576 persons (9.2%)
- Monash: 15, 254 persons (8.4%)
- Hume: 15,972 persons (8.1%)

PEOPLE NOT FLUENT IN ENGLISH - People aged 5 years and over who did not speak English well or at all  
As a percentage of the total population aged 5 years and over

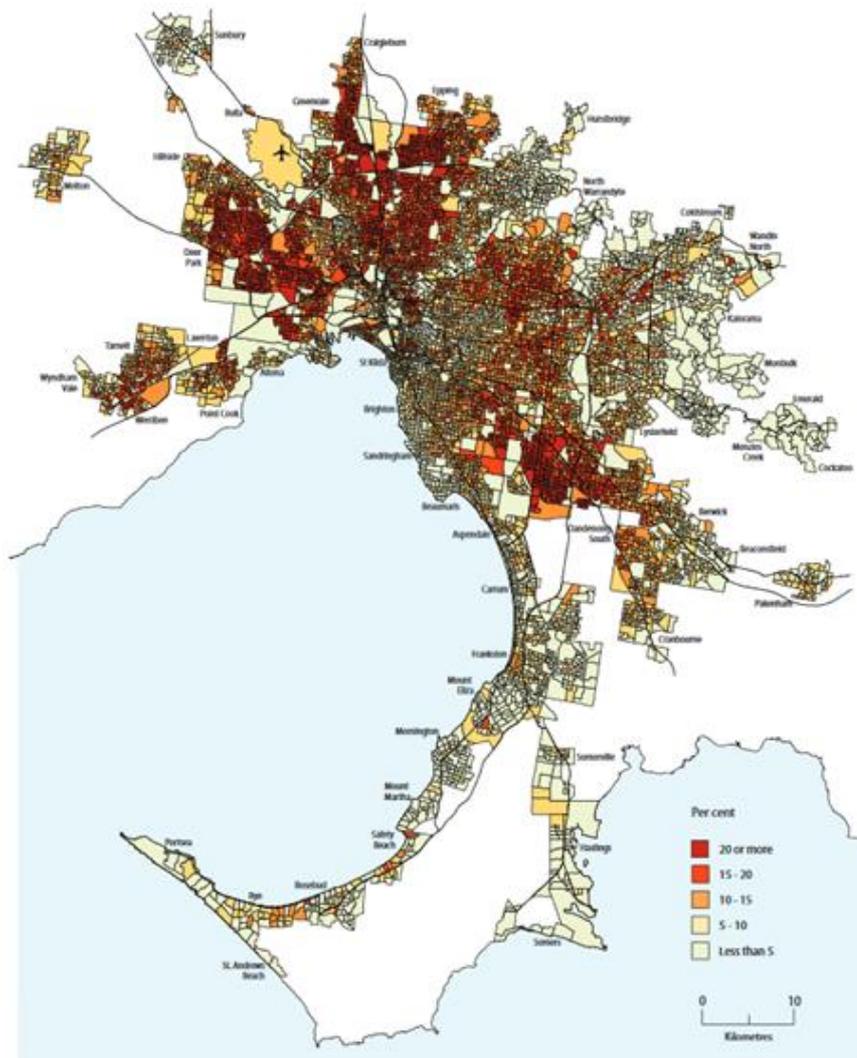


Image 1 People not fluent in English<sup>8</sup>

<sup>8</sup> DPCD (2012), Social Atlas of Melbourne, available at: [https://www.planning.vic.gov.au/data/assets/pdf\\_file/0021/29226/People-Not-Fluent-In-English.pdf](https://www.planning.vic.gov.au/data/assets/pdf_file/0021/29226/People-Not-Fluent-In-English.pdf), accessed 19.01.17.



To determine service delivery for migrant communities, the ABS recommends combining Year of arrival data, with Birthplace, Religion, and Language Spoken at home. Please see Appendix A for this data by LGA.

### **4.3 Age of population**

*Refer to Report 1 – Regional Snapshot, section 4.2 for more detail. Age structure by LGA, taken from the 2016 ABS census, is provided as an Appendices to Report 1.*

Age can increase vulnerability to both climate shocks and stressors. Babies and the very young, as well as older people, are more vulnerable to the effects of heat – particularly extreme heat and heatwave events, and are more susceptible to environmental hazards such as vector-borne diseases, a threat exacerbated under conditions of strained water and food resources<sup>9</sup>.

Due to changes in physiology, older people may be less mobile during emergency situations, and babies and children may be at higher risk during emergency situations as a result of their developmental level<sup>10</sup>. According to VCOSS, children and young people may be particularly vulnerable in emergency situations if they are: in out-of-home care, have child protection considerations, and have parents who are refugees or migrants<sup>11</sup>.

Areas with the highest number of residents aged over 65 years are Mornington Peninsula (38,134 persons), Monash (31,384 persons) and Casey (30,686 persons). Of particular note is the Eastern Metro region, which is facing pressures due to an ageing population, a trend set to continue to 2031<sup>12</sup>.

Areas with the highest number of residents, aged 0-9 years, are Casey (47,079 persons), Wyndham (39,780 persons), and Hume (30,299 persons)<sup>13</sup>.

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<sup>9</sup> D. Filiberto, E. Wethington, K. Pillemer, N. M. Wells, M. Wysocki & J. True Parise (2008), 'Older People and Climate Change: Vulnerability and Health Effects,' *Generations*, 33(4), pp. 19-25.

<sup>10</sup> VCOSS (2014), *Disaster and Disadvantage: Social Vulnerability in Emergency Management*, Melbourne

<sup>11</sup> Ibid

<sup>12</sup> DELWP (2016a), *Victoria in Future*, Victorian State Government.

<sup>13</sup> ABS TableBuilder: Cultural Diversity 2016



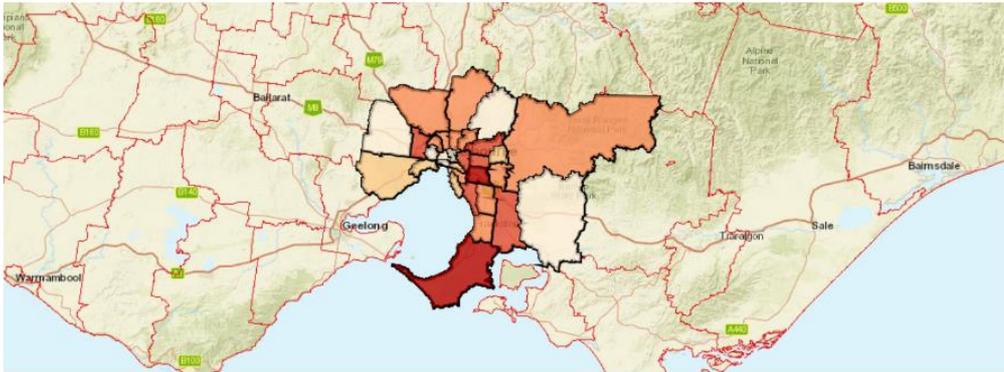
NORTHERN ALLIANCE FOR GREENHOUSE ACTION



**AGE5P - Age in Five Year Groups by LGA (UR)**

Counting Persons, Place of Usual Residence  
2016 Census - Cultural Diversity

Total	
31,383-38,134	Dark Red
24,704-31,383	Red-Orange
18,741-24,704	Orange
13,125-18,741	Light Orange
7,993-13,125	Yellow



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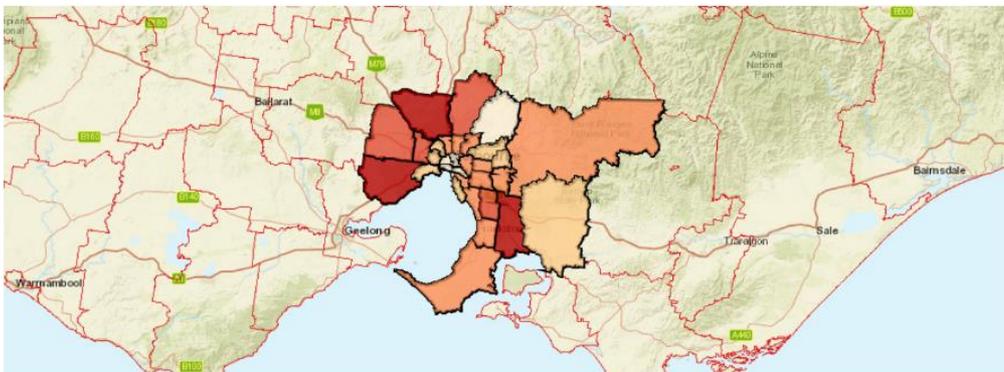
Image 2: Number of residents aged over 65 years



**AGE10P - Age in Ten Year Groups by LGA (UR)**

Counting Persons, Place of Usual Residence  
2016 Census - Cultural Diversity

0-9 years	
30,299-47,079	Dark Red
19,329-30,299	Red-Orange
15,338-19,329	Orange
9,982-15,338	Light Orange
6,854-9,982	Yellow



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Image 3: Number of residents aged 0-9 years



These maps show the breakdown by aged over 65 years, and aged 0-4 years:

[https://www.planning.vic.gov.au/data/assets/pdf\\_file/0016/29221/People-Aged-65-Years-and-Over.pdf](https://www.planning.vic.gov.au/data/assets/pdf_file/0016/29221/People-Aged-65-Years-and-Over.pdf)

[https://www.planning.vic.gov.au/data/assets/pdf\\_file/0022/29218/People-Aged-0-4-Years.pdf](https://www.planning.vic.gov.au/data/assets/pdf_file/0022/29218/People-Aged-0-4-Years.pdf)

#### 4.4 Health & Wellbeing

Health region	Local Government Areas
Eastern	Boroondara, Manningham, Maroondah, Monash, Knox, Whitehorse, Yarra Ranges
North & West	Banyule, Brimbank, Darebin, Hobsons Bay, Hume, Maribyrnong, Moreland, Moonee Valley, Melbourne, Melton, Nillumbik, Whittlesea, Wyndham, Yarra
Southern	Bayside, Cardinia, Casey, Frankston, Glen Eira, Greater Dandenong, Kingston, Mornington Peninsula, Port Phillip, Stonnington

Table 1: Metropolitan health regions

Individuals who are particularly vulnerable to the impacts of heat, in relation to their physical health, include: people with a medical condition such as heart disease, high blood pressure, diabetes, cancer or kidney disease; people taking medications that may affect the way the body reacts to heat; people with an illness or infection that causes dehydration or fever; people with health conditions that impair sweating; people who are overweight or obese and people with low cardiovascular health.<sup>14</sup>

The Public Health Information Development Unit (PHIDU) map type 2 diabetes,<sup>15</sup> by ABS Statistical Area 2 (see image 6). Smoking rates also pose a health risk,<sup>16</sup> and given that smoking poses a health risk overlapping with identified risk factors above, smoking rates are also mapped in image 4, by Statistical Area 2. For the health risk factors of smoking and

<sup>14</sup> Department of Health and Human Services (DHHS) (2015), Heat Health Plan for Victoria: Protecting health and reducing harm from extreme heat and heatwave, Victorian State Government, Melbourne.

<sup>15</sup> Diabetes: Modelled estimates of chronic diseases: type 2 diabetes. SA2 data for this indicator are derived from Population Health Area (PHA) data. PHAs are comprised of one or more whole SA2s.

<sup>16</sup> Risk factor: Modelled estimates of health risk factors: weight and smoking by SA2, 2011-13. SA2 data for these indicators are derived from Population Health Area (PHA) data. PHAs are comprised of one or more whole SA2s.



obesity, there is a higher proportion of residents in the North and Western Metropolitan area who smoke, and who are pre-obese and obese.

The North and West Metropolitan regions proportionally have poorer health and wellbeing outcomes across several measures.

Reduced health or wellbeing is shaded red in the tables below, while increased health or wellbeing is shaded green. Where findings are similar, they are not shaded.

#### 4.4.1 Smoking

Smoking is the most significant modifiable health risk factor.<sup>17</sup> Smokers are more likely to suffer respiratory and cardiovascular problems, which are among the leading causes of death during extreme heat events, and can lead to other health problems including cancer, which can make individuals more vulnerable to extreme heat.<sup>18</sup>

Daily smoking rates are linked to income. Proportionally, increasing household income sees declining smoking rates for both men and women. The North and West Metropolitan region has the highest instance of current smokers, with the other Metropolitan regions falling below the Victorian average.<sup>19</sup>

Health region	%
Victoria	18.5
All metropolitan regions	18.5
Eastern Metropolitan	13.9
North & West Metropolitan	21.9
Southern Metropolitan	17.0

Table 2: Current Smokers

<sup>17</sup> Department of Health and Human Services (DHHS) (2017), Victorian Population Health Survey (2015): Selected Survey Findings, Victorian State Government

<sup>18</sup> Ibid; Department of Health and Human Services (DHHS) 2015, Heat Health Plan for Victoria: Protecting health and reducing harm from extreme heat and heatwave, Victorian State Government, Melbourne.

<sup>19</sup> Department of Health and Human Services (DHHS) (2017), Victorian Population Health Survey 2015: Selected Survey Findings, Victorian State Government

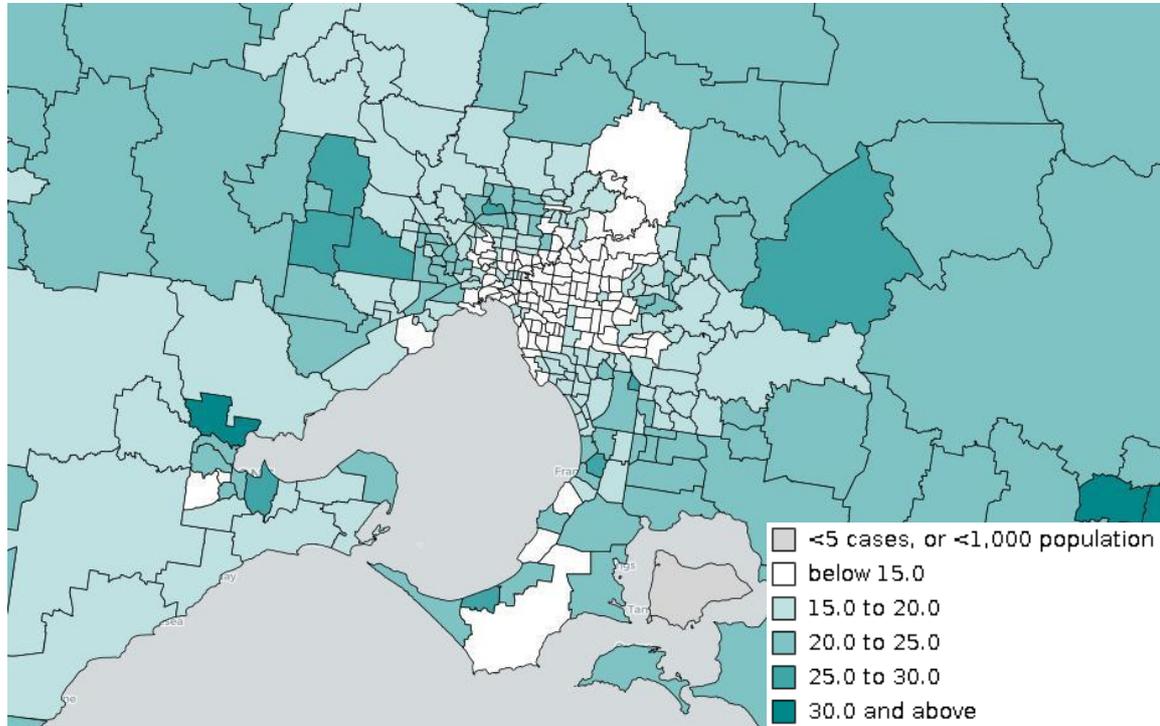


Image 4: Health risk factor - Smoking rates<sup>20</sup>

#### 4.4.2 Hypertension (High Blood Pressure)

Hypertension 'is a chronic medical condition in which the blood pressure in the arteries is elevated,' and is the second-most significant modifiable health risk factor (to smoking, see above)<sup>21</sup>. The North and West Metropolitan regions have the highest rates of people diagnosed with hypertension (25.5%) of the Metropolitan regions, though this is similar to the Victorian average (25.6%).

#### 4.4.3 Obesity

Metropolitan Melbourne has significantly lower rates of obesity, when compared to rural Victoria.<sup>22</sup> The North and West Metropolitan regions have higher than average levels of people who are pre-obese and obese, when compared with the Victorian average.

<sup>20</sup> Public Health Information Development Unit (PHIDU) 2013

<sup>21</sup> Department of Health and Human Services (DHHS) (2017), Victorian Population Health Survey 2015: Selected Survey Findings, Victorian State Government

<sup>22</sup> Ibid.

Health region	Pre-Obese %	Obese %
Victoria	30.1	19.1
All metropolitan regions	30.0	18.3
Eastern Metropolitan	27.0	17.6
North & West Metropolitan	32.9	19.4
Southern Metropolitan	30.1	17.2

Table 3: Health Risk Factor: Obesity

As shown in image 5, the inner Metropolitan region has proportionally fewer cases of obesity than the outer Metropolitan regions.

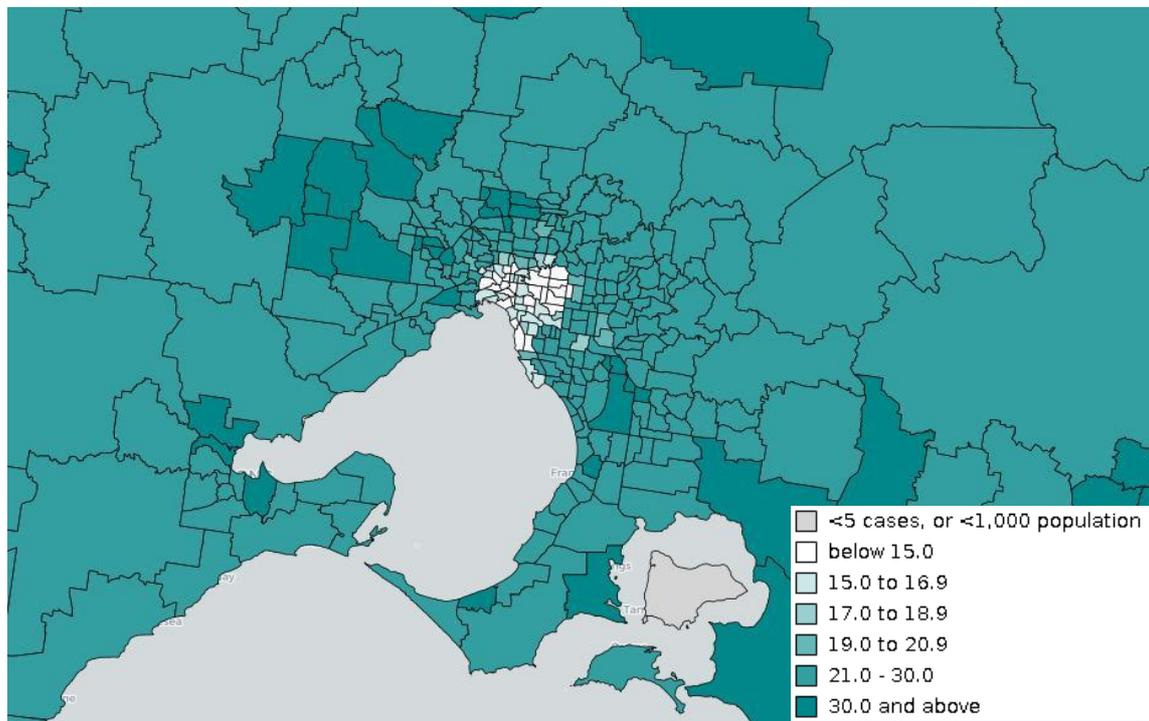


Image 5: Health risk factor - Obesity<sup>23</sup>

<sup>23</sup> Public Health Information Development Unit (PHIDU) 2013



#### 4.4.4 Diabetes

Diabetes is a common chronic medical condition, ‘characterised by high blood glucose (sugar) levels.’<sup>24</sup> Type 2 Diabetes is the most common form of diabetes.<sup>25</sup> A higher proportion of persons in the North and West Metropolitan region have Type 2 diabetes.

Health region	%
Victoria	6.0
All metropolitan regions	6.3
Eastern Metropolitan	4.4
North & West Metropolitan	7.7
Southern Metropolitan	6.6

Table 4: Health risk factor: Diabetes

<sup>24</sup> Department of Health and Human Services (DHHS) (2017), Victorian Population Health Survey 2015: Selected Survey Findings, Victorian State Government p,175

<sup>25</sup> Ibid

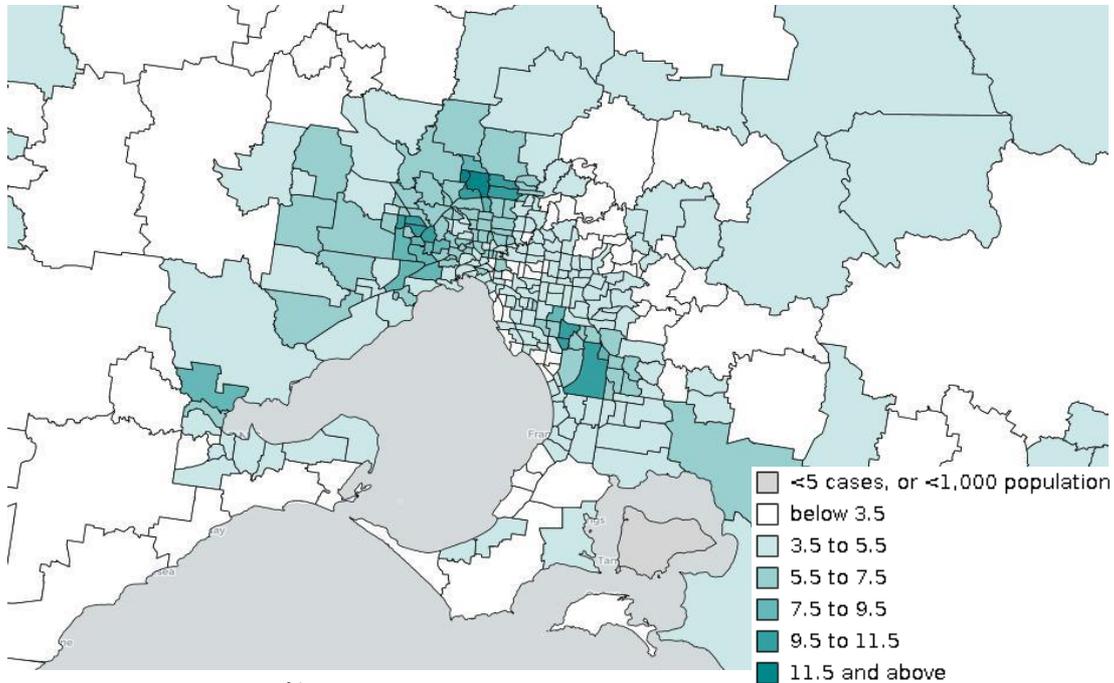


Image 6: Type 2 Diabetes<sup>26</sup>

#### 4.4.5 Alcohol and other Drugs

People with problematic use of alcohol and other drugs are more vulnerable to heat – particular heatwaves and extreme heat.<sup>27</sup> During emergency situations, people with problematic use of alcohol and other drugs may have impaired decision-making abilities.<sup>28</sup> Episodes of heavy drinking may place the person or others at risk of injury, and regular excessive drinking can place people at risk of chronic ill-health (a further risk factor for climate change impacts such as heat impact).<sup>29</sup>

Alcohol consumption, at levels considered harmful, is proportionally lower for the Port Phillip region, than for the Victorian rural regions. However, alcohol consumption at harmful levels is highest in the Eastern metropolitan region (60.4%), where rates of harmful drinking are above the Victorian average (58.6%).<sup>30</sup>

<sup>26</sup> Public Health Information Development Unit (PHIDU) 2013

<sup>27</sup> Department of Health and Human Services (DHHS) 2015, Heat Health Plan for Victoria: Protecting health and reducing harm from extreme heat and heatwave, Victorian State Government, Melbourne. P. 22.

<sup>28</sup> VCOSS (2014), Disaster and Disadvantage: Social Vulnerability in Emergency Management, Melbourne

<sup>29</sup> Department of Health and Human Services (DHHS) (2017), Victorian Population Health Survey 2015: Selected Survey Findings, Victorian State Government

<sup>30</sup> Here measured as increased lifetime risk of alcohol related harm. The National Health and Medical Research Council publishes guidelines relating to alcohol consumption. Alcohol consumption which exceeds this consumption is considered to increase risk of harm, either in the immediate, short-term, or increased lifetime risk (DHHS 2017).



Among both men and women, prevalence of lifetime risk of alcohol related harm increased with increasing household income.<sup>31</sup>

#### **4.4.6 Mental health**

Provided essential services are not disrupted, people with mental health issues typically function well following a disaster. However, some people with serious long-term mental health issues such as schizophrenia, bipolar and dementia may 'be vulnerable to rapid, unplanned changes in their environment such as an emergency event.'<sup>32</sup> People with a history of mental illness may be more likely to relapse or develop stress-related symptoms, and people with post-traumatic stress disorder may be more vulnerable in a disaster, as it could trigger or exacerbate symptoms.<sup>33</sup>

One measure of mental health is the Kessler Psychological Distress Scale 10 Items (K10). The PHIDU map the estimated number of people aged 18 years and over with high or very high psychological distress by SA2, from 2011 to 2013<sup>34</sup> (see Image 7).

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<sup>31</sup> Department of Health and Human Services (DHHS) (2017), Victorian Population Health Survey 2015: Selected Survey Findings, Victorian State Government

<sup>32</sup> VCOSS (2014), Disaster and Disadvantage: Social Vulnerability in Emergency Management, Melbourne

<sup>33</sup> Ibid

<sup>34</sup> Psychological distress: Estimated number of people aged 18 years and over with high or very high psychological distress by SA2, from 2011 to 2013. SA2 data for this indicator are derived from Population Health Area (PHA) data. PHAs are comprised of one or more whole SA2s.

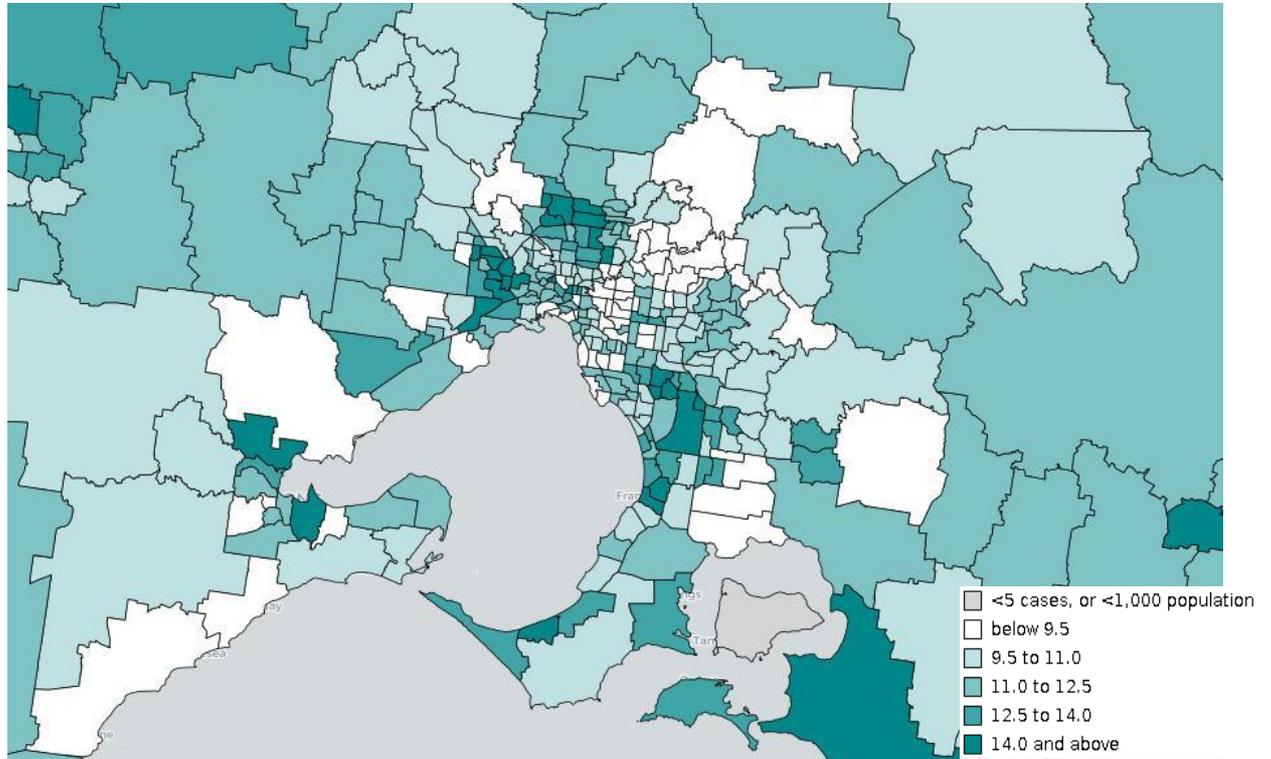


Image 7: Psychological Distress<sup>35</sup>

A higher proportion of adults in the North and Western Metropolitan region had a high or very high levels of psychological distress (see Table 5).<sup>36</sup>

<sup>35</sup> Public Health Information Development Unit (PHIDU) 2013

<sup>36</sup> Department of Health and Human Services (DHHS) (2017), Victorian Population Health Survey 2015: Selected Survey Findings, Victorian State Government



Health region	%
Victoria	17.3
All metropolitan regions	17.6
Eastern Metropolitan	14.1
North & West Metropolitan	20.3
Southern Metropolitan	17.5

Table 5: High or Very High Levels of Psychological Distress (K10: 22+)

#### 4.4.7 Subjective Wellbeing

Wellbeing is typically equated with happiness, though it is a broader concept which encompasses ‘asking people about their feelings,’ known as subjective wellbeing.<sup>37</sup> Reduced wellbeing is associated with vulnerability to disasters (including the recovery period) and increased wellbeing is associated with greater resilience, and is a protective factor for individuals and communities identified by the Australian Red Cross.<sup>38</sup>

The Victorian Population Health Survey takes measures four indicators for subjective wellbeing.<sup>39</sup> Against all four indicators, the North and West Metropolitan regions had reduced wellbeing, when compared with the other metropolitan regions.

#### 4.5 People with a Disability

*Refer to Report 1 – Regional Snapshot, section 4.2 for more detail. Core Activity need for assistance by Metropolitan Inner-Middle and Metropolitan Growth Area, taken from the 2016 ABS census, is provided in Report 1, at section 4.2.*

People with a disability are a heterogeneous group, and will be impacted in different ways by climate shocks and stressors. People with a disability have been identified by the DHHS as

<sup>37</sup> Department of Health and Human Services (DHHS) (2017), Victorian Population Health Survey 2015: Selected Survey Findings, Victorian State Government

<sup>38</sup> Department of Communities, Child Safety and Disability Services (2017), Toolkit - People with vulnerabilities in disasters, available at: <https://www.qld.gov.au/community/documents/disasters-emergencies/supporting-people-with-vulnerabilities-toolkit.pdf>. Accessed 19.01.17

<sup>39</sup> Department of Health and Human Services (DHHS) (2017), Victorian Population Health Survey 2015: Selected Survey Findings, Victorian State Government pp. 162-170, for information regarding subjective wellbeing indicators.

potentially more vulnerable to heat events,<sup>40</sup> and by VCOSS during emergency situations.<sup>41</sup> This could be due to a range of factors, such as reliance on carers and service delivery (where service delivery may be disrupted due to extreme weather events), a potential reliance on medication and aids, and potential decreased mobility. Communications of emergency and climatic risk may also need to be tailored for people with a disability.

The ABS collect data for people who require assistance for their core activities. This category defines ‘core activity need for assistance’ as someone who requires assistance during day to day activities for any or all of the following: self-care, body movements or communication.

LGAs with the highest number of residents who need assistance for their core activities are:

- Casey (14,144 persons)
- Brimbank (12,473 persons)
- Hume (12,429 persons)
- Whittlesea (11,264 persons)<sup>42</sup>



Image 8: Core activity

<sup>40</sup> Department of Health and Human Services (DHHS) (2015), Heat Health Plan for Victoria: Protecting health and reducing harm from extreme heat and heatwave, Victorian State Government, Melbourne.

<sup>41</sup> VCOSS (2014), Disaster and Disadvantage: Social Vulnerability in Emergency Management, Melbourne

<sup>42</sup> ABS TableBuilder: Cultural Diversity 2017



#### 4.6 Housing Tenure

*Refer to Report 1 – Regional Snapshot, section 4.7 for more detail. by LGA, taken from the 2016 ABS census, is provided as an Appendices to Report 1.*

Housing tenure impacts vulnerability to climate change impacts, and individual capacity to adapt to climate change impacts in different ways. People in insecure housing are more vulnerable in emergency situations, and may lose their housing as a result of emergency situations.<sup>43</sup> Further, people in insecure housing, particularly people sleeping rough and in temporary shelters, may not be factored into emergency plans and emergency communications.<sup>44</sup> Private adaptation measures on a property level, such as flood-proofing housing, is also less viable for people renting their homes. According to VCOSS, people in poor quality housing may also be living in areas more prone to disaster, such as floodplains.<sup>45</sup>

The Melbourne StreetCount collects data on people sleeping rough in the City of Melbourne, through direct observation and verbal survey. Between 2014 and 2016, people sleeping rough increased from 142 to 247 persons (+74%), with an increase in people observed sleeping rough from 59 to 127 (+115%).<sup>46</sup>

The lowest number of outright home ownership (increasing vulnerability to climate change) are in:<sup>47</sup>

- Maribyrnong (6,551 dwellings)
- Yarra (7,243 dwellings)
- Cardinia (7,626 dwellings)

The number of dwellings that are owned is mapped in image 9.

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<sup>43</sup> VCOSS (2014), Disaster and Disadvantage: Social Vulnerability in Emergency Management, Melbourne p.18

<sup>44</sup> Ibid

<sup>45</sup> Ibid

<sup>46</sup> City of Melbourne StreetCount 2016, available at:

<https://www.melbourne.vic.gov.au/SiteCollectionDocuments/streetcount-2016-final-report.pdf>

Accessed 19.01.18.

<sup>47</sup> ABS TableBuilder: Selected Dwelling Characteristics (2016)

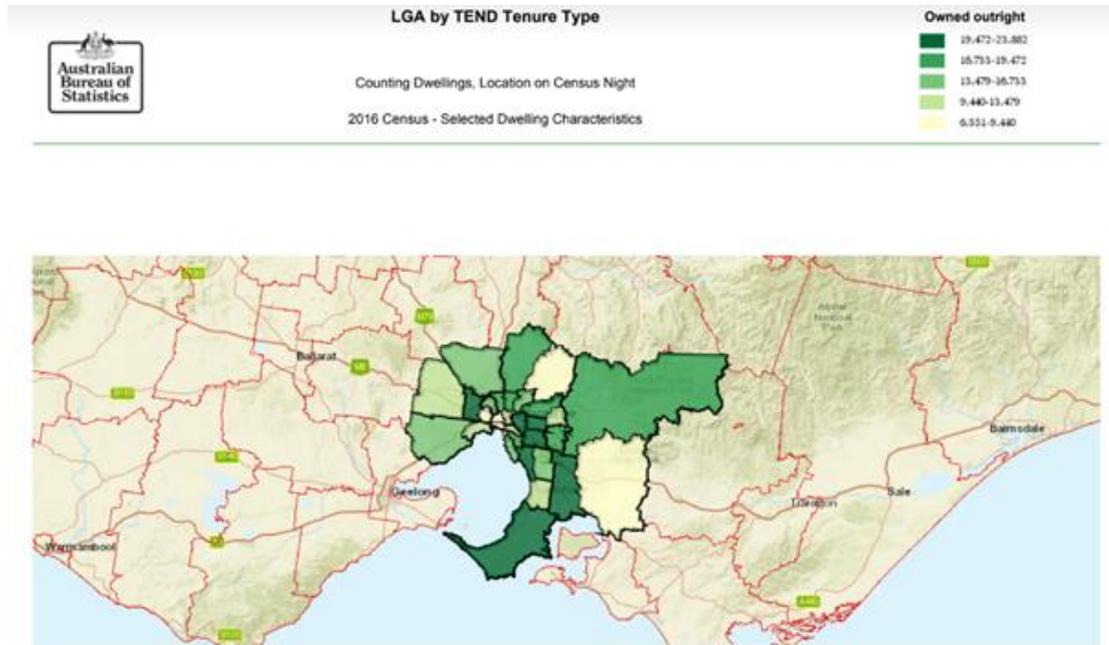


Image 9: Housing owned outright

The highest number of rented dwellings are in the LGAs of:

- Melbourne (38,401)
- Port Phillip (24,506)
- Moreland (22,837)

These are mapped in image 10.

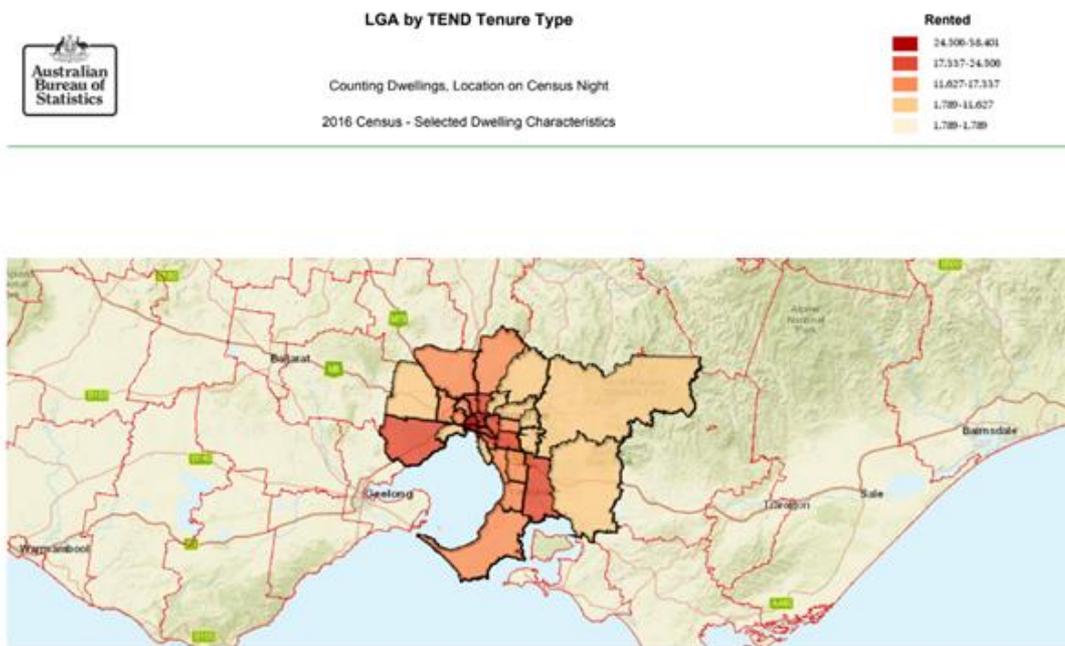


Image 10 Rented dwellings

The highest number of low income households with mortgage stress (increasing vulnerability to climate change) ranked by percentage are in (the rest of Victoria is 9.5%):<sup>48</sup>

- Greater Dandenong 2,687 (18.2%)
- Brimbank 3,525 (16.7%)
- Hume 4,557 (16.7%)

The highest number of low income households with rental stress (increasing vulnerability to climate change) ranked by percentage are in (the rest of Victoria is 30.4%):

- Hume 5,052 (34.7%)
- Melbourne 12,915 (33.6%)
- Greater Dandenong 5,476 (32.8%)

*Links to these reports on rental and mortgage stress can be found at Appendix B.*

#### **4.7 Socio-economic status**

*Refer to Report 1 – Regional Snapshot, section 4.2 for more detail. SEIFA by LGA, taken from the 2011 ABS census, is provided as an Appendices to Report 1.*

Socio-economic disadvantage can increase vulnerability to climate change shocks and stressors both directly and indirectly. People from a low socio-economic background may be

<sup>48</sup> Public Health Information Development Unit (PHIDU) InstantAtlas (2017)



more likely to live in disaster prone areas and are less likely to be insured; they are more likely to be employed casually and informally, and therefore more vulnerable to disruptions to work caused by infrastructure damage, road closures, and extreme heat events (for outdoor workers, or workers in hot environments); and they are more likely to cross over with other categories which can impact vulnerability to climate change - for example, living in insecure housing.<sup>49</sup>

SEIFA is a geographical measure of socio-economic disadvantage in Australia, compiled using several different measures from the ABS Census data. Based on the 2011 Census data, the LGAs in Melbourne with the highest levels of socio-economic disadvantage are:

- Greater Dandenong (895)
- Brimbank (925.8)
- Hume (951.8)
- Maribyrnong (974)
- Whittlesea (988.6)

The SEIFA index for the 2016 Census will be available in 2018.<sup>50</sup> SEIFA maps, according to different indices (Index of Education and Occupation, Index of Economic Resources, Index of Relative Socio-economic Advantage and Disadvantage, and Index of Relative Disadvantage) are available through the AURIN database.<sup>51</sup>

A further measure of socio-economic disadvantage is financial stress. Financial Stress is here defined as: had no access to emergency money, can't afford a night out once a fortnight and leaving low income from benefit.<sup>52</sup> Statistical areas (provided by the ABS) are used. Areas with high financial stress include Meadow Heights, Campbellfield-Coolaroo, Broadmeadows, and Upper Yarra Valley (in the East).

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<sup>49</sup> VCOSS (2014), *Disaster and Disadvantage: Social Vulnerability in Emergency Management*, Melbourne

<sup>50</sup> ABS (2016), 2011.0 - Information Paper: Census of Population and Housing -- Proposed Products and Services.

<sup>51</sup> Australian Urban Research Infrastructure Network, *AURIN Map*, <https://aurin.org.au/>

<sup>52</sup> Leaving low income from benefit is the gross earning (expressed as a percentage of average full time earnings) required for a family to reach a 60% of median household income threshold from benefits of last resort (State welfare payments or income support). All estimates were derived using a spatial microsimulation model which used the Survey of Income and Housing and the 2011 Census data as base datasets, so they are synthetic estimates. This table forms part of the AURIN Social Indicators project.

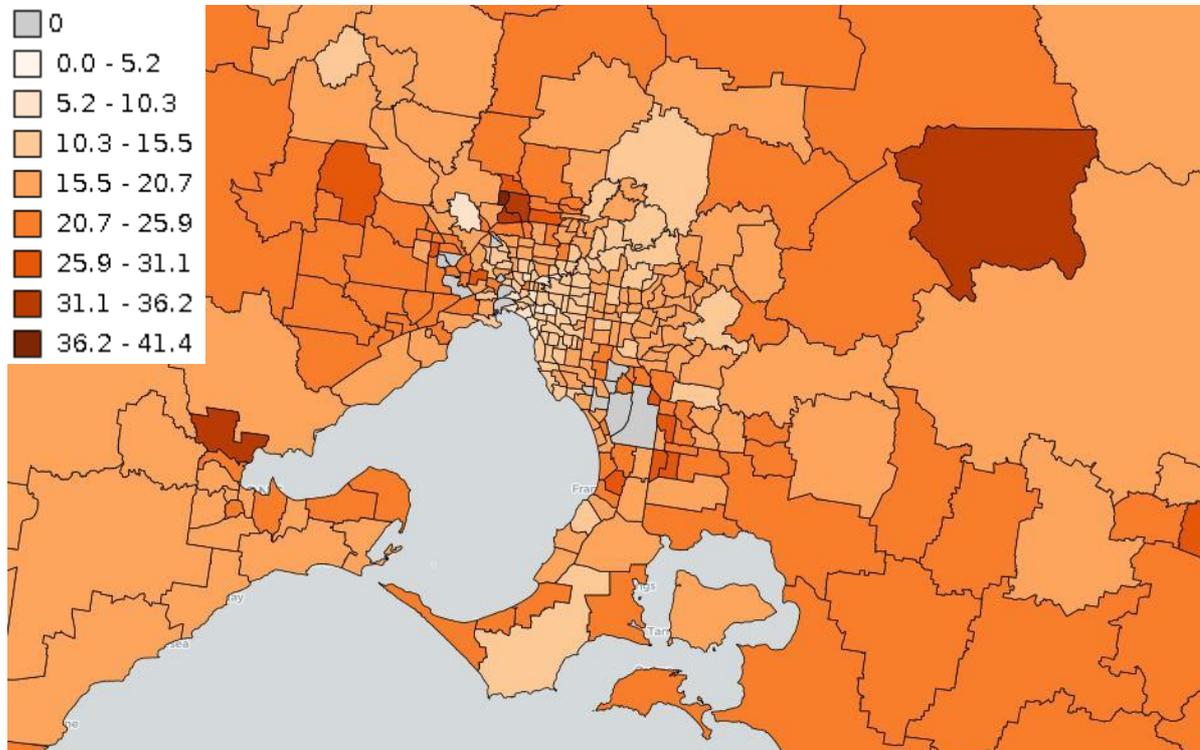


Image 11: Financial Stress

#### 4.8 Transient Populations

As with newly arrived migrants, transient populations (tourists and visitors) may be more vulnerable to climate shocks and stressors, due to a lack of understanding of risk, and a poor understanding of how to manage extreme weather events. This can be due to a lack of understanding and prior experience with extreme weather events, such as bushfires and extreme heat days.

Between 2012 and 2017, domestic overnight visitors to Melbourne increased at 5.4% per annum, with 8.9 million domestic visitors for the year ending September 2017,<sup>53</sup> and 2.7 million international visitors, with a growth of 6.7% on the previous year<sup>54</sup>. The strongest year-on-year growth for domestic visitation in the Port Phillip outer metropolitan areas was for the Yarra Valley and Dandenong Ranges (+26.9%)<sup>55</sup>. Domestic daytrip visitors grew for

<sup>53</sup> Using Excel downloadable data from: <http://www.business.vic.gov.au/tourism-industry-resources/research/domestic-and-regional-research>

<sup>54</sup> Using Excel downloadable data from: <http://www.business.vic.gov.au/tourism-industry-resources/research/international-research>

<sup>55</sup> Using Excel downloadable data from: <http://www.business.vic.gov.au/tourism-industry-resources/research/domestic-and-regional-research>



the Mornington Peninsula (+14.5%).<sup>56</sup> International day trips to the Mornington Peninsula grew (+10.9%) to 170,300 people. International day trips to the Yarra Valley and Dandenong Ranges grew (+9.3%) to 529,100<sup>57</sup>.

N.B. Tourism areas are defined by ABS Statistical Area 2 and do not strictly follow LGA boundaries. Bracketed growth rates represent year-on-year growth. This map outlines tourism regions:

[http://www.business.vic.gov.au/data/assets/pdf\\_file/0011/1551755/Victorias\\_Regions\\_map\\_2017\\_Updated.pdf](http://www.business.vic.gov.au/data/assets/pdf_file/0011/1551755/Victorias_Regions_map_2017_Updated.pdf)

During bushfire situations, ‘recently established communities, newly established residents, day trippers, short-stay visitors and holiday-home owners’ can be more vulnerable, as they are more likely to have a poor understanding of risk, and to have developed response plans.<sup>58</sup> The Yarra Valley and Dandenong Ranges are bushfire prone areas, and these areas combined attract approximately 4.1 million visitors per year<sup>59</sup>.

Key sporting events held in Melbourne include the Australian Open and the Formula 1 Grand Prix<sup>60</sup>. During key events, Melbourne is likely to have large numbers of short-stay visitors. For example, the Australian Grand Prix Corporation estimated the total attendance for the 2011 Grand Prix as 298,187 persons<sup>61</sup>.

The Australian Open is held in the summer, and is often subject to extreme heat. This was demonstrated during the 2014 Australian Open, resulting in a change to the Australian Open heat policy, and questions remain at the 2018 Australian Open<sup>62</sup>. Visitors may also be vulnerable to the impacts of extreme heat events and heatwaves.

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<sup>56</sup> Using Excel downloadable data from: <http://www.business.vic.gov.au/tourism-industry-resources/research/domestic-and-regional-research>

<sup>57</sup> Using Excel downloadable data from: <http://www.business.vic.gov.au/tourism-industry-resources/research/international-research>

<sup>58</sup> DELWP (2015a), Strategic Bushfire Management Plan: East Central, Victorian State Government.

<sup>59</sup> Yarra Ranges Tourism (2016), Submission to Standing Committee on Economy and Infrastructure – Inquiry into Ride Sourcing Services, in Eastern Metro Region: Regional Background Paper (Internal document)

<sup>60</sup> Inner Metro Region: Regional Background Paper (Internal DELWP document)

<sup>61</sup> Tourism Victoria (2011), The economic impact of the 2011 Formula 1 Grand Prix, Ernst & Young, Melbourne.

<sup>62</sup> D. Colasimone, Australian Open: Heat policy needs to be looked at, Djokovic says, but Federer maintains his cool. Available at:

<http://www.abc.net.au/news/2018-01-19/australian-open-heat-policy-federer-djokovic-monfils/9342328>



The 2018 Formula 1 Grand Prix will be held at Albert Park 22-25 March, which is typically still within the fire danger period, and may affect visitors based in or travelling from outer metropolitan areas.

An increase in extreme rainfall events also means transient visitor populations are vulnerable to flooding - particularly events with little warning such as flash flooding.<sup>63</sup>

More on the impact on tourism as an industry is addressed in section 7.4.

#### 4.10 Geographical Factors

Certain physical characteristics impact on the vulnerability of communities to climate change. Within the Port Phillip region, communities identified as vulnerable to the impacts of climate change are: coastal communities, low-lying communities, and communities living in bushfire prone areas. Urban communities face different challenges to their rural counterparts.

##### 4.10.1 Coastal Communities

The coastal zone is sensitive to climate change impacts, by nature of its physical characteristics. The coastal zone is particularly vulnerable to sea level rise, attendant increased wave heights, and an increase in storm frequency. Coastal vulnerability is of particular concern, given the cultural and socio-economic importance of the coast.<sup>64</sup> While climate change is not projected to introduce any new coastal hazards, it is projected to exacerbate existing coastal hazards, particularly coastal inundation and coastal erosion and recession.

Coastal Hazard	Effect of climate change
Coastal inundation	Coastal inundation typically results from a storm surge combining 'with a high tide level and perhaps heavy rainfall over the catchment.' <sup>65</sup> A storm surge combined with a high tide (storm tide) can prevent draining in low-lying areas inundated as a result of heavy rainfall events. While currently infrequent, coastal inundation 'has the potential to cause significant damage to both private and public assets.'

<sup>63</sup> Department of Communities, Child Safety and Disability Services (2017), Toolkit - People with vulnerabilities in disasters, available at: <https://www.qld.gov.au/community/documents/disasters-emergencies/supporting-people-with-vulnerabilities-toolkit.pdf>. Accessed 19.01.17

<sup>64</sup> Department of Sustainability and Environment (DSE) (2012), Victorian Coastal Hazard Guide, Victorian State Government, p.8.

<sup>65</sup> Ibid, p.8, p. 40



Coastal erosion and recession	Coastal erosion (storm-induced) and recession (progressive erosion) can cause shoreline retreat. Erosion and recession is caused by high waves, high tides and storm surges. These drivers are projected to worsen as the climate changes, as rising sea levels will drive erosive waves higher along the shoreline (‘something that only larger, infrequent storms can do at present.’ <sup>66</sup>
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Table 6: Coastal Hazards exacerbated by climate change

The Australian Government First Pass Assessment notes the areas currently most vulnerable to inundation are generally beach frontage and low-lying wetlands and coastal reserve. In the Port Phillip Bay, areas vulnerable to inundation include Tooradin, Point Cook to St Kilda, and Mordialloc to Seaford<sup>67</sup>. Local governments at particular risk of a 110 cm SLR and a one-in-100 year storm tide include Kingston, Hobsons Bay & Port Phillip. In Kingston by 2100 storm-related flooding could impact 30% of residential buildings<sup>68</sup>. Frankston City has an estimated number of 1,500 to 3,100 existing residential buildings at risk of inundation from a sea level rise of 1.1 metres and 1-in-100 year storm tide<sup>69</sup>.

<sup>66</sup> Department of Sustainability and Environment (DSE) (2012), Victorian Coastal Hazard Guide, Victorian State Government, p.41.

<sup>67</sup> Department of Climate Change 2009, Climate change risks to Australia’s coasts: a first pass national assessment, Australian Government. <http://www.environment.gov.au/system/files/resources/fa553e97-2ead-47bb-ac80-c12adffea944/files/cc-risks-full-report.pdf>

<sup>68</sup> Ibid

<sup>69</sup> Climate Change Impacts and Adaptation Plan (2011) Frankston City Council [www.frankston.vic.gov.au/.../Climate\\_Change\\_Impacts\\_and\\_Adaptation\\_Plan.pdf](http://www.frankston.vic.gov.au/.../Climate_Change_Impacts_and_Adaptation_Plan.pdf)

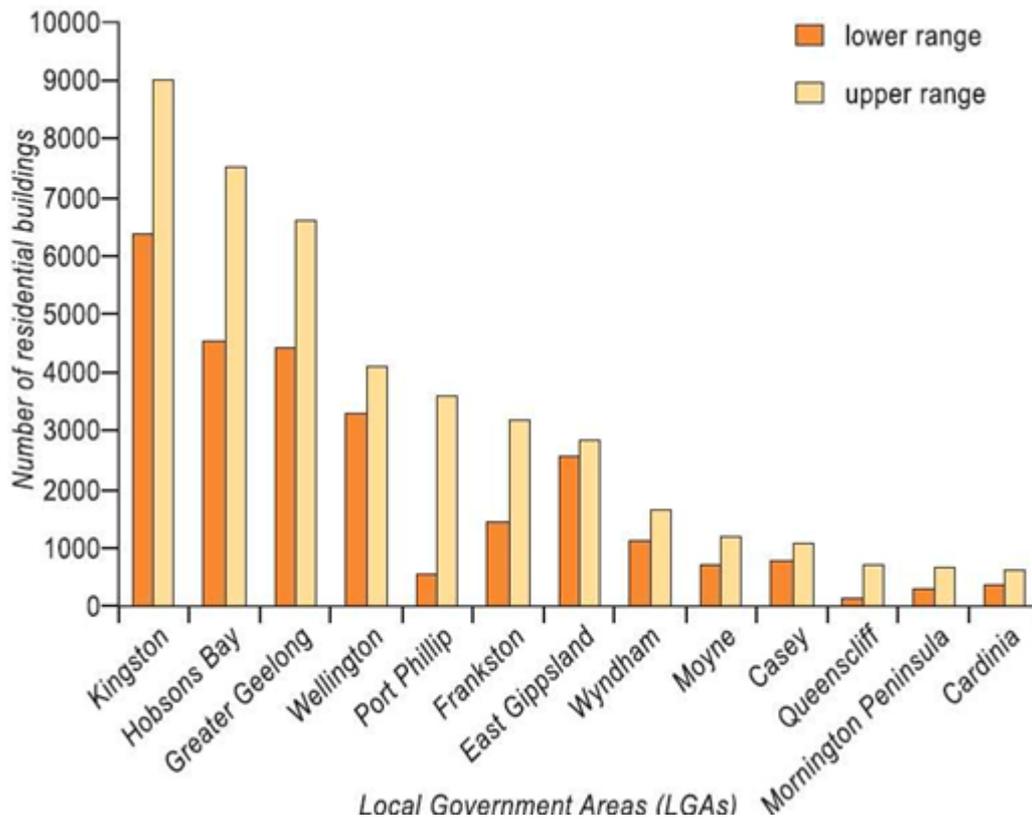


Image 12 Estimated number of existing residential buildings in Victoria at risk of inundation from sea level rise of 1.1 metres and 1-in-100 year storm tide with lower range (0.4m mean sea level rise) and upper range (1.2m mean sea level rise)<sup>70</sup>.

#### 4.10.2 Low-lying Communities

Low-lying communities are susceptible to the impacts of inundation. Flash flooding can occur in low-lying areas, as can riverine and coastal flooding, and these areas can lack the ability to drain flood waters effectively, resulting in prolonged impacts of floods. Inundation will increase as a result of sea level-rise, increased storm tides, and heavy rainfall events will see an increase in flash flooding, riverine flooding, and overflow flooding from nearby areas unable to drain.

Floods pose a risk to human life, health and safety. Because of the increased risk of inundation, low-lying communities are more likely to face flooding of infrastructure,

<sup>70</sup> Department of Climate Change (2009), Climate change risks to Australia's coasts: a first pass national assessment, Australian Government.  
<http://www.environment.gov.au/system/files/resources/fa553e97-2ead-47bb-ac80-c12adffea944/files/cc-risks-full-report.pdf>



disrupting essential service delivery. Many floods will also see minor road closures, and the closure of local businesses.

A loss of land value for areas in flood-prone areas presents another vulnerability, as does the rising costs of insurance in flood prone areas, which could become prohibitive for some households, increasing vulnerability to climate change impacts.<sup>71</sup>

*See Appendix C for a table of infrastructure services identified as at risk from flood events.*

#### **4.10.3 Communities in bushfire prone areas**

Victoria is a particularly fire-prone region, and several landscapes found within the Port Phillip region pose a risk as being fire-prone: close to or among dense or open bush, where cities and towns meet the bush, near coastal scrub, where cities and towns meet grasslands, close to or among rural grass or paddocks.<sup>72</sup> Climate change is projected to increase the intensity and frequency of bushfires.<sup>73</sup>

Fire poses a danger to human life, property and infrastructure, and also carries the potential to disrupt essential services. A disruption of essential services poses further threats to communities and individuals, particularly where this overlaps with other factors such as geographical isolation, health and wellbeing service delivery, and individual factors (for example, those more susceptible to heat impacts will also be more susceptible to an interruption to electricity supply and attendant loss of cooling).

Urban areas are less fire-prone. However, much of the Port Phillip region, and the outer-metropolitan region, is fire prone. Bushfire prone areas include Banyule, Brimbank, Cardinia, Casey, Frankston, Greater Dandenong, Hobsons Bay, Hume, Kingston, Knox, Manningham, Maroondah, Melton, Monash, Mornington Peninsula, Nillumbik, Whitehorse, Whittlesea, Wyndham and Yarra Ranges.<sup>74</sup>

The designated bushfire prone areas in the Port Phillip region covers an extensive amount of the region, and is mapped in image 13.

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<sup>71</sup> Office of the Queensland Chief Scientist, Understanding floods, available at: <http://www.chiefscientist.qld.gov.au/publications/understanding-floods/flood-consequences> accessed 19.01.18.

<sup>72</sup> CFA (2012), Am I at risk, available at: <http://www.cfa.vic.gov.au/plan-prepare/am-i-at-risk/> accessed 19.01.18

<sup>73</sup> DELWP (2015a), Strategic Bushfire Management Plan: East Central, Victorian State Government.

<sup>74</sup> DELWP (2017), Building in Bushfire Prone Areas, available at: <https://www.planning.vic.gov.au/bushfire-protection/building-in-bushfire-prone-areas>

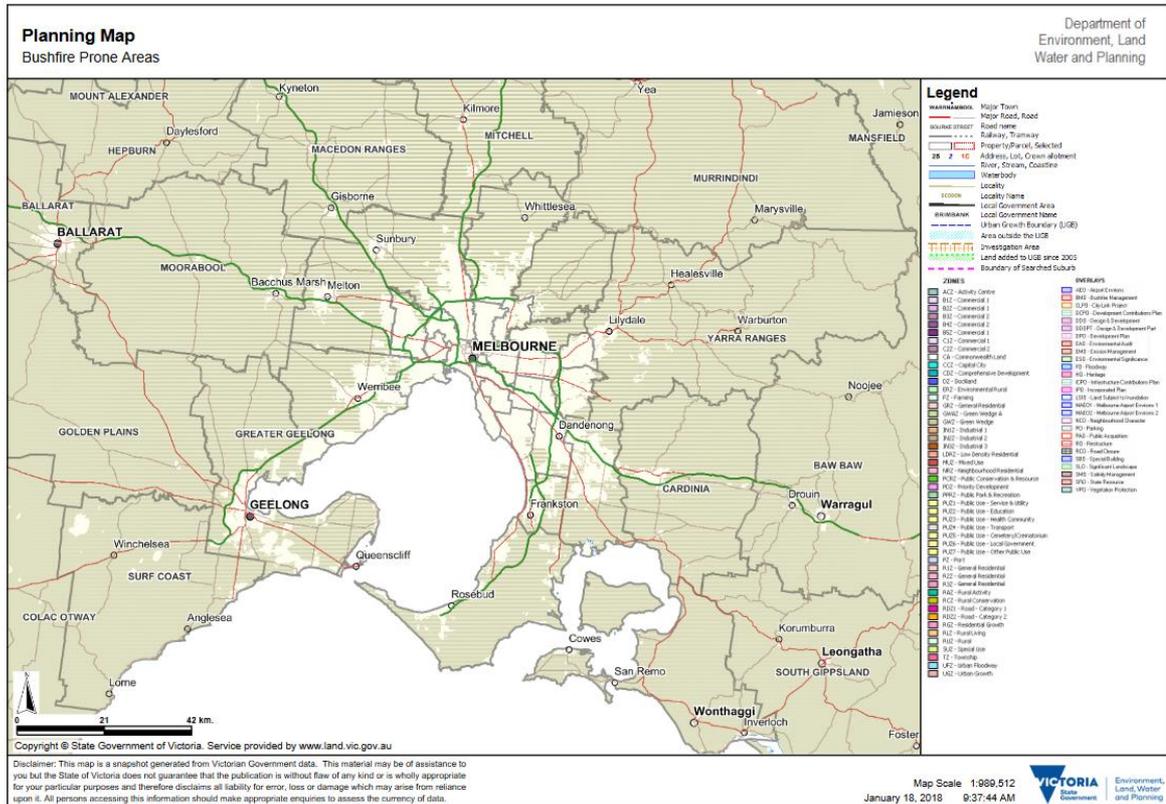


Image 13: Bushfire prone areas

#### 4.10.4 Urban & Rural Areas

Urban areas are more likely to have access to essential services, and are less likely to be vulnerable to climate change impacts as a result of the geographical isolation as in more rural areas.<sup>75</sup> Urban areas are likely to be more resilient to infrastructure damage and service disruption, through value of their proximity to alternative infrastructure and services. The following maps display the metro ARIA index, a geographic index quantifying service accessibility in metropolitan areas. Services are measured across:<sup>76</sup>

- Education
- Health
- Shopping
- Public transport
- Financial/Postal Services

<sup>75</sup> Department of Communities, Child Safety and Disability Services 2017, Toolkit - People with vulnerabilities in disasters, available at: <https://www.qld.gov.au/community/documents/disasters-emergencies/supporting-people-with-vulnerabilities-toolkit.pdf>. Accessed 19.01.17

<sup>76</sup> AURIN, Metro ARIA, definition available at: <https://aurin.org.au/projects/data-hubs/metro-aria/> accessed 19.01.18

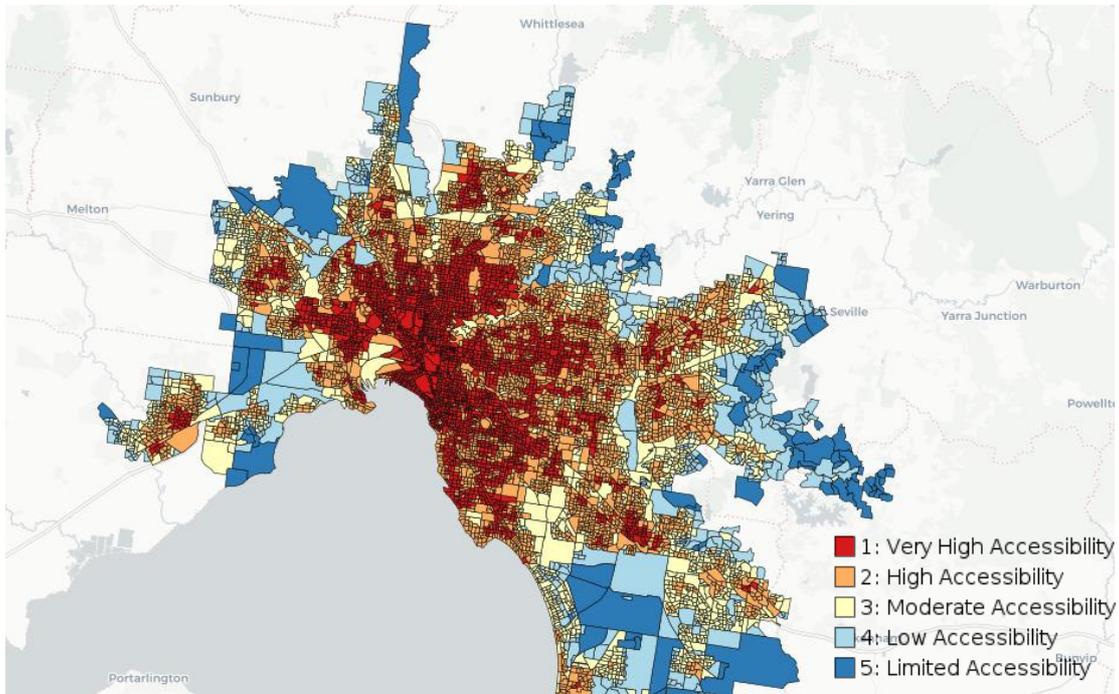


Image 14: Metro ARIA - Melbourne

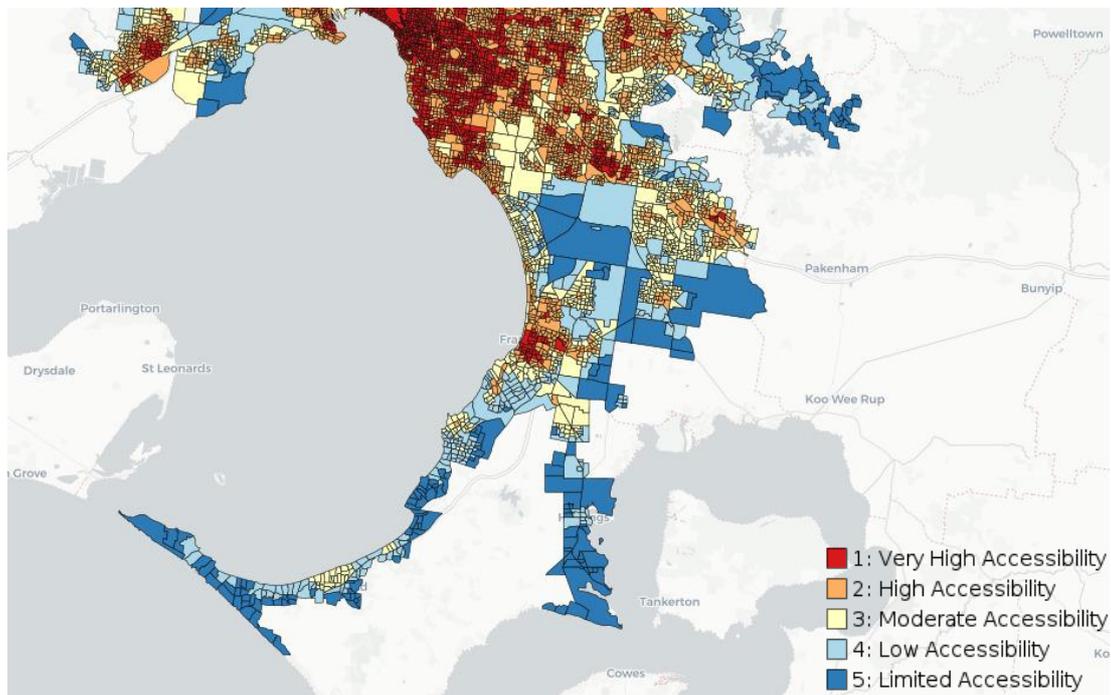


Image 15: Metro ARIA - Melbourne (South)



However, living in urban areas can pose different risks, such as:

- As a result of a decrease in porous surfaces, urban areas are more prone to flash flooding
- Urban areas are more prone to the Urban Heat Island Effect, where urban areas reach temperatures higher than vegetated areas, and retain heat more so than vegetated areas (see Report 1: Climate Change Impacts for more detail). This is of particular concern for the Western Metro Region, with just 5% average tree canopy cover (as discussed in Report 1: Regional Snapshot).

Increased heat impacts (as a result of the urban heat island effect) will see an increase in vulnerability to heat related illnesses such as:<sup>77</sup>

- exacerbation of medical conditions including heart (cardiac) and kidney (renal) disease
- confusion, muscle weakness, unsteadiness and falls due to dehydration
- exacerbation of asthma and other respiratory illness
- gastroenteritis, mostly due to poor food handling.
- Heat cramps, heat exhaustion and heat stroke

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<sup>77</sup> Department of Health and Human Services (DHHS) (2015), Heat Health Plan for Victoria: Protecting health and reducing harm from extreme heat and heatwave, Victorian State Government, Melbourne.



NORTHERN  
ALLIANCE FOR  
GREENHOUSE  
ACTION

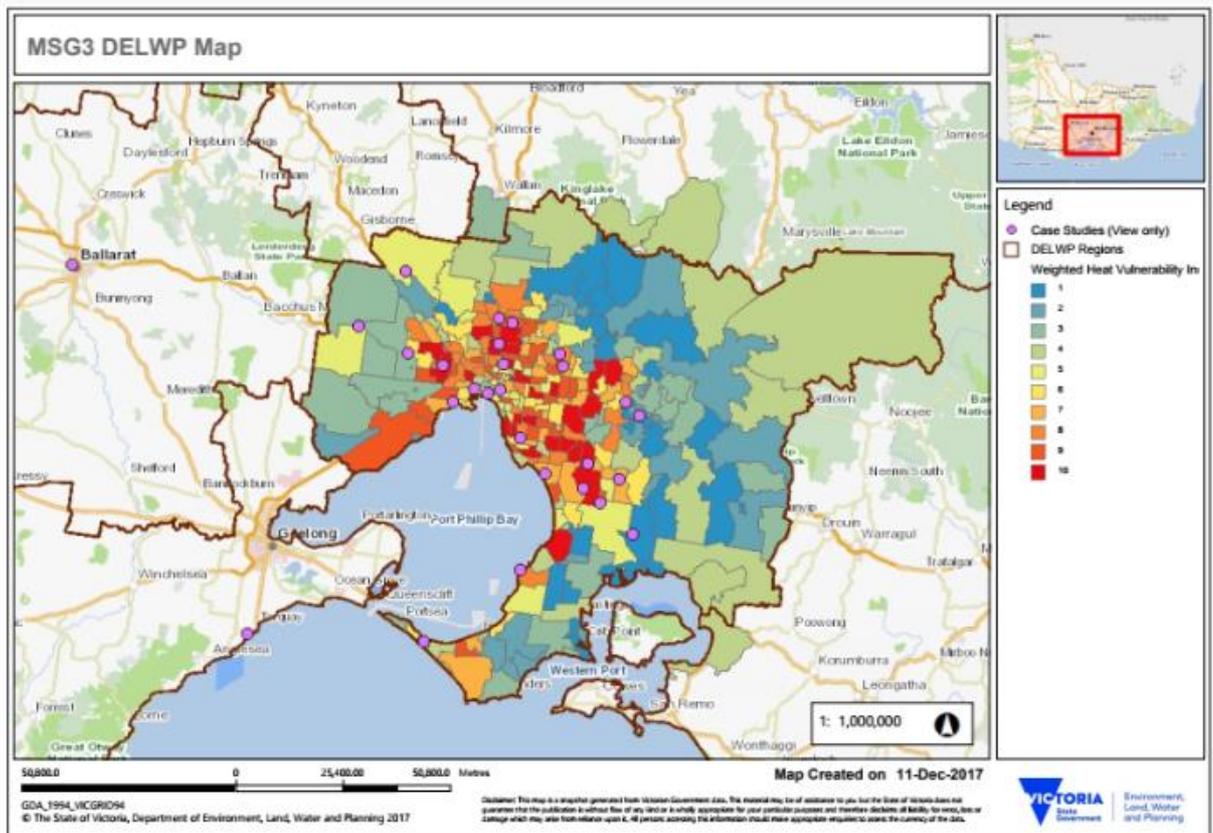


Image 15: Heat vulnerability areas

## 5. Assets

*Further details on assets can be found in Report 1: Regional Snapshot.*

### 5.1 Natural Assets

Climate change will have differential impacts across regions and landscapes, though the effect of climate change on the natural environment will be frequently severe and irreversible, impacting individual species, through to entire ecosystems.<sup>78</sup>

#### 5.1.1 Native vegetation

*Refer to report 1: Regional Snapshot for greater detail on Native vegetation.*

Native vegetation forms an incredibly part of our natural landscapes and ecosystems. Native vegetation ‘nourishes our ancient soils; shelters and sustains wildlife; protects streams,

<sup>78</sup> DELWP (2016b), Victoria’s Climate Change Adaptation Plan 2017-2020, Victorian Government, p.38.

wetlands, estuaries, and coastlines; absorbs carbon dioxide and emits oxygen.<sup>79</sup> A loss of native vegetation (through land clearing and bushfires) can be detrimental to water supplies and aquatic system, as a loss of stabilisation provided through vegetation can result in greater erosion and higher levels of sediment entering water bodies. The following map depicts native vegetation at risk from climate change, in the Port Phillip region.

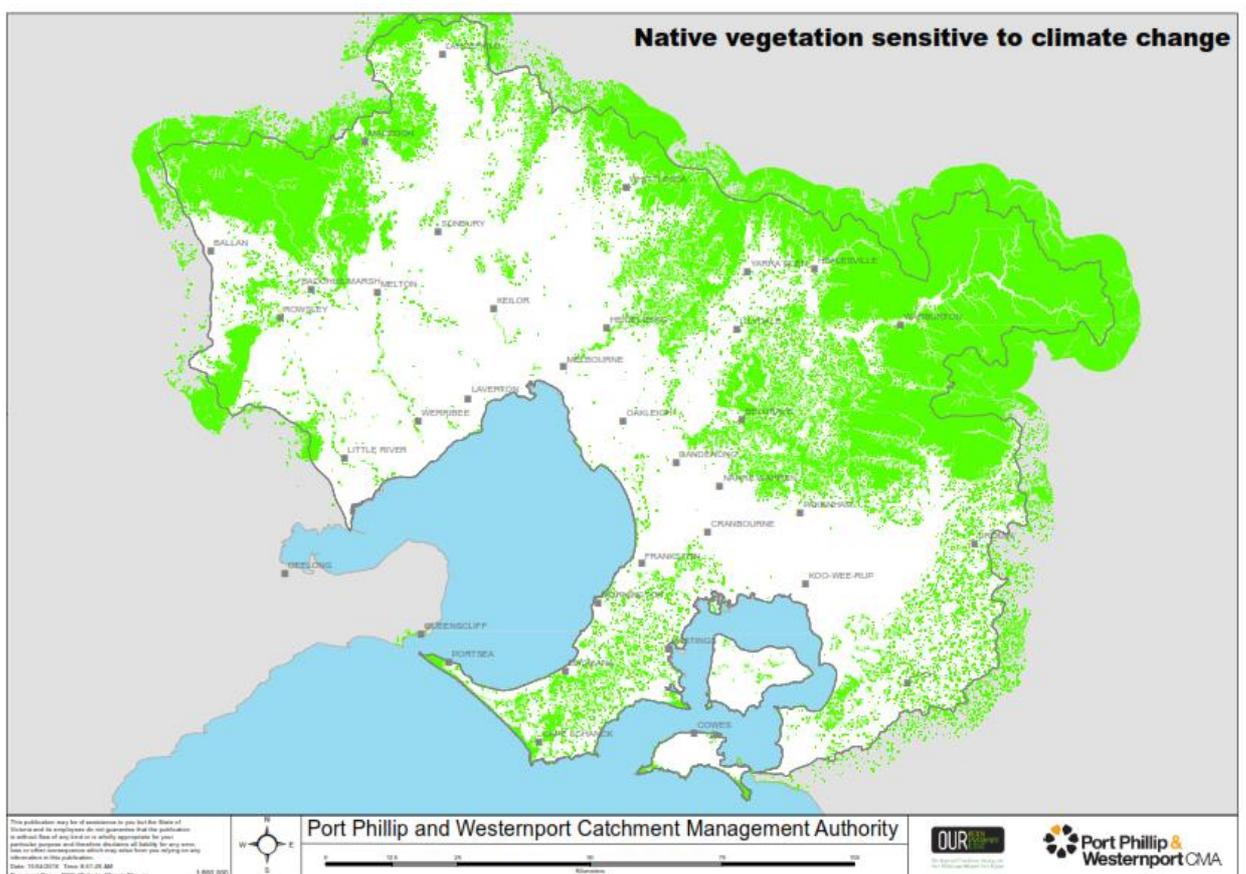


Image 17: Native vegetation sensitive to climate change

<sup>79</sup> Department of Environment and Energy, Native vegetation in Australia, available at: <http://www.environment.gov.au/topics/land/native-vegetation>



Native vegetation is at risk from the following climate change impacts:<sup>80</sup>

- Increased long-term average temperatures.
- Increased hot-day temperatures.
- Lower and more erratic rainfall.
- Higher evaporation.
- Lower soil moisture.
- Increased fire-weather frequency and intensity.
- Sea level rise.

Fauna is adapted to contemporary climatic conditions, and may not tolerate changes in temperature and change availability of moisture. More drought tolerant pest species may become invasive, as climate impacts become more pronounced. Sea level rise increases pressure on reduced margins of coastal land, particularly where urban areas compete for land.

### **5.1.2 Coastal areas**

Port Phillip Bay and Westernport are rich coastal areas, with important bio-physical traits. This includes three Ramsar designated wetlands<sup>81</sup> (see Report 1: Regional Snapshot), providing habitat for tens of thousands of migratory wader and water birds, and Point Nepean, and Mornington Peninsula National Parks.<sup>82</sup> Port Phillip and Westernport Bays host a diverse range of habitats, including ‘deep channels, seagrass meadows, mangroves and saltmarsh, and abundant fish fauna.’<sup>83</sup>

Coastal areas are particularly vulnerable to climate change impacts, with coastal inundation, and erosion and recession, being the most significant coastal hazards.<sup>84</sup> Sea level rise, causing higher waves and increased storm tide heights, is likely to drive both: greater erosion and recession, and greater coastal inundation. Increased flooding resulting from heavy rainfall events will also impact water quality, groundwater characteristics and sedimentation flows, and potentially species and ecosystems (through pollutants, and increased sediment and nutrients in stormwater runoff). In this way, floods can damage coastal food resources, water

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<sup>80</sup> Port Phillip and Westernport CMA, Native vegetation, <http://www.nrmclimate.vic.gov.au/regional-cma-information/278/>

<sup>81</sup> Ramsar is the Convention on Wetlands, which coordinates intergovernmental cooperation on wetlands. Article 2.2 of the Convention states that Ramsar designated sites are selected ‘on account of their international significance in terms of ecology, botany, zoology, limnology or hydrology.’

<sup>82</sup> Central Coast Board (DELWP) (2015), Central Regional Coastal Plan 2017-2020, Victorian Government, East Melbourne.

<sup>83</sup> Ibid p. 11.

<sup>84</sup> DSE (2012), Victorian Coastal Hazard Guide, Victorian State Government, p.9.



quality, and aquatic habitats.<sup>85</sup> Increased sea surface temperatures and ocean acidification will impact species distribution and ecosystems.

Foreshore areas most at risk of inundation are:<sup>86</sup>

- Estuaries
- Lagoons and waterways
- Low-lying areas lacking natural and artificial barriers

Foreshore areas are at different levels of risk, depending on the type of coastline, and natural and artificial barriers. The following are typical coastal shorelines along the Port Phillip Bay, identified in the Bay Blueprint 2070:<sup>87</sup>

- Sandy shorelines - can act as coastal buffers, prone to erosion.
- Rocky shoreline - continual exposure to tidal action can drive erosion.
- Waterways and wetlands - prone to inundation.
- Urbanised shoreline - prone to the urban heat island effect and flash flooding, due to its highly modified state

### **5.1.3 Biodiversity**

Biodiversity is: ‘the number and variety of native plants, animals and other living things across our land, rivers, coast and ocean.’<sup>88</sup> Biodiversity is valued for its own intrinsic value, and for the way in which humans interact with biodiversity. Biodiversity provides ecosystem services - for example, through food provision, and raw materials for pharmaceutical production; it is Victoria’s largest tourist attraction; it provides natural capital, through the contribution of Victoria’s parks and the agriculture, fishing and forestry industry; it is important for the cultural practices of Traditional Owners and Aboriginal Victorians; it is important for health, wellbeing, and liveability; it can improve resilience to climate change (for example, through providing cooler vegetated areas); and it is an important part of Victorian identity, with many species and ecosystems carrying cultural significance.<sup>89</sup>

Climate change will impact biodiversity in numerous ways, and the loss of species and habitat may be permanent.

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<sup>85</sup> Office of the Queensland Chief Scientist, Understanding floods, available at: <http://www.chiefscientist.qld.gov.au/publications/understanding-floods/flood-consequences> accessed 19.01.18.

<sup>86</sup> DSE (2012), Victorian Coastal Hazard Guide, Victorian State Government, p. 40

<sup>87</sup> Association of Bayside Municipalities (2017), Bay Blueprint 2070, Melbourne.

<sup>88</sup> DELWP (2017), Protecting Victoria’s Environment - Biodiversity 2037, Victorian State Government

<sup>89</sup> Ibid



Climate change is likely to alter habitats, and the amount of habitat available to species. This poses a risk to isolated ecosystems and the species which rely on them, and species which cannot relocate due to physiological constraints.<sup>90</sup>

Climate change impacts on biodiversity include:<sup>91</sup>

- Heat stress and drought will impact plants and animals
- Extreme weather events (including bushfires) will cause a loss of habitat
- Increased salinity will impact species
- Freshwater flows and levels will change
- Changing environments, and weather events will see a change to the composition and distribution of pest species (for example floodwaters can spread weeds)

## 5.2 Built environment

The Victorian critical infrastructure register lists vital, major and significant infrastructure for Victoria, and can provide the best overview of the infrastructure critical to the continuity of essential services, or overall economic and social well-being of the Port Phillip region.<sup>92</sup> The following section details the likely impacts of climate change on different sectors of the built environment.

An overarching concern for much of the built environment, including bridges, buildings and wharves is concrete erosion, accelerated by climate change. Carbonation and chloride-induced corrosion will likely take place under increased levels of carbon dioxide in the atmosphere, and this corrosion is likely to be accelerated by higher temperatures.<sup>93</sup> Australia's critical infrastructure is predominately concrete.

### 5.2.1 Water

As a result of rising temperatures and lower overall rainfall, Victoria's water resources will be strained. This will impact the health of waterways, and 'traditional water supply systems may not work in the same way'<sup>94</sup>.

Water supply and infrastructure will also be adversely impacted by the increase in severity and frequency of droughts, floods and heatwaves<sup>95</sup>.

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<sup>90</sup> DELWP (2015a), Strategic Bushfire Management Plan: East Central, Victorian State Government.

<sup>91</sup> DELWP (2016b), Victoria's Climate Change Adaptation Plan 2017-2020, Victorian Government, p.38.

<sup>92</sup> Emergency Management Victoria (2015), Critical Infrastructure Resilience Strategy, Victorian State Government.

<sup>93</sup> M.G. Stewart, X. Wang, Xiaoming, M. N. Nguyen, 2011, Climate change impact and risks of concrete infrastructure deterioration, *Engineering Structures*, 33, pp. 1326-1337.

<sup>94</sup> DELWP (2016b), Victoria's Climate Change Adaptation Plan 2017-2020, Victorian Government, page 47

<sup>95</sup> Ibid



Flash flooding is also problematic in many areas of the Port Phillip region, with intense rainfall events triggering flash flooding around stormwater drains (see for example South Melbourne Local Flood Plan advice through VicSES).<sup>96</sup> Stormwater drains are built for certain capacities – an increase in extreme rainfall events will also see an increase in flooding events.

Flooding can also impact water quality, as it can cause runoff from sediment, nutrients, and pollutants into water supplies. This can strain water supplies for population centres, and also water supplies available for agriculture and livestock.<sup>97</sup>

### **5.2.2 Transport (particularly PT and airports / ports)**

Damage to transport infrastructure can restrict access to towns, properties, and services<sup>98</sup>. Disruptions to transport will impact productivity. This can have short and long-term consequences, and cause significant financial losses ‘to Government, private owners and insurers’<sup>99</sup>. Climate change can impact transport through the following impacts:

- Extreme heat and flooding. Can slow or halt public transport, and threaten public health and safety. Heat damage can close roads short-term and create long-term degradation, as can damage resulting from floods.
- Extreme weather events. Can disrupt signalling and damage infrastructure<sup>100</sup>

Proportionally, most commuters to the Melbourne CBD use public transport with the greatest proportion travelling by train.<sup>101</sup>

During the 2006-07 Great Divide bushfires, 160 trains were cancelled and 616 trains delayed during Melbourne peak hour. This affected an estimated 175,000 passengers.<sup>102</sup>

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<sup>96</sup> VicSES, Local Flood Guide - Port Philip, available at:

<https://www.ses.vic.gov.au/documents/112015/134900/South+Melbourne+local+flood+guide-pdf/d734cd5d-c2f1-4a9b-a8fa-818a92bbca59>

<sup>97</sup> Office of the Queensland Chief Scientist, Understanding floods, available at:

<http://www.chiefscientist.qld.gov.au/publications/understanding-floods/flood-consequences> accessed 19.01.18.

<sup>98</sup> DELWP (2016b), Victoria’s Climate Change Adaptation Plan 2017-2020, Victorian Government, page 51

<sup>99</sup> Ibid, page 14

<sup>100</sup> Ibid, page 51

<sup>101</sup> Terill, M. (2017), Stuck in traffic? Road congestion in Sydney and Melbourne, Grattan Institute, Melbourne.

<sup>102</sup> DELWP (2015a), Strategic Bushfire Management Plan: East Central, Victorian State Government., p. 14



Table 7 details key network statistics for the metropolitan Melbourne public transport network.<sup>103</sup>

	<b>Metropolitan Trains</b>	<b>Metropolitan Trams</b>	<b>Metropolitan buses</b>
<b>Operators</b>	1	1	13
<b>Lines, Routes</b>	16 (lines)	24 (routes - including city circle)	346 (routes)
<b>Track/Route kilometres</b>	830 km of track	250 km of double track	114.3 million route km (approx)
<b>Total stations, Stops</b>	218 (stations)	1,761 (stops)	18,125 (stops)
<b>Premium Stations, Level Access Stops, Smartbus and Nightrider routes</b>	82 (premium stations)	383 (level access stops)	Smartbus routes: 9 Nightrider routes: 13
<b>Fleet size</b>	206 six-car sets comprising: 93 Comeng 36 Siemens 77 X'Trapolis	489 Total low floor fleet size: 118	1,753 Total low floor fleet size: 1551
<b>Annual patronage FY2016</b>	235.4 million passenger trips	203.8 million passenger trips	122.5 million passenger trips
<b>Annual patronage growth FY2016</b>	1.6%	12%	-0.9%

\*Metropolitan bus figures include NightRider/Night Bus services.

Table 7: Network Statistics - Metropolitan Transport

Key freight routes for the Port Melbourne region include (From internal Metro region regional background papers): Maroondah Highway, Eastlink, Eastern Freeway, Western Freeway, Princes Freeway, Westgate Freeway, Western Ring Road, Monash Freeway,

<sup>103</sup> PTV (2017), Network Statistics, available at: <https://www.ptv.vic.gov.au/about-ptv/victorias-public-transport-network/network-statistics/>



Western Port Highway, Hume Freeway, Tullamarine Freeway, Metropolitan Ring Road (M80), Nepean Highway and the Princes Highway.

Airports and Ports are also important regional transport infrastructure, and a disruption to their services could see impacts for the regional economy. See Report 1: Regional Snapshot, for ports and airports in the region.

- Extreme weather events could ground planes. Indirect impacts, such as smoke from bushfires, could potentially ground and delay planes due to poor visibility. This occurred in Sydney in 2013.<sup>104</sup>
- Climate change impacts will be differential across ports, depending on their systems and composition of their physical infrastructure (for example steel, wood, or concrete, storage systems). Overarching concerns for ports relate to extreme weather events and sea level rise.

It is worth noting that the impact of climate change on freight routes, ports and airports should be considered beyond their physical structures, and consideration should be given to potential impacts to key routes, which extend beyond regional impacts.

### 5.2.3 Energy

Energy is an essential service, and has interdependencies with other infrastructure services. For example, during the 2006-07 Great Divide bushfires, noted above in transport, the loss of power was the cause of the disruptions to transport. Victoria's main interconnector with New South Wales was cut, resulting in power outages for homes, loss of public lighting, and loss of mobile phone coverage over a 750 square km area.<sup>105</sup> Electricity supplies also face additional strains during heat events, due to cooling needs. This has the potential to contribute to fuel poverty, and interact with vulnerabilities such as socio-economic circumstances.<sup>106</sup>

Electricity infrastructure consists of both above-ground and subterranean infrastructure.

Climate change impacts on energy infrastructure will likely include:<sup>107</sup>

- Reduced water availability could also be significant for electricity generation, as less water will be available for thermal generator cooling and thermal generation.
- Rising sea levels and increased floods will be significant for electricity infrastructure, including generation facilities, but also electricity substations.

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<sup>104</sup> M. O'Sullivan (2013), Bushfire Smoke causes Sydney Airport delays, *Traveller*, available at: <http://www.traveller.com.au/bushfire-smoke-causes-sydney-airport-delays-2vvs1>

<sup>105</sup> DELWP (2015a), Strategic Bushfire Management Plan: East Central, Victorian State Government., p.14

<sup>106</sup> Foster, J, Bell, WP, Wild, P, Sharma, D, Sandu, S, Froome, C, Wagner, L, Misra, S & Bagia, R (2013), *Analysis of institutional adaptability to redress electricity infrastructure vulnerability due to climate change*, National Climate Change Adaptation Research Facility, Gold Coast, 345 pp.

<sup>107</sup> Ibid



- Ocean acidification, higher sea surface temperatures and rising sea levels combined will drive erosion of coastal energy infrastructure.
- Extreme weather events, including bushfires, can disrupt supply through damaging transmission and distribution networks

Energy infrastructure is typically concentrated in urban areas, as shown in the map below. Given the proximity of many urban areas to the coast, much of this infrastructure is also concentrated in coastal areas. Infrastructure with particular vulnerabilities is not noted here, as this analysis was beyond the scope of this report (information was not publically available). However, the National Climate Change Adaptation Research Facility conducted analysis on the National Electricity Market for the Australian Energy Market Operator in 2013.



**National Major Power Stations**  
Class

- ◆ Renewable
- ◆ Non Renewable

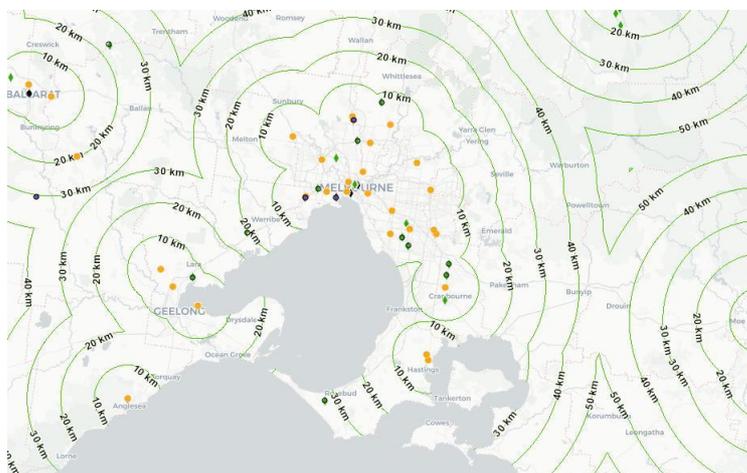
**National Electricity Transmission Substations**

- Substations

**National Electricity Transmission Lines**  
Capacity - Construction Type

- 500kV - Overhead
- 400kV - Underground
- 330kV - Underground
- 330kV - Overhead
- 275kV - Underground
- 275kV - Overhead
- 220kV - Underground
- 220kV - Overhead
- 132kV - Underground
- 132kV - Overhead
- 110kV - Underground
- 110kV - Overhead
- 88kV - Overhead
- 66kV - Underground
- 66kV - Overhead
- 44kV - Overhead
- 33kV - Overhead
- 22kV - Overhead
- 11kV - Overhead

Image 18: Transmission Lines



— Distance to Transmission Substations (10km intervals)



Image 19: Gas Pipelines

Australia is increasingly reliant on petroleum imports, due to decreased domestic production. As such, energy security for petroleum is reliant on other infrastructure, such as ports.

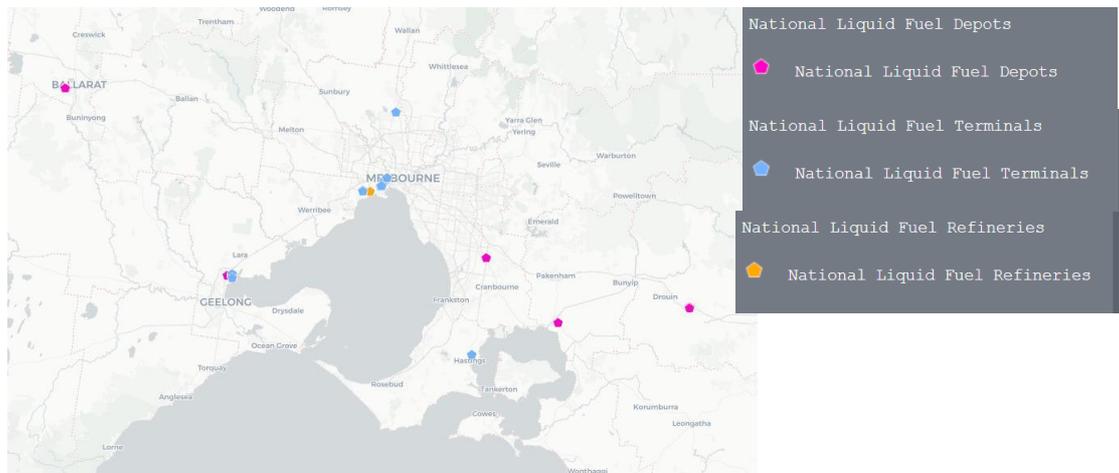


Image 20: Liquid fuel

### 5.2.4 Communications

Telecommunications are either mobile or fixed, depending on the users' subscription. Telecommunications infrastructure is largely concentrated in urban areas. Australians also have access to broadband services, mobile voice and data services, and fixed voice services. Broadcast services are also widely used.



Broadband quality and access, along with radio licences, can be mapped through the AURIN database, but are not included here due to the visibility of the maps. Climate change impacts, affecting communications infrastructure include:<sup>108</sup>

- Extreme weather events, which may cause service disruptions (lightning strikes during storm events, and bushfires may damage infrastructure)
- Coastal telecommunications assets are vulnerable to sea level rise
- Flooding of exchange and roadside manholes could disrupt broadband and mobile voice and data services, with flow-on economic impacts
- Storm-tide heights and flood events could have significant consequences for fixed voice, mobile and data services, which often rely on subterranean cables. Much of this infrastructure, concentrated in urban areas, is also located in close proximity to the coast, exacerbating this vulnerability
- A decrease in soil moisture could pose a risk to subterranean infrastructure

Disruptions to communications infrastructure poses a risk to individuals and communities during extreme weather events, as emergency communications may be limited.

### **5.2.5 Housing**

The Australian Building Codes Board (ABCB) in 2010 found that under a low emissions scenario most buildings will continue to meet safety requirements for the next 50 years. However, this is not the case for a high emissions scenario, on which we are currently tracking, where the building code would likely be deficient in some areas<sup>109</sup>. According to an analysis carried out for DELWP in 2017, the National Construction Code (NCC) is based on historic climate events and therefore does not currently take future climate change into account.<sup>110</sup> The NCC currently does not cover hail, storm tide or have specific requirements relating to heat stress.

The Nationwide House Energy Rating (NatHER) is a Star Rating from 0 to 10 that measures how energy efficient a house is, based on its design. Whilst most housing in Victoria is required to be built to a 6 star rating under the NCC<sup>111</sup>, this is based on the design of the building and not the final use.<sup>112</sup> Energy efficient housing is important in creating resilience to climate change impacts. As temperature increases, there are more hot weather days, and the

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<sup>108</sup> R. Garnaut (2008), The Garnaut Climate Change Review, available at:

<http://www.garnautreview.org.au/2008-review.html>

<sup>109</sup> Improved management in the planning and buildings systems of natural hazards in light of climate change Discussion Paper (2018) SGS Economics and Planning Pty Ltd, prepared for DELWP

<sup>110</sup> Ibid

<sup>111</sup> <http://nathers.gov.au/governance/national-construction-code-and-state-and-territory-regulations>

<sup>112</sup> <https://www.choice.com.au/home-improvement/energy-saving/reducing-your-carbon-footprint/articles/house-energy-ratings>



urban heat island effect will increase the need for use of cooling, especially in inefficient homes. This will be particularly affect those on low or vulnerable incomes.

The impact of climate change also affects insurance premiums, which is a particular issue for those on low or vulnerable incomes. Insurance companies are considering climate risks when pricing and approving house insurance, and following serious flooding in Victoria in 2010 and 2011, homeowners living in flood zones had insurance premium increases of up to 300%<sup>113</sup>.

## **6. Cultural Assets**

Cultural heritage can play an important role in the pride and identity of communities and individuals. Climate change poses a threat to many of Victoria's cultural assets.

### **6.1 Aboriginal Cultural Heritage**

Aboriginal peoples in Victoria are the Traditional owners and custodians of the land and water. Aboriginal Victorians 'have sustained the environment and the world's oldest continuous culture for countless generations, through a deep connection with the land.'<sup>114</sup> This impact on landscape and culture for Aboriginal peoples indicates that deep, long-term engagement is required with individuals, communities and Traditional Owners in relation to climate change adaptation.

Aboriginal culture is deeply linked to the natural environment, and therefore changes to ecosystems and biodiversity will have an impact on Aboriginal cultural heritage. Victoria also has many physical sites of cultural and spiritual importance, which are threatened by 'hotter temperatures, flooding, erosion and drought.'<sup>115</sup>

Victoria's coast hosts some of these physical sites, such as scar trees and shell middens, which date back 12,000 years,<sup>116</sup> and serve as reminders of continuous connection of Aboriginal culture and peoples to the Victorian landscape. The Aboriginal Heritage Register identifies many sites of significance, but access is not publicly available, as the register contains culturally sensitive information.

### **6.2 European settlement**

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<sup>113</sup> DELWP (2016b), Victoria's Climate Change Adaptation Plan 2017-2020, Victorian Government, page 15

<sup>114</sup> Ibid

<sup>115</sup> Ibid

<sup>116</sup> Central Coast Board (DELWP) (2015), Central Regional Coastal Plan 2017-2020, Victorian Government, East Melbourne.



Victoria's coastline hosts many sites of historical and cultural significance, threatened by climate change impacts such as sea level rise and increased erosion and recession. Sullivan's Bay (1803) was Victoria's first European settlement in Victoria, established thirty years prior to Melbourne. The Quarantine Station (1852) at Point Nepean was a significant processing station for new migrants to Melbourne, and other heritage buildings exist in this area. Important defences were also built at Point Nepean in the 1880s, and persist in the area. Port Phillip also hosts colourful bathing boxes, iconic structures in the region. The coast also has many historic lighthouses.<sup>117</sup>

## 7. Industry & Economy

Particular industries and people working within those industries may be disproportionately impacted by climate change, as a result of their interactions with different climate change impacts.

### 7.1 Healthcare and Social Assistance

*Refer to Report 1 – Regional Snapshot for more detail. Main industry sector by employment provided at Appendix C in Report 1.*

By employment, healthcare and social assistance is the largest industry in the Port Phillip region. Healthcare and social assistance employs 249,701 persons in the Port Phillip region<sup>118</sup>. Healthcare and social assistance is particularly significant for those living in Casey (16,833 persons employed) and Boroondara (11,669 persons employed).

Climate change is projected to increase environmental stressors such as heat stress<sup>119</sup>, vector-borne diseases, and auto-allergens (linked to asthma and allergic disease),<sup>120</sup> which will in turn negatively impact community health and wellbeing. It is expected that this will increase the strain on healthcare and social assistance services.<sup>121</sup> Community sector organisations have been identified as being ill-prepared for responding to climate change shocks and stressors such as extreme weather events, and are themselves particularly vulnerable to damage to physical impacts on infrastructure and disruption of services (such as electricity

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<sup>117</sup> Central Coast Board (DELWP) (2015), Central Regional Coastal Plan 2017-2020, Victorian Government, East Melbourne

<sup>118</sup> ABS Table Builder: Employment, Income and Education 2016

<sup>119</sup> Department of Health and Human Services (DHHS) (2015), Heat Health Plan for Victoria: Protecting health and reducing harm from extreme heat and heatwave, Victorian State Government, Melbourne.

<sup>120</sup> K.M. Shea, R.T. Truckner, R. W. Weber, D.B Peden (2008), 'Climate change and allergic disease, *Journal of Allergy and Clinical Immunology*, 122(3), pp. 443-453.

<sup>121</sup> DELWP (2016), Victoria's Climate Change Adaptation Plan 2017-2020, Victorian Government, p.14



supplies and telecommunications).<sup>122</sup> The DHHS are currently mapping the resilience of community sector organisations to climate change, and will be well placed to understand the level of resilience for service delivery in the region (see Report 1: Stakeholders - Daniel Voronoff).

Where healthcare and social assistance services are disrupted, this can have severe consequences for those that rely on these services - clients may not be able to access emergency shelter, administer medications, bathe, or shop for food.<sup>123</sup>

Because of the halt to work necessary to safeguard human health and safety (for example, due to road closures during bushfire and flood events), services will be disrupted. These periods will result in a loss of work for healthcare and social assistance workers, resulting in a negative effect on productivity. These losses may impact the economy, but may also impact upon individuals who work in the industry, particularly where individual factors such as socioeconomic circumstances impact upon social vulnerability.

## **7.2 Small and medium enterprises**

*Refer to Report 1 – Regional Snapshot for more detail on employment in retail trade and value-added.*

Small and medium enterprises may be disproportionately impacted by climate change, as they may suffer significant losses that they are less able to deal with than larger businesses as they have fewer specialist staff and smaller margins. This will disrupt the local and regional economy, enterprises and their workers. Extreme weather events can disrupt these enterprises, because:<sup>124</sup>

- employees can't get to work
- supplies of goods and energy are interrupted
- buildings and infrastructure get damaged
- people are in an unsafe work environment
- employees are less productive
- fewer people are out and about using services and buying from businesses in extreme heat or during storms

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<sup>122</sup> Mallon, K, Hamilton, E, Black, M, Beem, B & Abs, J (2013), Adapting the community sector for climate extremes: Extreme weather, climate change & the community sector– Risks and adaptations, National Climate Change Adaptation Research Facility, Gold Coast, 286 pp.

<sup>123</sup> Ibid

<sup>124</sup> DELWP (2016b), Victoria's Climate Change Adaptation Plan 2017-2020, Victorian Government, p.16



Small business is particularly important in the Western Metro region: 18,708 of the total 19,800 businesses (94.5%) employ less than 20 people, 1069 (5.4%) employ between 20 and 199 and 23 businesses (0.1%) employ 200 or more.<sup>125</sup>

Retail trade is also a key industry in the Inner South East Metro region, Eastern Metro region, and Southern Metro region, and are projected to remain key industries to 2020.<sup>126</sup>

### 7.3 Agriculture

*Refer to Report 1 – Regional Snapshot for more detail.*

Climate change will place pressure on the agricultural sector, which is particularly vulnerable to climatic impacts and extreme weather events.<sup>127</sup> Climate change impacts ‘affecting livestock and grain, grape, vegetable, fruit and other crops’ include higher temperatures, lower rainfall and extreme weather events.<sup>128</sup> Bushfires and floods can destroy assets such as machinery and buildings. Bushfires can also indirectly impact crops through smoke permeating the skin of fruit. In the Port Phillip region, viticulture is particularly vulnerable to smoke taint, particularly as the fruit ripens during bushfire season and planned burns throughout autumn.<sup>129</sup>

Typically, characteristics of food production in the Port Phillip region are:<sup>130</sup>

- Intensive production
- High value production
- Grown on small areas of land
- Highly perishable foods, such as berries

The Port Phillip region produces:<sup>131</sup>

- 23% of Victoria's vegetables (62% of lettuce, 93% of herbs, 94% of asparagus)
- 7% of Victoria's fruit (including 96% of its berry fruits)
- 59% of the state's chicken meat and over a third of its eggs

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<sup>125</sup> <http://www.rdv.vic.gov.au/regional-development-australia/western-melbourne/regional-snapshot>

<sup>126</sup> DELWP (2017), Plan Melbourne 2017-2050, Victorian State Government.

<sup>127</sup> DELWP (2016b), Victoria's Climate Change Adaptation Plan 2017-2020, Victorian Government p. 45

<sup>128</sup> Ibid

<sup>129</sup> DELWP (2015b), Strategic Bushfire Management Plan: West Central, Victorian State Government, p. 17.

<sup>130</sup> Sheridan J., Larsen, K. and Carey, R. (2015) Melbourne's foodbowl: Now and at seven million. Victorian Eco-Innovation Lab, The University of Melbourne. pp.3-11.

<sup>131</sup> Ibid



Particular areas in Port Phillip are significant for particular crops, as a result of their climate, soil, and other conditions.<sup>132</sup>

- The Yarra Valley produces 78% of Victoria’s strawberries
- Koo Wee Rup grows over 90% of Australia’s asparagus

#### 7.4 Tourism and hospitality

Please note: Tourism regions are divided according to Statistical Areas 2 (as determined by the ABS) and do not strictly follow LGA boundaries. Tourism regions are defined here:

[http://www.business.vic.gov.au/data/assets/pdf\\_file/0011/1551755/Victorias\\_Regions\\_map\\_2017\\_Updated.pdf](http://www.business.vic.gov.au/data/assets/pdf_file/0011/1551755/Victorias_Regions_map_2017_Updated.pdf)

Tourism is an important industry for Victoria, and in 2015-16, directly contributed \$10.5 billion to Victoria’s total Gross Value Added (GVA). Melbourne contributed \$7.5 billion in this period, representing 71.4% of Victoria’s direct Gross Regional Product (GRP). Melbourne attracts more international visitors (43%) than Victoria’s regions (22%). Tourism is also a growing industry, growing at an average annual rate of 6.2% in Melbourne, for the period between 2010-11, and 2015-16.

Tourism region	GVA	GRP	GRP (\$M)	Employment	Employment (persons)
Yarra Valley & Dandenong Ranges	3.8%	3.7%	317	6.2%	5,800
Mornington Peninsula	3.7%	3.7%	373	5.9%	6,400
Melbourne	2.9%	2.9%	8,071	3.9%	81,900

Table 8: The direct contribution of tourism to the economy 2015-16 (Ranked by GRP, percentage share of the regional economy)

The impact of climate change on tourism is difficult to quantify, particularly as much of domestic tourism is made up of visiting friends and relatives, and business.<sup>133</sup> However, several climate change impacts and outcomes are likely to affect the industry. Damage to infrastructure and disruption of critical services is likely to have a negative impact on tourism as a whole, and damage to private and public assets could also impact the viability of tourism

<sup>132</sup> Sheridan J., Larsen, K. and Carey, R. (2015) Melbourne’s foodbowl: Now and at seven million. Victorian Eco-Innovation Lab, The University of Melbourne, p.11.

<sup>133</sup> Business Victoria (2017), Domestic and Regional Research, available at: <http://www.business.vic.gov.au/tourism-industry-resources/research/domestic-and-regional-research>



in the region. Tourism is also ‘dominated by small businesses,’<sup>134</sup> and as discussed above at section 7.2, can therefore be more vulnerable to the impacts of climate change.

Some climate change impacts are likely to have differential impacts for tourism across regions. For example:

- Heatwaves and extreme heatwave events impact foot traffic. Extreme heat days results in an average 14.2% decrease in daily non-commuter pedestrian traffic near the Melbourne Town Hall<sup>135</sup>. Visit Victoria cites shopping and cafe culture in laneways and byways of Melbourne as a key activity in Melbourne,<sup>136</sup> which may be negatively through being less accessible during heat events.
- An increase in bushfires will likely impact the attractiveness of the Yarra Valley and Dandenong Ranges, as this will result in damage to native vegetation, and native fauna which relies on this habitat.<sup>137</sup> Damage to agriculture could also impact on agritourism in the region. The Mornington Peninsula would also be susceptible to a decline in agritourism.<sup>138</sup>
- Rising sea levels and increased erosion and recession have the potential to impact tourism for coastal areas (Melbourne and Mornington Peninsula), through potential loss of foreshore and public beach access, and a loss of cultural heritage along the coast.<sup>139</sup> Increased salinity as a result of rising sea levels will also negatively impact ecosystems, potentially impacting tourism.
- A loss of habitat and changes in species distribution could also impact recreational activities such as snorkelling and diving, and boating.<sup>140</sup> Recreational fishing will be negatively impacted by rising sea surface temperatures and ocean acidification, through driving change in species distribution and a decline in biodiversity. In 2008/09, recreational fishing contributed \$228.8 million in Gross Regional Product to the Melbourne and Port Phillip region, and employed 1,400 people.<sup>141</sup>

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<sup>134</sup> Tourism Research Australian 2017, Tourism Businesses in Victoria, available at: [http://www.business.vic.gov.au/\\_data/assets/pdf\\_file/0009/1551897/Tourism\\_Businesses\\_Factsheet\\_Victoria\\_June2016\\_Final.pdf](http://www.business.vic.gov.au/_data/assets/pdf_file/0009/1551897/Tourism_Businesses_Factsheet_Victoria_June2016_Final.pdf)

<sup>135</sup> DELWP (2016b), Victoria’s Climate Change Adaptation Plan 2017-2020, Victorian Government, page 16

<sup>136</sup> <http://www.visitvictoria.com/Regions/Melbourne/Things-to-do>

<sup>137</sup> DELWP (2015a), Strategic Bushfire Management Plan: East Central, Victorian State Government.

<sup>138</sup> DELWP (2017), Protecting Victoria’s Environment - Biodiversity 2037, Victorian State Government

<sup>139</sup> Central Coast Board (DELWP) (2015), Central Regional Coastal Plan 2017-2020, Victorian Government, East Melbourne

<sup>140</sup> Ibid

<sup>141</sup> <https://vfa.vic.gov.au/operational-policy/publications-and-resources/fisheries-reports/your-licence-fees-at-work-reports/2009-2010/economic-study-of-recreational-fishing-in-victoria-headline-results-vrfish>



The impact of climate change on tourists as a transient population was addressed in section 4.8 above.

### **7.5 Outdoor workers**

*Refer to Report 1 – Regional Snapshot for more detail. Main industry sector by employment provided at Appendix C in Report 1.*

Outdoor workers are particularly vulnerable to the effects of rising temperatures, particularly during heatwaves and extreme heat events<sup>142</sup>. During heat events, and other extreme weather events, working outdoors poses a risk to human health and safety. Because of the halt to work necessary to safeguard human health and safety, these periods will result in a loss of work for outdoor workers, resulting in a negative effect on productivity. These losses will impact the economy, but may also impact upon individuals and communities - particularly where individual factors such as socioeconomic circumstances impact upon vulnerability and resilience.

Outdoor workers are here defined as those working in agriculture, forestry and fishing, and in construction. The highest number of outdoor workers are in Cardinia (15,736 persons) and the Yarra Ranges (11,520 persons); followed by Mornington Peninsula (10,123 persons), Whittlesea (9,520 persons) and Hume (8,274).

*More detail can be found in Appendix D.*

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<sup>142</sup> Department of Health and Human Services (DHHS) (2015), Heat Health Plan for Victoria: Protecting health and reducing harm from extreme heat and heatwave, Victorian State Government, Melbourne.

## 8. Outcomes of Climate Change Impacts

The physical impacts of climate change are projected to result in different outcomes for the built and natural environment. Table 9 provides an indication of some of these projected outcomes, and Table 10 highlights some of the vulnerabilities these outcomes will exacerbate or create. Impacts of flooding are discussed in section 8.1, to provide a more localised analysis of the risk.

<b>Impact</b>	<b>Rising temperatures</b>	<b>Changes in wind speed</b>	<b>Reduced Rainfall</b>	<b>Increase in heavy rainfall events</b>	<b>Sea level rise</b>	<b>Ocean acidification</b>
<b>Rising temperatures</b>	Urban heat island, Heatwaves, Extreme heat days		Increase in bushfire weather	Changes to peak precipitation rates	Increased sea surface temperatures creating changes to habitat – impacting biodiversity and species distribution	Changes to habitat – impacting biodiversity and species distribution, increasing susceptibility to pest species
<b>Changes in wind speed</b>					Increase in storm height return levels	
<b>Reduced Rainfall</b>			Decreased water supply; Increase in droughts – in turn impacting temperature and			



			bush fire weather; Reduced soil moisture, leading to increase in bushfire weather and flash flooding			
<b>Increase in heavy rainfall events</b>				Flooding, riverine and flash flooding	Inundation	
<b>Sea level rise</b>					Changes to coastal erosion and recession, resulting in the loss of foreshore in some areas; Increased saltwater intrusion	Changes to habitat – impacting biodiversity and species distribution
<b>Ocean acidification</b>						Changes to habitat – impacting biodiversity and species distribution

Table 9: Outcomes of climate change impacts



The outcomes outlined in Table 9 will affect populations and assets differentially. Table 10 outlines certain population and assets, identified as vulnerable to particular outcomes of the physical impacts of climate change.

<b>Outcome</b>	<b>Vulnerabilities</b>
Changes to habitat	<p>Recreational fishing, snorkelling and diving (and attendant impacts on tourism and hospitality, and liveability)</p> <p>Detrimental to eco-tourism</p> <p>Commercial fishing</p> <p>Aquaculture (in Port Phillip Bay, a potential growth industry)</p> <p>Loss of biodiversity</p> <p>Potential extinction and strain on native species</p> <p>Loss of cultural heritage (particularly Aboriginal cultural heritage)</p>
Coastal erosion and recession	<p>Loss and damage to private property on the foreshore</p> <p>Loss and damage to infrastructure on the foreshore</p> <p>Loss of private and crown land</p> <p>Reduced liveability and amenity for those living in coastal areas in particular, and for the Port Phillip region more generally</p> <p>Loss of cultural heritage (for example, coastal middens)</p> <p>Detrimental to the tourism and hospitality industry</p> <p>Loss of biodiversity</p>
Droughts	<p>Natural habitat – straining already stressed ecosystems and species</p> <p>Reduced water supply – straining existing water infrastructure</p> <p>Elderly people &amp; babies and young children are more susceptible to environmental factors and vector-borne diseases, more common under strained water supplies</p> <p>Agriculture – less water available for irrigation – low yields and strain on the food supply</p> <p>Less water to irrigate green spaces – decreasing amenity and liveability</p>
Urban heat island	<p>Danger to human life and health, particularly: Babies and young children, Older people, disadvantaged groups, People who are sick</p> <p>Communities living in highly urbanised areas – particularly urban areas lacking tree cover and green spaces (the Western Metro region is of particular concern)</p>

	<p>Strain on electricity infrastructure through increased use of air conditioning – potential for loss of productivity through involuntary load-shedding</p> <p>Financial strain for low-income households, through increased electricity usage</p> <p>People in poor quality housing – less likely to have well-insulated homes</p> <p>Homelessness – urban heat will be dangerous for people in insecure housing, and particularly people sleeping rough</p>
Increase in heatwaves and extreme heat days	As above
Increase in bushfire weather	<p>Communities living in bushfire prone areas - this covers much of the Port Phillip region, outside of the highly urbanised centre (see section 4.10.3)</p> <p>Damage to native vegetation</p> <p>Damage to biodiversity</p> <p>Damage to agricultural crops, impacting yields and straining the food supply</p>
Increased saltwater intrusion	<p>Detrimental to groundwater aquifers, impacting water quality and availability</p> <p>Reducing water availability for households, and for agriculture</p> <p>Lower crop yields, adding strain to the food supply</p>
Reduced soil moisture	<p>Increased bushfire threat from inland winds, endangering lives, health, homes and assets</p> <p>Lower crop yields, adding strain to the food supply</p> <p>Damage to subterranean infrastructure</p>
Flooding	<p>Danger to human life and safety</p> <p>Damage to critical infrastructure, disrupting essential services</p> <p>Damage to private property</p> <p>Damage to farming infrastructure, with flow on effects for agriculture</p> <p>Potential for damage to the water supply, decreasing the water supply available for agriculture, energy and populations, and negatively impacting biodiversity</p> <p>Dispersal of pest species, harmful to biodiversity</p>

Table 10: Vulnerabilities in the Port Phillip region to climate change outcomes

### 8.1 Flooding

Under climate change, the risk of flooding is exacerbated by lower rainfall on average (with low soil moisture contributing to poor absorption and flash flooding), combined with more



extreme rainfall events. Changes to wind patterns and sea levels will also affect coastal inundation.

Appendix D outlines further detail of areas of at risk of flooding, by LGA. This table has been compiled through Flood Management Plans and Local Flood Plans, compiled and published by the VicSES (the control agency for floods in Victoria) and by municipalities.<sup>143</sup> The following LGAs are pending local flood plans:

- Brimbank
- Glen Eira
- Greater Dandenong (though the municipality notes the region is prone to riverine and overland flow flooding, and the Green Wedge is prone to flooding)
- Wyndham

Flash flooding carries the potential for severe damage to property and infrastructure, and due to the lack of predictably and warnings, poses a risk to human safety and life. Urban areas carry the greatest risk of flash flooding, particularly where they lack green space. Low lying areas such as Altona and Seaholme and Fairfield lack the ability to drain, and can be more susceptible to flooding impacts. Tooradin is low-lying, and particularly vulnerable to an increase in storm tide heights, which will be greater for Western Port Bay than Port Phillip Bay<sup>144</sup>. Areas in close proximity to the Port Phillip Bay, particularly were rivers such as the Maribyrnong River are directly connected to the bay, may also be impacted by tidal events.

## **8.2 Overarching social concerns**

While some vulnerabilities can be considered in a more localised way, some impacts will lead to cross-cutting outcomes. Overarching threats posed by climate change to individuals and communities relate to health and wellbeing, a loss of ecosystem services, and economic impacts.

### **8.2.1 Health and wellbeing**

Climate change is likely to strain health services, and extreme weather events will endanger human health and safety. Extreme heat poses a health risk, particularly to the young and older people, and those with health conditions listed above (at section 4). Climate change will also affect mental health in the future directly, through exposing people to trauma, and indirectly, through negatively impacting: physical health, and attendant mental health consequences; and community wellbeing.<sup>145</sup>

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<sup>143</sup> VicSES, available at: <https://www.ses.vic.gov.au/get-ready/floodsafe>

<sup>144</sup> Sheridan J., Larsen, K. and Carey, R. (2015) Melbourne's foodbowl: Now and at seven million. Victorian Eco-Innovation Lab, The University of Melbourne

<sup>145</sup> Berry, H.L., Bowen, K. and Kjellstrom, T 2010, 'Climate Change and Mental Health: A causal pathways framework,' *International Journal of Public Health*, 55(2), pp. 132-132.



### **8.2.2 Economic impacts**

Climate change will impact ‘on human health, public safety, infrastructure, primary production, settlements and the natural environment,’ will impact the economy, with local regional and national impacts.<sup>146</sup>

### **8.2.3 Ecosystem services**

Damage to the natural environment as a result of climate change will have far-reaching consequences for society. We rely heavily on ecosystem services, and a strain on ecosystems will limit the benefit provided. For example, coastal vegetation mitigates erosion of beaches, biodiversity provides products for food and pharmaceuticals.

## **9. Changing Melbourne**

Stressors on resources and the natural environment as a result of Melbourne’s growing population and increasing trend towards urbanisation are exacerbated by the impacts of climate change.

### **9.1 Population trends<sup>147</sup>**

Melbourne is Australia’s fastest growing city, and is projected to exceed the size of Sydney by 2061.<sup>148</sup>

Melbourne’s Western Metro region has a growth rate of 14% (with the Melbourne average of 10%) between 2016 and 2021. Outside of the Inner Metro, this is the highest growth rate in the region. Immigration is a driver of population growth in this region. Greater urban density is concentrated in the inner areas of Western Melbourne, while the Western Growth Corridor is projected to see greenfield developments drive growth.

Melbourne’s Eastern Metro region has traditionally been a centre of population growth, however this trend is projected to decline, as a result of physical constraints (the Dandenong Ranges) and longer travel times to work. A key issue for the Eastern Metro region is its ageing population.

Melbourne’s Southern Metro region is the largest population of Melbourne, with 22% of Melbourne’s total.<sup>149</sup> It is projected to grow 11% between 2016 and 2021, faster than the

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<sup>146</sup> DELWP (2016b), Victoria’s Climate Change Adaptation Plan 2017-2020, Victorian Government

<sup>147</sup> Informed by DELWP (2016a), Victoria in Future 2016, Victorian State Government; and Metro Region: Regional Background Papers (Internal documents).

<sup>148</sup> DELWP (2016a), Victoria in Future 2016, Victorian State Government

<sup>149</sup> Ibid



Melbourne average. Cardinia and Casey are rapidly urbanising, while the Mornington Peninsula has an ageing population.

Melbourne's Northern Metro region contains inner LGAs, and also the growth areas of Hume, Nillumbik and Whittlesea. The Northern Metro region is projected to grow at a faster rate, 12% between 2016 and 2021, than the Metropolitan Melbourne average. Melbourne's Northern Metro region plays a key role in transport and supply chains, and houses the Epping Market, a key point of supply chain integration for Victoria's fruit, vegetable and cut flower trading. Much of the inner metro LGAs are gentrifying, with higher average household incomes contributing to resilience to climate change. Outer suburban growth areas include Wallan, Craigieburn, Mernda and Wollert.

Melbourne's Inner South East Metro region is geographically small, though contains 12% of Melbourne's population total. Slower growth (of 6%) is projected for this region than the other Melbourne Metro regions. Melbourne's Inner South East Metro region faces pressures from an ageing population, with the period to 2031 seeing the age bracket of 80-84 year olds seeing proportionally the fastest growth.

Melbourne's Inner Metro region has 7% of the metropolitan total, and is projected to have the highest growth rate of any Metropolitan region, at 18%. One in two workers in the Inner Metro region both live and work locally. High density trends pose problems for service and infrastructure provision.

## 9.2 Urbanisation

Urbanisation poses risks to populations residing in these areas, due to increases in flash flooding, and the Urban Heat Island effect. The Urban Heat Island effect causes temperature in urban areas to rise above those in surrounding rural areas, due to an increase in hard, dark impervious surfaces. Urban areas also do not cool down overnight with evapotranspiration (as happens in vegetated areas), limiting relief from heat which can happen during this time. An increase in impervious surfaces also increases the risk of flash flooding. Areas of the Melbourne region, such as South Melbourne, are now prone to flash flooding due to increased urbanisation.<sup>150</sup>

Areas with ageing populations (who are particularly sensitive to heat impacts) include Melbourne's East Metro region and Melbourne's Inner South East Metro Region. Melbourne's North & West Metropolitan health regions have higher poorer health outcomes, which also impacts sensitivity to heat. Melbourne's West also has limited tree canopy cover,

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<sup>150</sup> VicSES, Local Flood Guide - Port Philip, available at: <https://www.ses.vic.gov.au/documents/112015/134900/South+Melbourne+local+flood+guide-pdf/d734cd5d-c2f1-4a9b-a8fa-818a92bbca59>



exacerbating the impact of the urban heat island effect. The areas of Cardinia and Casey are rapidly urbanising, and are already prone to flooding.

No specific mechanism exists in the building or planning system to deal with future heatwaves.<sup>151</sup> Green spaces and tree canopy cover are important considerations for future liveability, and human health and safety, in urbanising areas.

Water sensitive urban design can help mitigate the impacts of heavy rainfall events, flooding and inundation.

### **9.3 Pressures for land use**

As the Metropolitan area continues to grow, the areas around Melbourne will face increasing pressures for land use. This is a particular concern as climate change will limit the amount of land that is viable for communities to live (for example, as inundation risks increase) and viable agricultural land is impacted (for example, through saltwater intrusion into the landscape). Urban growth areas are already placing strain on the agricultural land available close to Melbourne, and ‘by 2050, up to 77% of farmland in Melbourne’s inner food bowl could be lost if long-term urban density trends continue.’<sup>152</sup>

Urban growth and agricultural land will also compete for space with native vegetation, placing increasing pressures on biodiversity, and with land clearing potentially hastening erosion of the landscape, degrading soil and water quality, and placing strain on water supplies. Increased urban density can also place strain on existing infrastructure and services, as in the Inner South East Metro region.

Coastal areas are also experiencing ‘coastal squeeze,’ whereby land available on the coast is facing pressures due to increasing urbanisation and density, while sea level rise, increasing storm surges and increasing storm tide heights are limiting the amount of coastal land available.<sup>153</sup> This places pressures on public and private land, coastal ecosystems, and coastal diversity.

### **9.4 Household Pressures**

Climate change has the potential to increase pressures on households, particularly for those who have existing social vulnerabilities. Land pressures could see the price of housing stock rise. This could see an increase in the number of households experiencing mortgage stress, or decrease home ownership accessibility. Quality of housing and housing tenure, as discussed above, also interact with vulnerability to climate change. The Port Phillip region is currently seeing a decline in homeownership rates (see Report 1: regional snapshot). Insurance has the

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<sup>151</sup> Improved management in the planning and buildings systems of natural hazards in light of climate change Discussion Paper (2018) SGS Economics and Planning Pty Ltd, prepared for DELWP

<sup>152</sup> Sheridan J., Larsen, K. and Carey, R. (2015) Melbourne’s foodbowl: Now and at seven million. Victorian Eco-Innovation Lab, The University of Melbourne p. 3

<sup>153</sup> Association of Bayside Municipalities (2017), Bay Blueprint 2070, Melbourne



potential to become prohibitively expensive for low income households, living in areas with known risks.

### 9.5 Housing quality

The building code is based on present rather than future hazards<sup>154</sup> so lots of new housing not being built for future climate change. In the planning scheme, coastal risks are taken into account, but other hazards are assessed based on present day risks not future, climate related risks.

## 10. Identified gaps in data

Whilst carrying out this research, a number of gaps in data have been identified:

- Work would need to be done to understanding on how ‘*climate adaptation ready*’ local government plans are across the board - not just whether they have explicit adaptation plans, but how comprehensive they are and how integrated climate change adaptation is to other key plans
- There is a lack of *spatial understanding of the vulnerability* of communities and infrastructure to climate impacts. Consistent hazard mapping including climate change projections and impacts is needed<sup>155</sup>
- The *planning and building systems* do not identify the impact of extreme storm surges<sup>156</sup>
- *Bushfire management overlays* in planning are based on present not future risks<sup>157</sup>
- The lack of data for *storm vulnerability* and future bushfire overlays mean it’s hard to identify where geographical areas or housing type overlap with people who are vulnerable to emergencies / disasters e.g. major floods and fires
- *There is a gap in data on homelessness*. While City of Melbourne collect a streetcount, this is purely data on people sleeping rough, and does not collect information on those in insecure housing (for example, sleeping on couches, staying at caravan parks). The ABS note that their data cannot capture segments of populations experiencing homelessness. Rental reports, and rental and mortgage stress, alongside housing affordability and Centrelink data may be used, though these are approximations
- *Some local flood plans are not yet available*. VicSES are the control agency for flooding in Victoria. Some local flood plans are pending, and not currently available.

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<sup>154</sup> Improved management in the planning and buildings systems of natural hazards in light of climate change Discussion Paper (2018) SGS Economics and Planning Pty Ltd, prepared for DELWP

<sup>155</sup> Ibid

<sup>156</sup> Ibid

<sup>157</sup> Ibid



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