Socio-economic Vulnerability Assessment of the Hunter-Central Rivers Grazing Sector

Key Points

What's at Stake?

- 8% of New South Wales' grazing sector workforce lived in the Hunter-Central Rivers region in 2011. When the beef cattle workforce is considered separately, 14% of the New South Wales' beef cattle workforce lived in the region.
- 8% of the gross value of New South Wales' production of grazing commodities occurred in the region (2010-11). When the gross value of cattle & calves slaughterings/disposals is considered separately, Hunter-Central Rivers contributed 11% to the value of cattle & calves slaughterings/disposals in New South Wales.

Potential Vulnerability

- The grazing sectors located in the far western and central northern areas of the region are characterised by high levels of potential vulnerability to the impacts of climate change.
- When compared to other parts of the region, the potential vulnerability of these two subregions is revealed by the intersection of several lines of evidence, including: a) the highest percentages of the labour force employed in grazing; b) the highest contributions to the regional value of grazing commodities produced; c) the highest degree of geographic remoteness; and d) high percentages of beef cattle and sheep farming owner managers aged 55 years or older. These vulnerabilities are potentially intensified in the far west where there are higher levels of socio-economic disadvantage and less economic diversity than in the central north.

Implications for the Future

- The proximity of Hunter-Central Rivers to major metropolitan centres (Newcastle and Sydney) suggests that the grazing sector may be able to capitalise upon new and emerging markets (e.g., growing domestic and international populations, and increased size of the middle classes in Asia).
- Emerging social and economic trends suggest that these opportunities may only be realised if graziers can successfully navigate: a) increasing production costs in the face of increased resource scarcity such as water and energy; b) increasing agricultural production from emerging nations; c) an ageing workforce; and d) a workforce that resides in areas of increasing socio-economic disadvantage.

Introduction

This commentary reports an assessment of socio-economic vulnerability to the impacts of climate change focusing upon the grazing sector in the Hunter-Central Rivers Natural Resource Management (NRM) Region. The agricultural focus of the vulnerability assessment was guided by the premise that economic sectors and populations which are more dependent upon natural resources are likely to be more sensitive to climate change impacts than sectors and populations which are less dependent upon natural resources.[1]

This commentary should be read alongside the Hunter-Central Rivers NRM Region Grazing Sector Fact Sheet.[2] Appended to this commentary are a set of maps that show the 2010-11 regional distribution of various characteristics of the sector (Maps 1-7).[3] When combined, these maps provide a snapshot of the sector's potential vulnerability to the impacts of climate change.

The assessment is then contextualised against six megatrends. "A megatrend is defined as a major shift in environmental, social and economic conditions that will substantially change the way people live" (Hajkowicz, Cook & Littleboy, 2012).

Each megatrend is discussed in terms of how it may influence the potential vulnerability of the grazing sector in the future. The six megatrends were identified by CSIRO in the report *Our future world: Global megatrends that will change the way we live* (Hajkowicz et al., 2012). These megatrends are: a) More from less; b) Going, going… gone?; c) The silk highway; d) Forever young; e) Virtually here; and f) Great expectations.

It is recommended that this commentary be read and interpreted in the context of more detailed knowledge of local circumstances.

What's at Stake?

The Hunter-Central Rivers grazing sector comprises: a) beef cattle farming; b) dairy cattle farming; c) mixed sheep-beef farming; and d) other grazing.[4] In 2011, 0.6% of the total Hunter-Central Rivers labour force was employed in the grazing sector. In the context of the New South Wales grazing sector, 8% lived in Hunter-Central Rivers, which represented 2% of the Australian grazing sector workforce (Figure 1).

In 2010-11, the combined value of commodities produced by the Hunter-Central Rivers grazing sector was $290 million which represented 8% of the value of grazing commodities produced in New South Wales, or 2% of all grazing commodities produced in Australia (Figure 2). Grazing commodities include: cattle/calves slaughterings & disposals;[5] sheep/lambs slaughterings & disposals; whole milk; and wool.[6]

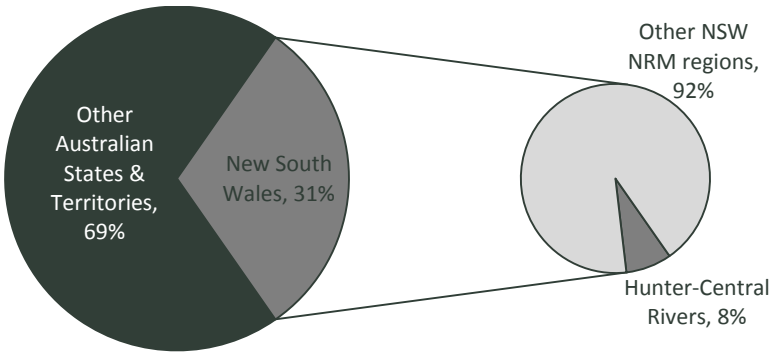

Figure 1: Place of Residence by Percentage of the Australian Grazing Workforce (2011)

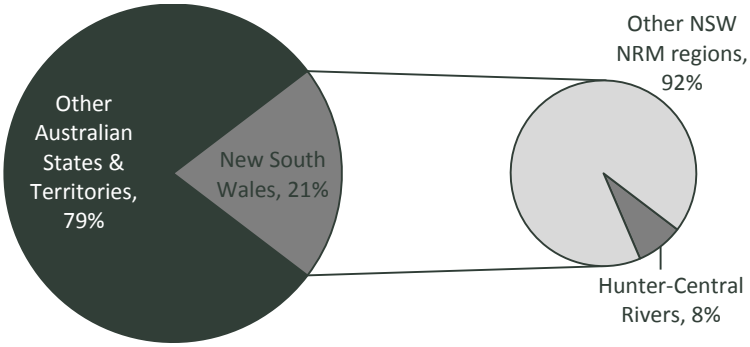

Figure 2: Place of Production by Percentage of Australia's Gross Value of Grazing Commodities (i.e., cattle/calves slaughterings & disposals;[5] sheep/lambs slaughterings & disposals; whole milk; wool)[6] (2010-11)

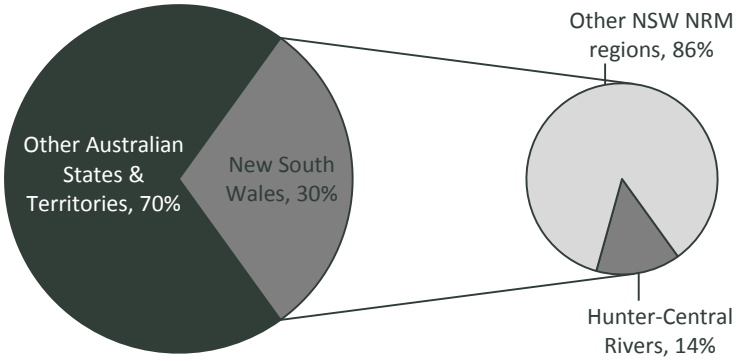

Figure 3: Place of Residence by Percentage of the Australian Grazing Workforce (Beef Cattle, specialised)

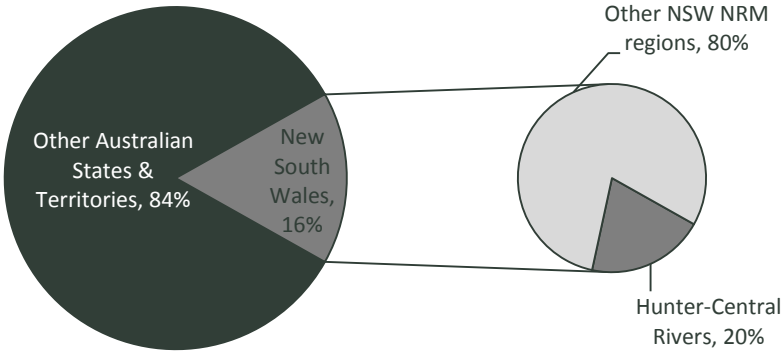

Figure 4: Place of Residence by Percentage of the Australian Grazing Workforce (Dairy)

Employment in the Grazing Sector

Upon closer inspection, the Hunter-Central Rivers grazing sector was dominated by beef cattle grazing (68% of the grazing sector workforce).[7] When compared to the wider New South Wales beef cattle workforce, 14% lived in Hunter-Central Rivers (the second highest percentage of all NRM regions in New South Wales), which represented 4% of the national beef cattle workforce (Figure 3).

The dairy sector contributed 21% of employment in the Hunter-Central Rivers grazing sector workforce. The Hunter-Central Rivers dairy workforce accounted for 20% of the New South Wales dairy workforce, which equated to 3% of the national dairy workforce (Figure 4).

The mixed sheep-beef farming sector employed a smaller percentage of the Hunter-Central Rivers grazing sector workforce (5%). The Hunter-Central Rivers mixed sheep-beef farming workforce accounted for 3% of all New South Wales' mixed sheep-beef farming workers, which was equivalent to just over 1% of the Australian workforce who were employed in the mixed sheep-beef farming sector (Figure 5). The remaining 6% of the Hunter-Central Rivers grazing workforce were employed in other grazing sectors including sheep grazing and mixed livestock-cropping.

Gross Value of Grazing Commodities

In 2010-11, Hunter-Central Rivers contributed 11% of New South Wales' gross value of cattle/calves slaughterings & disposals, or 2% of the Australian gross value of cattle/calves slaughterings & disposals (Figure 6).

In the same season, 20% of the gross value of New South Wales' milk production occurred in Hunter-Central Rivers, which equated to almost 3% of the national gross value of milk production (Figure 7).

Consistent with the smaller contribution the sheep farming

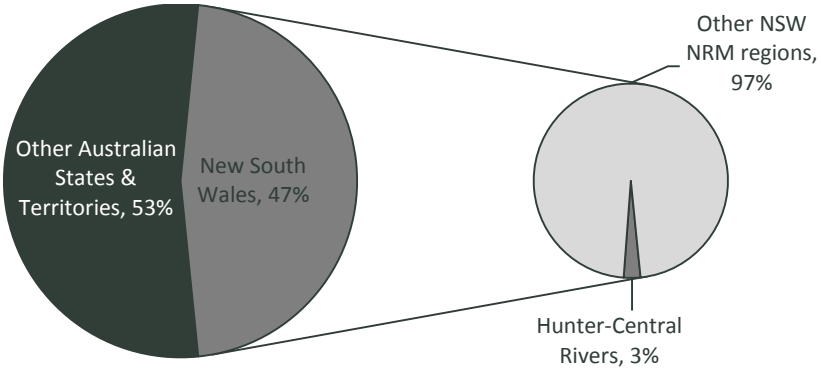

Figure 5: Place of Residence by Percentage of the Australian Grazing Workforce (Mixed sheep-beef farming)

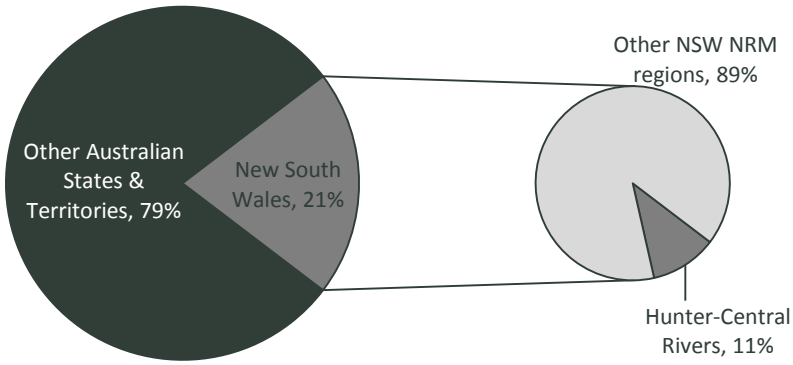

Figure 6: Place of Production by Percentage of Australia's Gross Value of Grazing Commodities (Cattle/Calves Slaughterings & Disposals)

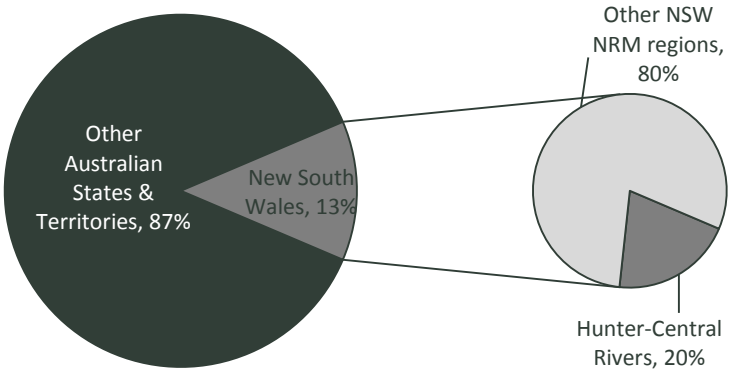

Figure 7: Place of Production by Percentage of Australia's Gross Value of Grazing Commodities (Whole Milk)

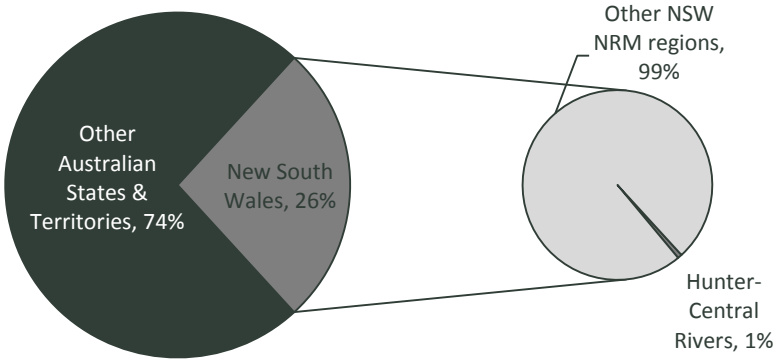

Figure 8: Place of Production by Percentage of Australia's Gross Value of Grazing Commodities (Sheep/Lambs Slaughterings & Disposals + Wool)

sector made to the grazing sector's workforce (included as 'other grazing' above), Hunter-Central Rivers produced only 1% of the combined gross value of sheep/lambs slaughterings & disposals and wool production in New South Wales (Figure 8).

What are the Potential Vulnerabilities?

The potential vulnerability of the grazing sector was assessed using five factors known to shape socio-economic vulnerability:
a) percentage of the labour force employed in agriculture (Map 1); b) geographic remoteness (Map 2); c) socio-economic advantage/ disadvantage (Map 3); d) economic diversity (Map 4); and e) age (Maps 5a and 5b). Each factor is considered one line of evidence. Areas in which multiple lines of evidence intersect suggest higher potential vulnerability than areas in which fewer lines intersect. Areas of potential high vulnerability are then compared to the areas that are characterised by high reliance upon the grazing sector. Reliance upon the grazing sector is indicated by: a) percentage of the gross value of grazing commodities produced (Map 6); and b) percentage of the labour force employed in grazing (Map 7).[3]

Northern Hunter-Central Rivers, stretching westwards from Gloucester to the western boundary, was characterised by the intersection of multiple lines of evidence which suggest high potential socio-economic vulnerability. First, in this part of the region, high percentages of the labour force were employed in agriculture (generally more than 20%) when compared to the eastern and southern parts of the region (Map 1).[8] Second, with the exception of the areas surrounding Scone, Denman and Muswellbrook, northern Hunter-Central Rivers was classified as 'outer regional', the most remote classification in the region (Map 2).

The spatial trends with regards to socio-economic advantage/disadvantage and economic diversity were more varied. The far west (generally north west of Denman, deciles 3-4) and north east Hunter-Central Rivers (east of Gloucester and north of Newcastle, deciles 1-4) were characterised by high levels of socio-economic disadvantage, indicating high potential vulnerability. The central north of the region was moderately disadvantaged (deciles 5-6), which suggests that the area between Scone and Gloucester may be less vulnerable than the far western and north eastern parts of the region (Map 3). In the case of economic diversity, the entire western section of the region (west of Singleton, with the exception of Scone) was characterised by high potential vulnerability (Hachman Scores 0.20 or less). The far north east (north east of Gloucester, excluding Taree) and a small area south west of Maitland also had limited economic diversity (Hachman Scores 0.21-0.40) (Map 4).

In the context of where the Hunter-Central Rivers grazing sector is most concentrated, two subregions can be identified, both of which correspond to areas of high potential vulnerability: a) the far west, especially north of Merriwa;[8] and b) the central north, between Scone , Gloucester and the northern boundary. Both subregions are characterised by high percentages of the labour force employed in grazing (Map 7). In the far west, 40.1-60.0% of the labour force was employed in grazing (i.e., north of Merriwa). In the central north, the highest percentages of the labour force employed in grazing were located on the northern boundary, while further south towards Gloucester, the grazing sector employed 20.1-40.0% of the labour force. In the case of the gross value of grazing commodities produced in the region, the north west of the region (the areas surrounding Merriwa and Scone), contributed 20%. The areas surrounding Gloucester and Taree in the north east contributed 19% (Map 6) to the gross value of grazing commodities produced in the region.

The age profiles[9] of the beef cattle and sheep grazing owner managers in both the north west and north east subregions were skewed towards the older age groups (Map 5a). The north east had a higher percentage of owner managers aged 55 years or older (North East Region = 77%) when compared to similarly aged owner managers in the north west (Scone Region = 64%). The employee age profiles demonstrated the same pattern. In the north east, 32% of employees were aged 55 years or older; in the north west, 25% of employees were similarly aged (Map 5a). These sub-groups of the workforce may have increased vulnerability because of older people's increased physical sensitivity to climate changes (e.g., increased temperatures) (Vaneckova et al., 2008). Thus, when compared to beef cattle and sheep graziers, the eastern dairy subregion, which overlaps part of the north east grazing region, may be less vulnerable because the age profile comprised a lower percentage of owner managers aged 55 years or older (44%). Similarly, a much smaller percentage (8%) of dairy sector employees was aged 55 years or older (Map 5b).

Younger members of the workforce may have different vulnerabilities, particularly in relation to their adaptive capacity. For example, younger-aged members of the workforce may be more vulnerable because research has demonstrated that they disproportionately experience income loss during weather-related disasters when compared to older people (Clemens et al., 2013). The north west grazing sector supported the largest number of employees (Scone Region = 281 employees, Map 5a), more than half of which were aged 15-44 years (59%). Similarly, just over half (55%) of employees in the north east were in these age cohorts (North East Region = 76 employees, Map 5a), although the absolute number of employees was much lower than in the north west.

The age profile of employees in the eastern dairy subregion was skewed towards the younger age groups with 67% aged 15-44 years (Map 5b).

Table 1 below summarises the individual influence of each factor upon the potential vulnerability of the Hunter-Central Rivers grazing sector. It shows each of the variables assessed with respect to their having limited or substantial influence upon the potential vulnerability of the sector.

Table 1: Summary of the influence of each factor upon the potential vulnerability of the Hunter-Central Rivers grazing sector

	Influence upon the potential vulnerability of the grazing sector
Percentage of the Labour Force Employed in Agriculture (Map 1)	Substantial influence: The percentage of the labour force employed in agriculture was highest in the far north of the central north grazing region; as well as, in the far west region. This suggests that these localised subregions may be more vulnerable than the areas immediately to the north and west of Gloucester because of a higher dependence upon agriculture (Marshall et al., 2013; 2014). However, throughout most of the grazing subregions, the percentage of the labour force employed in grazing was similar to the percentage employed in the wider agricultural sector. This suggests that there may be limited agricultural employment opportunities outside of the grazing sector, decreasing people's capacity to adapt to a downturn in the grazing sector.
Geographic Remoteness (Map 2)	Substantial influence: The two subregions characterised by the highest percentages of the labour force employed in grazing and the highest percentages of the value of grazing commodities produced were entirely located in areas categorised as 'outer regional', which suggests that access to services may be poorer than in the less remote eastern and southern areas of the region. People living in more remote areas are likely to be disproportionately affected by weather/climate related disasters or events than people in less remote areas (Clemens et al., 2013).
Socio-economic Advantage & Disadvantage (Map 3)	Substantial influence: The two subregions characterised by the highest percentages of the labour force employed in grazing and the highest percentages of the value of grazing commodities produced corresponded to areas of high socio-economic disadvantage, suggesting that people living in these areas may have reduced adaptive capacity (Sano et al., 2011; Clemens et al., 2013). However, socio-economic advantage/disadvantage is likely to have less influence upon the potential vulnerability of the central north grazing region in which there are lower levels of disadvantage when compared to the far west.
Economic Diversity (Map 4)	Substantial influence: The two subregions characterised by the highest percentages of the labour force employed in grazing and the highest percentages of the value of grazing commodities produced corresponded with areas that had less diverse local economies than other parts of the region, suggesting higher potential vulnerability to downturns in the grazing sector because job opportunities are likely to be more specialised and may be more limited (Alston & Witney-Soanes, 2008). However, the central north grazing region traversed multiple levels of economic diversity, some of which were higher than the far west. These patterns suggest that potential vulnerability is lower in the central north than the far west.
Age (Maps 5a & 5b)	Substantial influence: The north west and north east grazing areas in Hunter-Central Rivers were characterised by workforces with high proportions of owner managers aged 55 years or older. Members of the workforce in these age groups may be more vulnerable than younger aged members because of older people's increased physical sensitivity to climate changes (e.g., increased temperatures) (Vaneckova et al., 2008). However, in the north east, the percentage of owner mangers in the two oldest age cohorts was more than three-quarters, 13% higher than similarly aged owner managers in the north west, which suggests higher potential vulnerability in the north east grazing sector. In addition, more than half of grazing employees in the north west and north east were in the three youngest age groups. This characteristic of the workforce may increase the potential vulnerability of the grazing sector because people in younger age cohorts tend to be disproportionately affected by income loss during weather-related disasters when compared to older people (Clemens et al., 2013).

Vulnerability Assessment

The grazing sector located in the far west of the region is characterised by the highest levels of potential vulnerability to the impacts of climate change. In the context of the wider region, this area is one of two subregions in which there is a high social and economic reliance upon the grazing sector (i.e., they have high percentages of the labour force employed in grazing and produce high percentages of the value of grazing commodities, Maps 6 & 7).

It is in the far west subregion that most lines of evidence for potential vulnerability intersect. Specifically, this area is characterised by: a) high percentages of the labour force employed in agriculture (Map 1); b) a high level of geographic remoteness (Map 2); c) high levels of socio-economic advantage/disadvantage; d) low levels of economic diversity (Map 4); 3) high percentages of beef cattle and sheep farming owner managers aged 55 years or older (Map 5a); and f) high percentages of beef cattle and sheep farming employees in the youngest three age cohorts (Map 5a).

The second grazing subregion is the central north, between Scone, Gloucester and the northern boundary. Although some of the characteristics of this subregion are similar to the far west (e.g., percentages of the labour force employed in agriculture/grazing; geographic remoteness; and the age profiles of the workforce), the central north may have lower potential vulnerability to the impacts of climate change because this region is characterised by lower levels of socio-economic disadvantage (Map 3) and, in parts, there appear to be more diverse local economies (Map 4) when compared to the far west.

The Hunter-Central Rivers dairy sector has not been extensively discussed in this assessment due to its location largely outside of the dominant grazing regions identified. For example, although the western dairy region identified on Map 5b partly overlaps with the far west grazing region, closer inspection of the data reveals that the workforce is primarily located south of Scone.[10] However, the distribution of the dairy sector in the eastern region is less clear. The eastern dairy region (Map 5b) partly overlaps the central north grazing region, but it is not possible to determine precisely where the dairy sector is concentrated within this subregion on the basis of these data. If the dairy sector is concentrated in the area surrounding Gloucester and extending northwards to the Hunter-Central Rivers boundary, it warrants consideration by natural resource managers when this assessment is interpreted in the context of more detailed knowledge of local circumstances.

What May Change?

Recognising that adaptations to climate change will be carried out in the context of other social, environmental and economic influences on the sustainability of the grazing sector, it is useful to consider some key trends in more detail. CSIRO reports that 'megatrends', comprising the interaction between many trends, represent major shifts in "environmental, social and economic conditions that will substantially change the way people live" (Hajkowicz et al., 2012, p. 4).

CSIRO identify six megatrends that will influence contemporary decision-making and shape the future of Australia:

1. The 'More from Less' megatrend considers the limits to natural resources and how quality of life for current and future generations will be facilitated by companies, governments and communities.
2. The 'Going, Going… Gone?' megatrend considers the implications of declining ecological habitats and biodiversity due, in part, to climate change.
3. 'The Silk Highway' megatrend considers how the world economy will shift from west to east and north to south, changing export markets, trade ties and business models.
4. The 'Forever Young' megatrend focuses upon the advantages and the challenges posed by Australia's ageing population.
5. The 'Virtually Here' megatrend considers the implications of increased connectivity of individuals, communities and governments through virtual platforms.
6. The 'Great Expectations' megatrend considers the implications of increasing demand—particularly in relation to demand for experiences over products – and the importance of social relationships in financially wealthy segments of society. At the same time, people in impoverished parts of the world will have expectations for basic necessities.

In this section, we consider the implications for the agricultural sector in light of CSIRO's megatrends alongside the indicators of socio-economic vulnerability. The associations and conclusions made below are not meant to be definitive; rather they are intended to demonstrate an approach to deliberating the potential implications of trends and system drivers that might not otherwise be traditionally applied to regional NRM practice.

Percentage of the Labour Force Employed in Agriculture

The impact of the six megatrends upon the percentage of the labour force employed in agriculture will likely be complex and multifaceted. The composition of the agricultural workforce will likely change, even if the percentage of the labour force employed in the sector remains stable. These changes may be driven by the new/different skill sets required and the changing location of agricultural production due to wider changes in the sector

(e.g., residential expansion, competing land uses, increased corporatisation of supply chains, and investment cycles).

An increase in the ageing but active population offers the sector new (and potentially flexible) labour markets, but may limit opportunities for younger people as increased numbers of older people intensify competition for employment. These dynamics may have flow-on effects for agricultural innovation. For example, an ageing but more active labour force may also limit the opportunities for new, entrepreneurial workers to enter the agricultural sector, thereby inhibiting new ideas and innovation (see Florida, 2002, for an analysis of 'The Creative Class').

As people's economic and social expectations increase, those who are able to leave the agricultural sector for higher paying employment may do so, potentially reducing skill levels among agricultural workers. At the same time, adoption of digital technologies (e.g., precision farming techniques), and continued automation of production processes and supply chains may reduce the need for labour. These same technologies, however, offer opportunities for increased productivity and cost efficiencies, increased collaboration across scales, and access to new but more distant markets.

The effects of these trends will be experienced differently between regions. Agricultural industries located in more urbanised regions (e.g., Hawkesbury-Nepean and South East Queensland) will likely have better access to more diverse labour markets than more regional or remote areas (e.g., Fitzroy and Northern Rivers).

Geographic Remoteness

A growing population and increased urbanisation may intensify the differentiation between metropolitan areas and regional/rural/remote areas. These trends may be more acutely experienced in Fitzroy, Burnett-Mary and areas in Northern Rivers where large areas are already classified as 'outer regional or 'remote'.

In addition, increased levels of foreign investment will likely concentrate in particular areas where prevailing conditions are more conducive to investment needs – meaning that other areas will be bypassed – potentially exacerbating existing disadvantage (Pritchard & Tonts, 2011). The implication for NRM managers is that they may need to consider the likely cycles of foreign investment, the differential impacts these cycles will have within and between regions, and the potential implications for changes in land use.

Akin to urbanisation trends, these changes will also potentially intensify the differential between regions in different remoteness categories. Any adverse effects may be mediated by increased access to digital technologies in the regions, providing agricultural businesses with better access to information, markets and professional networks (e.g., national broadband network).

Altered growing conditions shaped by climatic changes (e.g., increased temperatures, increased evapotranspiration, and reduced soil moisture),[11] may force or allow for crop and/or farm system changes. In turn, there may be positive, but spatially differentiated, consequences for agricultural production and the economic value generated, potentially making some remote, marginal agricultural areas less marginal. However, any advantages may be counteracted by increased water scarcity which will likely drive changes in growing seasons and farm systems.

An ageing population is a marked feature of many rural and regional areas, but there are different dynamics with regards to the key drivers (e.g., people ageing in place, high in-migration of older people or high out-migration of young people) (Regional Australia Institute, 2014). The implication for NRM managers is to recognise the likely continued ageing of many regional/rural areas and the associated implications for the agricultural labour force, as well as agricultural support services.

Socio-economic Advantage/Disadvantage

The megatrends will likely increase the overall wealth of a population, but its distribution will likely be uneven, intensifying current socio-economic inequalities. The differentiation between advantaged populations and disadvantaged populations may be exacerbated by increasing energy costs and food prices. The challenges experienced by socio-economically disadvantaged cohorts may be further intensified by increased wealth and demand originating in Asia, with flow-on impacts to higher living costs.

The potential limitations to increasing economic diversity arising from resource scarcity (in particular water) may increase socio-economic disadvantage of marginal agricultural areas. Despite there being increased opportunities for innovation and use of digital technologies, higher levels of socio-economic disadvantage may continue to limit the capacity of some population groups to reap the benefits. Socio-economic disadvantage may also be exacerbated in some areas where retirees have limited financial resources. These adverse impacts may be off-set by older people being more active and, therefore, able to stay in the workforce for longer. These trends may simply displace socio-economic disadvantage to younger people who may be unable to find employment.

Economic Diversity

Diverse economies are often less vulnerable than economies characterised by lower levels of economic diversity (Alston & Witney-Soanes, 2008). It is unclear how the megatrends may affect wider economic diversity at the local scale; however, the potential implications for diversity within the agricultural sector are clearer.

Population growth at domestic and global scales, combined with

changing patterns of consumption, will potentially create pressure for agricultural businesses and regions to diversify their product base to satisfy consumer demands from emerging markets (e.g., South East Asia). However, increases to agricultural production and production efficiencies in emerging nations may increase competition for agricultural products in the global market. The success of Australian producers in this context will continue to be influenced by global trading rules and the agricultural policies of individual nations. Adverse consequences may be mitigated by: a) increased demand through the increasing population of middle classes in nations such as China and India; and b) increased demand for high value-added products linked to healthy lifestyles and rural experiences (e.g., agri-tourism).

The capacity of individual businesses and regions to capitalise on these opportunities may be hindered in light of increased resource scarcity (e.g., water), which may inflate the costs of production. The way in which these trends intersect will likely differ between places; in particular, diversification in already marginal agricultural areas may be especially difficult.

Innovation in business models and farm systems is likely to be a critical influence upon economic diversity. New digital technologies offer scope for innovation in supply chains, collaboration, access to knowledge and marketing. However, longer life spans combined with an ageing agricultural workforce may constrain workforce turnover, reducing the number of new entrants with new knowledge and skills and, subsequently, impede sector innovation (see above).

Age

The implications of the megatrends for the age profiles of the agricultural sector will not be linear. In general, longer lifespans and an ageing population, combined with social expectations related to higher living standards (e.g., services and experiences), will likely result in an older agricultural workforce as people seek to maintain income levels beyond the official retirement age. These dynamics may entrench further aged workforces in some agricultural sectors.

At the same time, it is well established that older people tend to be more vulnerable to temperature extremes (Vaneckova et al., 2008). Thus, increases in extreme climate-related events may reduce older people's capacity to participate in the labour force. These potential adverse effects upon the agricultural workforce may be counteracted by older people who are more active. In the short- to medium-term, an ageing agricultural workforce may have reduced capacity with which to deploy and use digital technologies that may provide diversification benefits, improve business management and enhance productivity.

More extreme climate-related events may also heighten adverse impacts for owners of income producing property who also have dependent family members (Clemens et al., 2013).

In Table 2 below we highlight which aspects of CSIRO's megatrends seem most relevant to the potential vulnerability of the Hunter-Central Rivers grazing sector.

Table 2: Possible implications of the megatrends for the Hunter-Central Rivers grazing sector

	Implications of the megatrends
Percentage of the Labour Force Employed in Agriculture (Map 1)	The grazing sector's location away from major urban centres suggests that it may face labour market access challenges when compared to agricultural sectors located closer to urban centres. These challenges may be driven by increased out-migration as people who are able to leave rural/regional areas and/or agricultural employment will do so in pursuit of higher education and higher paying occupations. Similarly, the tendency for mining employees to reside in Scone (near the far west grazing region) and commute to work around Singleton and Muswellbrook may continue to increase labour market competition for the grazing sector (McManus & Connor, 2013). In contrast, an increase in the ageing but active population offers the sector new (and potentially more flexible) labour markets.
Geographic Remoteness (Map 2)	The far west and central north grazing regions are located in areas categorised as 'outer regional'. Foreign investment patterns may create and/or exacerbate differentiation within and between these subregions. Any adverse impacts may be counteracted by better access to technology enabling information sharing, collaboration and innovation in marketing. Both grazing subregions are suitably located near tertiary education facilities (TAFE New South Wales Scone and Taree campuses; University of Newcastle) that have agricultural offerings, which may be used to address workforce skill shortages and/or increase innovation in the sector.
Socio-economic Advantage & Disadvantage (Map 3)	The dominant influence of the megatrends upon socio-economic advantage/disadvantage may be one of entrenching existing inequalities. Any entrenchment of existing inequalities may increase the potential vulnerability of the grazing sector in far west Hunter-Central Rivers as it is already located in areas of high socio-economic disadvantage. Thus, on the one hand, the grazing sector may benefit from increased consumer demand and wealth, but on the other, its workforce may be negatively impacted by associated increases in energy and food costs imposed by increased demand and resource scarcity.
Economic Diversity (Map 4)	The grazing sector's locational advantage with respect to large metropolitan areas when compared to grazing sectors located further from key metropolitan areas suggests that there may be opportunities to take advantage of emerging domestic and international markets. Increased demand for higher value added products among the increasing middle class in Asia also provides opportunities for diversification. Despite these advantages, increased resource scarcity (e.g., water scarcity) and any increases in agricultural production from emerging nations, will likely necessitate innovative solutions in order to manage production costs to remain competitive
Age (Maps 5a & 5b)	Although the populations in both grazing subregions are characterised by average rates of ageing when compared to other parts of Australia (Regional Australia Institute, 2014), these dynamics suggest that the grazing sector may become increasingly reliant upon older workers in the future, particularly in the north west of the region where the grazing sector comprises a higher number of employees relative to the number of owner managers. These circumstances may result in decreased workforce turnover, with flow-on challenges for innovation as discussed above. Continued trends of out-migration from regional Australia on the part of younger people may further intensify the vulnerabilities associated with older workforces.

Endnotes

[1] Using resource dependency as a proxy for sensitivity to climate change impacts follows recent Australian work (see Marshall et al. 2014; Marshall et al. 2013).

[2] Smith E., Keys N., Lieske S., & Smith T. (2014a). *Hunter-Central Rivers Natural Resource Management Region: Grazing Sector*, prepared as part of the East Coast NRM Cluster, University of the Sunshine Coast, Sippy Downs, Queensland, Australia.

[3] An earlier report describes in detail the methods used to compile the data from which the maps are derived (Smith et al., 2014b).

[4] These subsectors were derived from the Australian Bureau of Statistics classifications used to report data from the 'Census of Population and Housing 2011' (see Smith et al., 2014b). Due to the way in which the Australian Bureau of Statistics aggregates these data, it is impossible to separate completely livestock farming from crop farming. Here, people working in mixed livestock-cropping enterprises are included in the 'other grazing' category. In the case of Hunter-Central Rivers, up to 90 people (3%) were employed in enterprises that likely produced crops alongside beef cattle or sheep grazing.

[5] The Australian Bureau of Statistics' data does not separate beef cattle from dairy cattle.

[6] These subsectors were derived from the Australian Bureau of Statistics classifications used to report data from the 'Agricultural Census 2010-11' (see Smith et al., 2014b).

[7] Defined by the Australian Bureau of Statistics' classification 'Beef cattle farming (Specialised)'; thus, does not include beef cattle farming conducted in conjunction with sheep farming or cropping.

[8] The area south west of Denman is also characterised by a high percentage of the labour force employed in the agricultural sector generally (Map 1) and the grazing sector specifically (Map 7). Most of this area corresponds to the Goulburn River and Wollemi National Parks; thus, the significance of this area should be evaluated accordingly.

[9] The Australian Bureau of Statistics includes another employment classification: contributing family members. Owing to the ambiguity surrounding their role in agricultural businesses (i.e., they may or may not have ownership and/or management responsibilities) this subpopulation of the workforce has not been included in the age profiles. In the case of the Hunter-Central Rivers beef cattle and sheep farming workforce, there were 978 contributing family members. The age profiles of these workers were broadly consistent with the age profiles for owner managers in each of the subregions identified on Map 5a.

[10] The Scone Region was included in the compilation of the data for the western dairy region to ensure maximum coverage of the sector.

[11] See The East Coast Cluster Climate Projections report for a comprehensive assessment of anticipated climatic changes in the region.

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Further Information

This commentary should be referenced as:

Smith, E., Keys, N., Lieske, S. & Smith, T. (2014). *Socio-economic Vulnerability Assessment of the Hunter-Central Rivers Grazing Sector*, prepared as part of the East Coast NRM Cluster, University of the Sunshine Coast, Sippy Downs, Queensland, Australia.

This commentary forms part of the activities of the Climate Change Adaptation for Natural Resource Management in East Coast Australia project. It is the fourth and final product from the socio-economic vulnerability component of the project. The three other products from the socio-economic vulnerability component are:

1. Six sector-based Fact Sheets (one for each NRM region in the East Coast Cluster)
2. An interim Report (Smith, Lieske, Keys & Smith, 2014b)
3. Six sets of maps (one for each NRM region in the East Coast Cluster)

The Climate Change Adaptation for Natural Resource Management in East Coast Australia project aims to foster and support an effective "community of practice" for climate adaptation within the East Coast Cluster regions that will increase the capacity for adaptation to climate and ocean change through enhancements in knowledge and skills and through the establishment of long term collaborations. The East Coast Cluster consists of the coastal Natural Resource Management (NRM) bodies in Queensland and New South Wales between Rockhampton and Sydney. The Research Consortium comprises: University of Queensland (Consortium leader); Griffith University; University of Sunshine Coast; CSIRO; University of Wollongong; New South Wales Office of Environment and Heritage; and Queensland Department of Science, IT, Innovation and the Arts (Queensland Herbarium). The views expressed herein are not necessarily the views of the consortium partners, and the consortium partners do not accept responsibility for any information or advice contained herein. The East Coast NRM Cluster received funding from the Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education as part of the Natural Resource Management Climate Change Impacts and Adaptation Research Grants Program, under the Natural Resource Management Planning for Climate Change Fund - A Clean Energy Future Initiative. The views expressed herein are not necessarily the views of the Commonwealth of Australia, and the Commonwealth does not accept responsibility for any information or advice contained herein.

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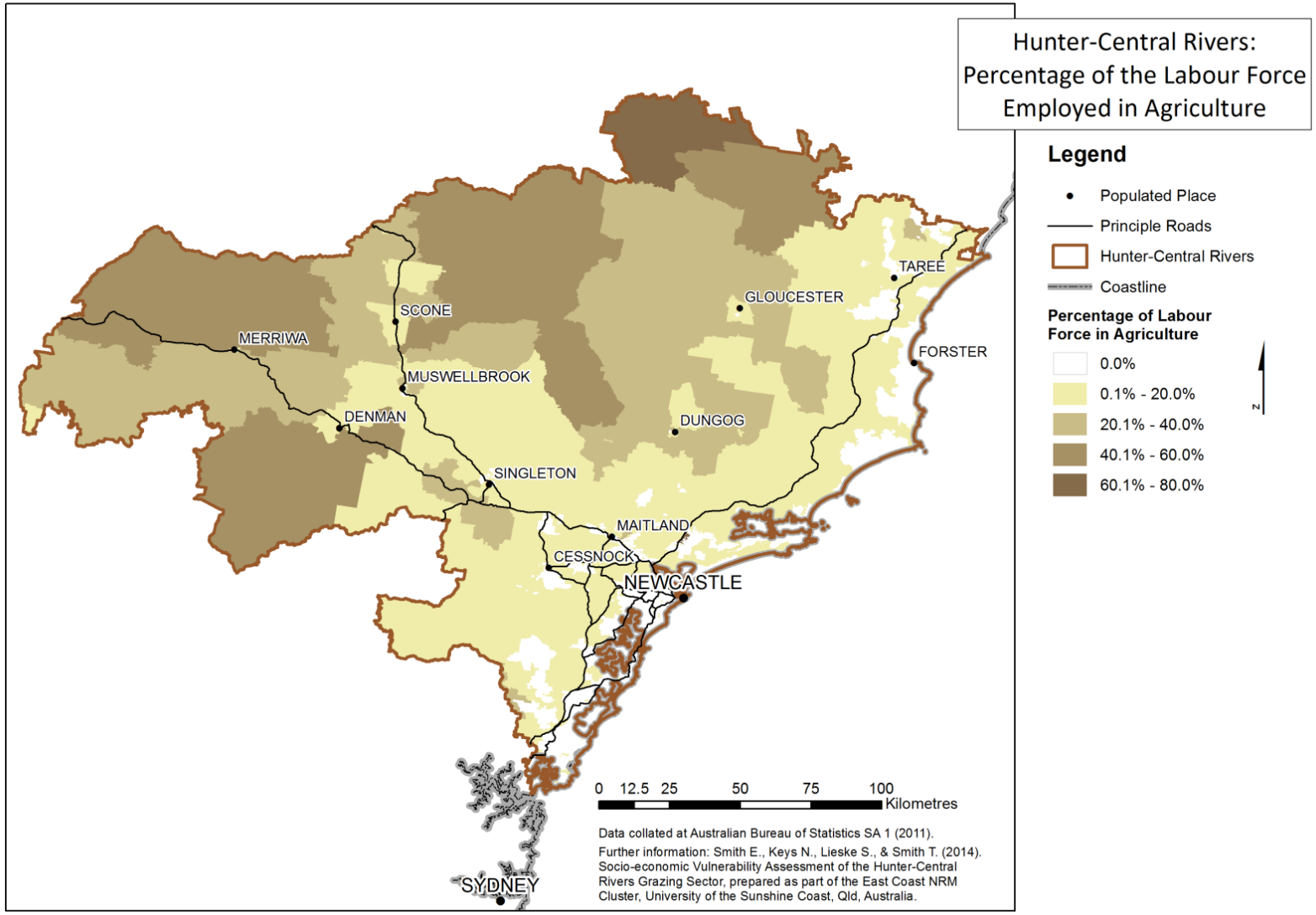
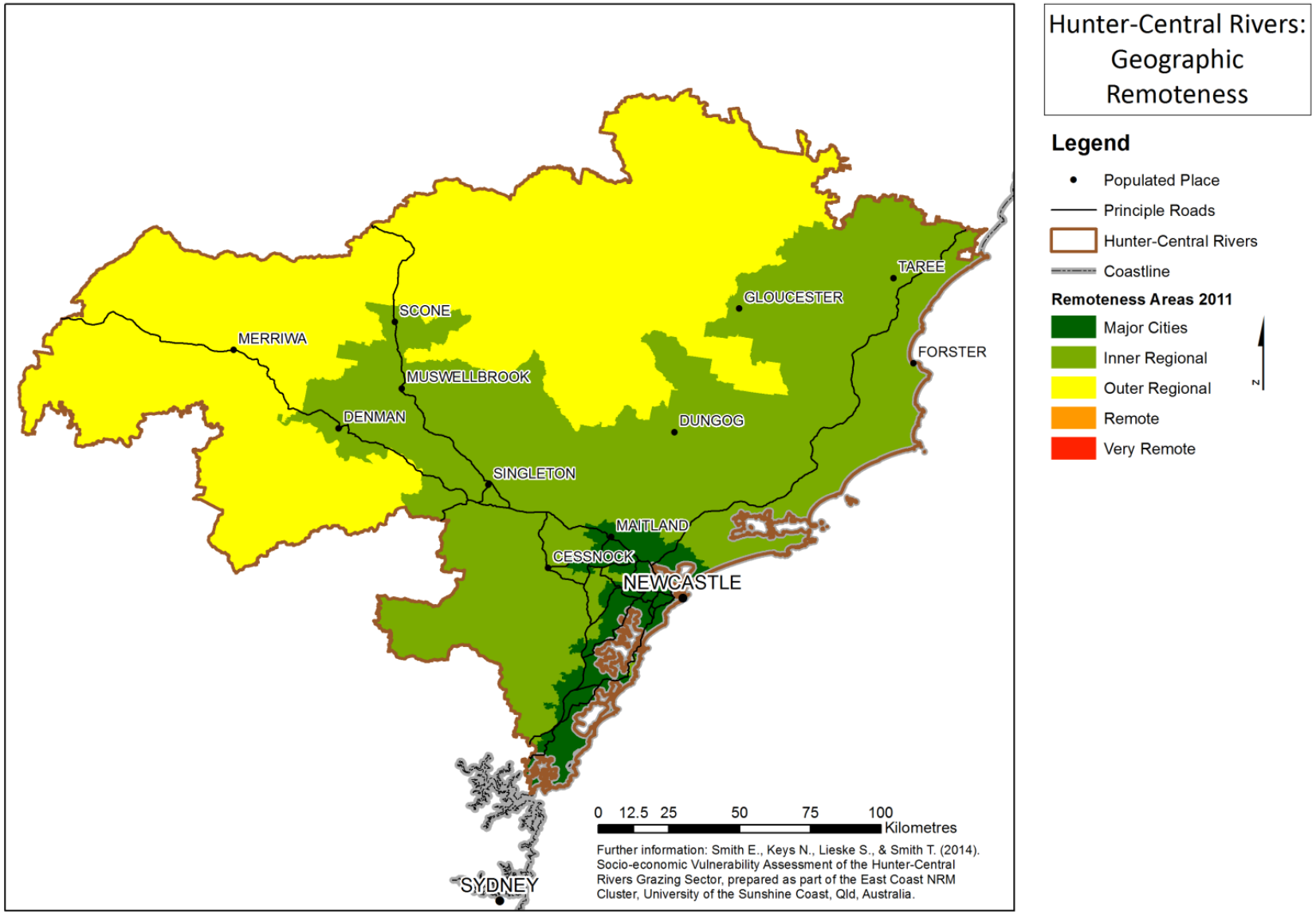
Map 1: Percentage of the Labour Force Employed in Agriculture

Why consider the percentage of the labour force employed in agriculture? Sensitivity to the impacts of climate change has been associated with the degree to which a population is dependent upon natural resources (Marshall et al., 2013; Marshall et al., 2014). Populations dependent upon economic sectors that are characterised as being highly resource dependent may be highly sensitive to climatic variability. Agriculture, broadly defined, is highly dependent upon natural resources; thus, populations in which a high percentage of the labour force is employed in agriculture may be more vulnerable to downturns in one or more agricultural sectors. Assessing the percentage of the labour force employed in agriculture enables comparisons to the percentage of the labour force employed in individual agricultural sectors (e.g., horticulture, grazing) and, therefore, provides an indication of the diversity of the agricultural sector.



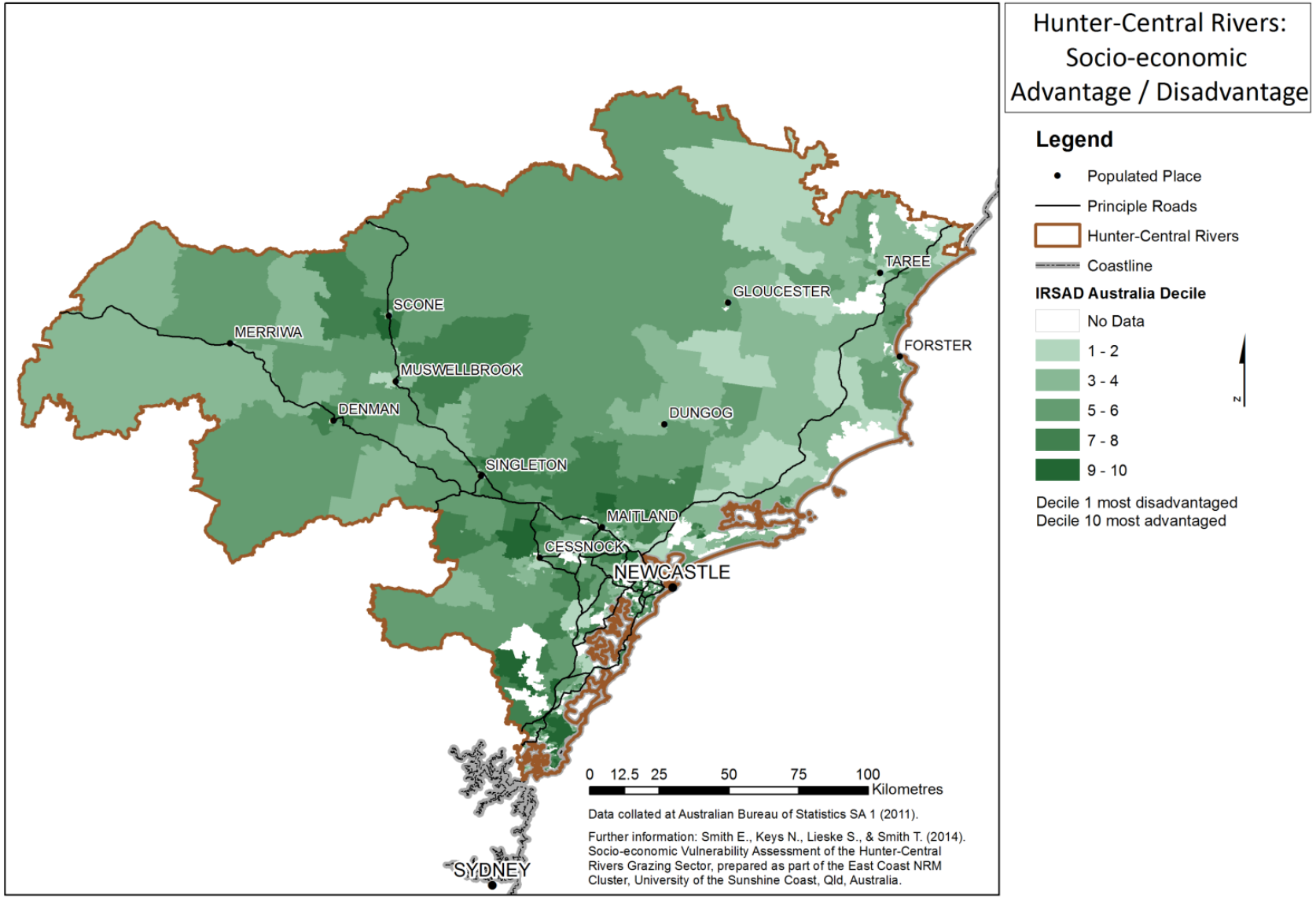
Map 2: Geographic Remoteness

Why consider geographic remoteness? Rural and regional areas are often characterised by higher levels of disadvantage than urban areas because of the interaction between socio-economic characteristics of the population and the characteristics of particular places (Gray & Lawrence, 2001; Barclay, 2014). After the natural disasters in Queensland in 2010-11, researchers found that higher proportions of people living in rural and remote areas reported suffering adverse impacts when compared to people living in larger urban areas (Clemens, et al., 2013).



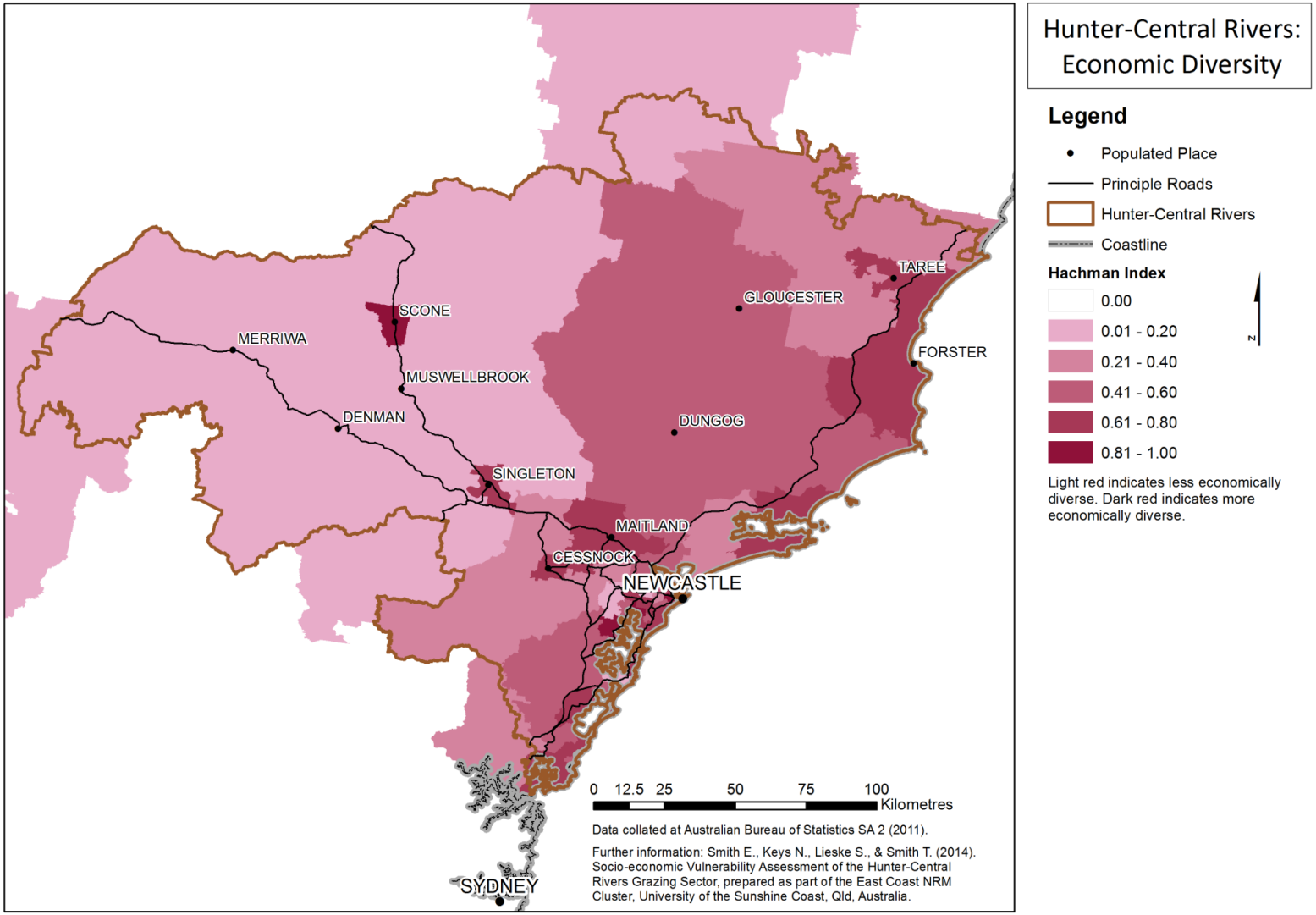
Map 3: Socio-economic Advantage / Disadvantage

Populations with higher levels of socio-economic disadvantage may have increased sensitivity (and reduced adaptive capacity) to the impacts of climatic and environmental changes. For example, in a study of the impacts of trauma after Queensland's floods in 2010-11, Clemens et al., (2013) reported that people in socio-economically disadvantaged areas were disproportionately likely to report exposure to property damage and emotional impacts when compared to more advantaged subpopulations.



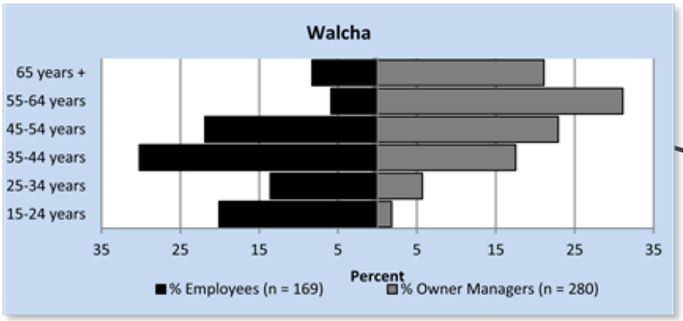
Map 4: Economic Diversity

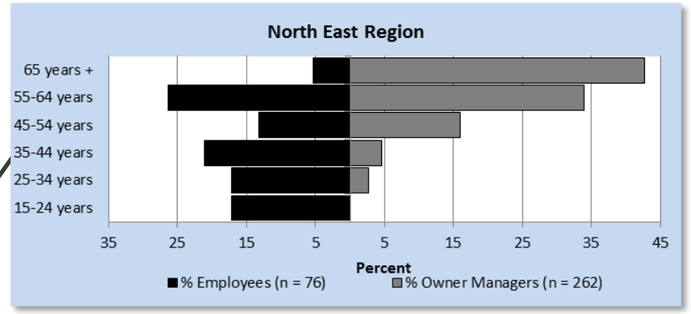
Why consider economic diversity? A diverse economy may contribute toward reduced socio-economic vulnerability because it provides a broader range of employment opportunities if individual sectors experience a downturn due to economic or environmental factors. Researchers found that farming and small communities in the Murray-Darling Basin tended to experience more acutely negative social impacts of drought if they were almost totally reliant upon agricultural sectors, with almost no alternative avenues of employment (Alston & Witney-Soanes, 2008). The Hachman Index is a measure of how closely the employment distribution of a region resembles the distribution of employment in a benchmark region. Hachman scores range from 0.00-1.00, where the economic diversity of the Australian economy is assumed to be equal to 1.00.

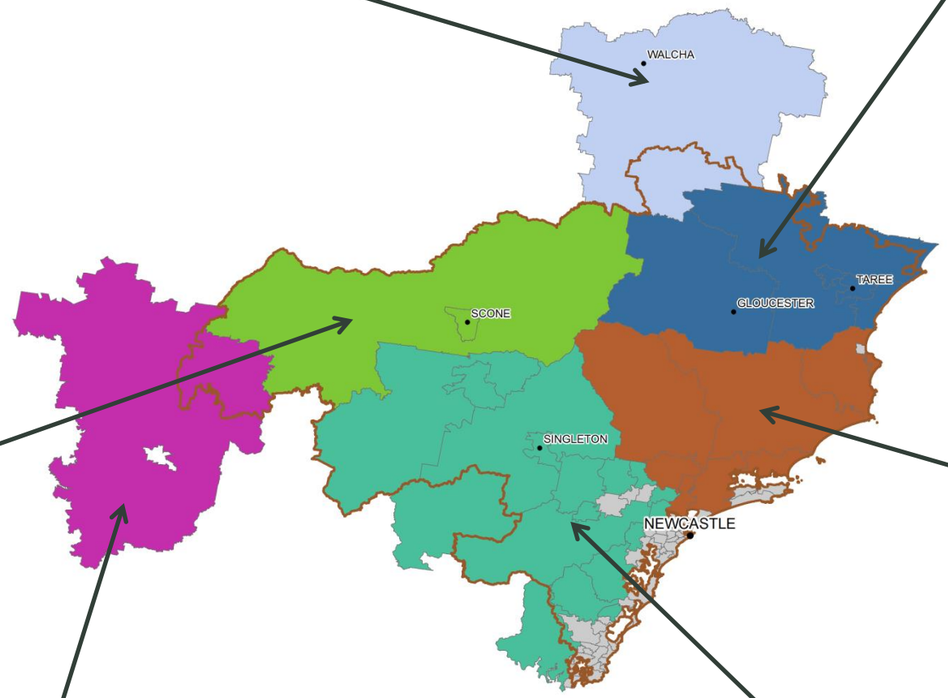


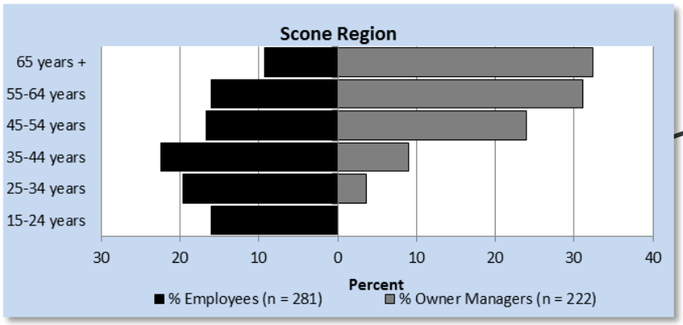
Map 5a: Hunter-Central Rivers: Age Profiles of the Grazing Workforce (Beef Cattle & Sheep)

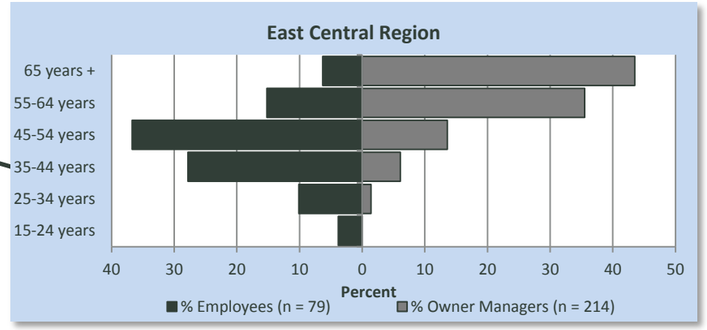
Why consider age? In general, older people may be more vulnerable to climate impacts than younger people because of their increased sensitivity to negative health impacts of climate changes (e.g., increased temperatures) (Vaneckova et al., 2008). Middle-aged owner managers may also be more vulnerable than employees because of reduced adaptive capacity arising from potential adverse climate-related impacts on their business property combined with potential adverse social impacts with their having dependent children (Clemens et al., 2013). For this reason, the age profiles of owner managers are separated from employees, as well as to capture differences/similarities in the age distribution of people who have decision-making responsibility when compared to the wider workforce.

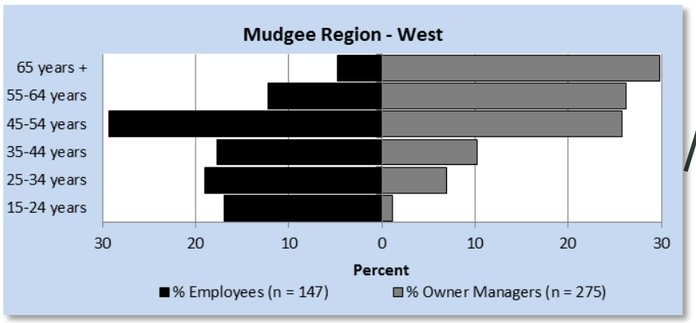


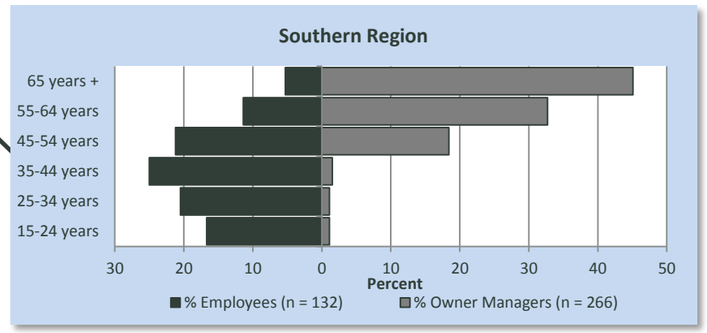






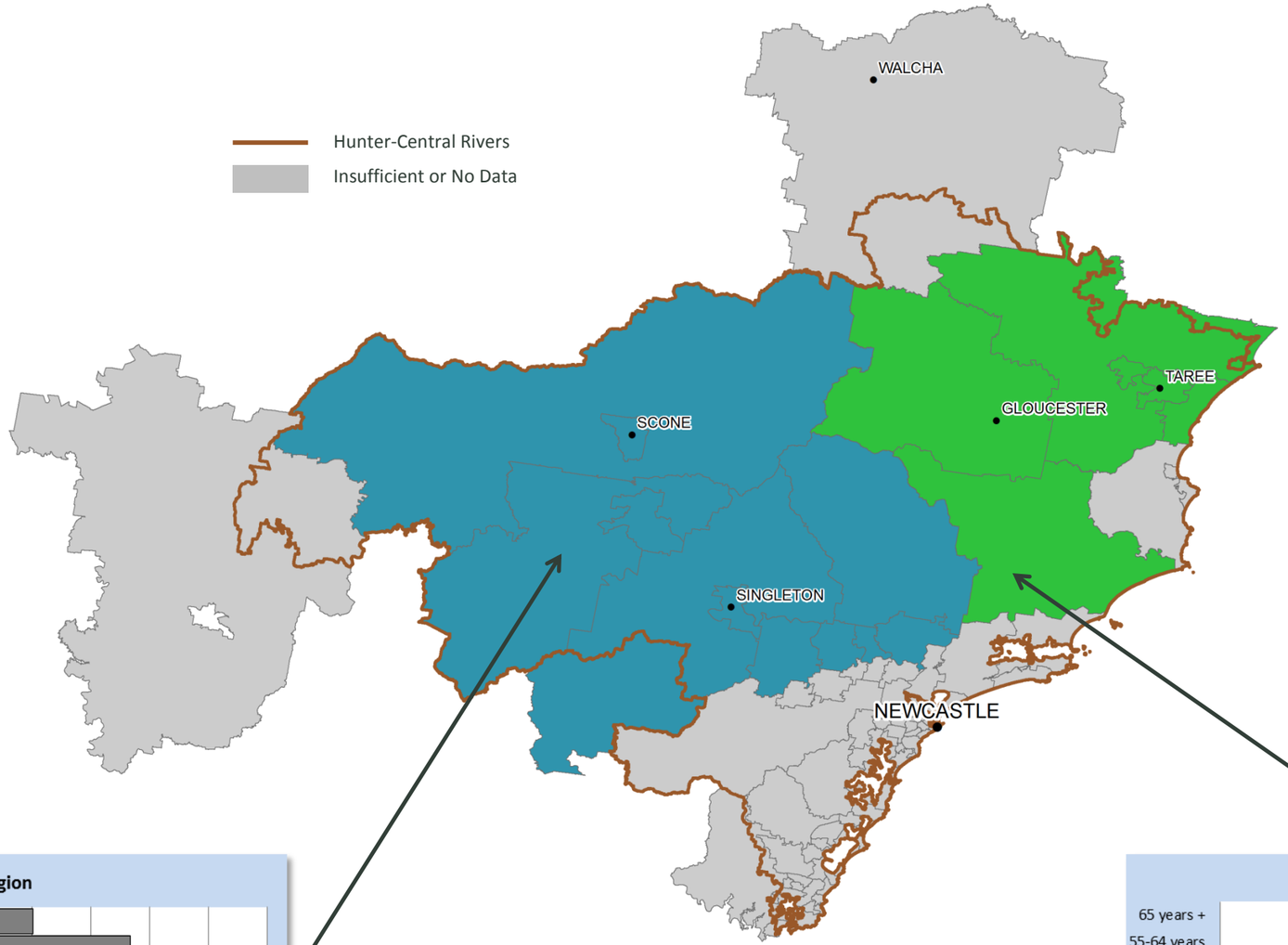


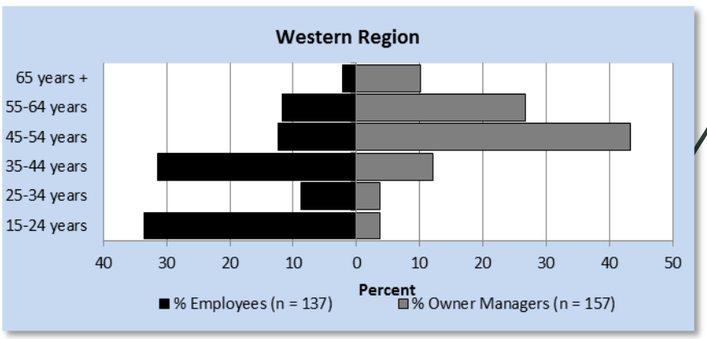


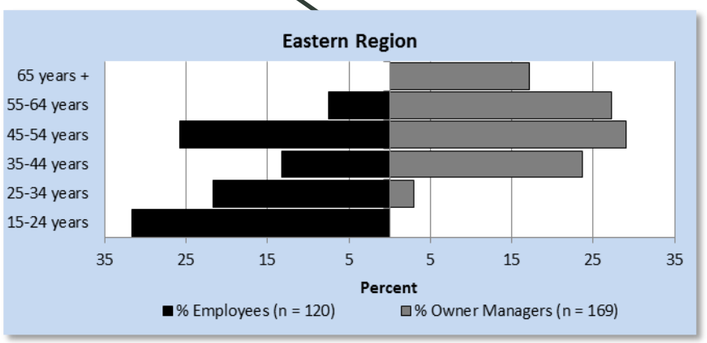


Map 5b: Hunter-Central Rivers: Age Profiles of the Grazing Workforce (Dairy)

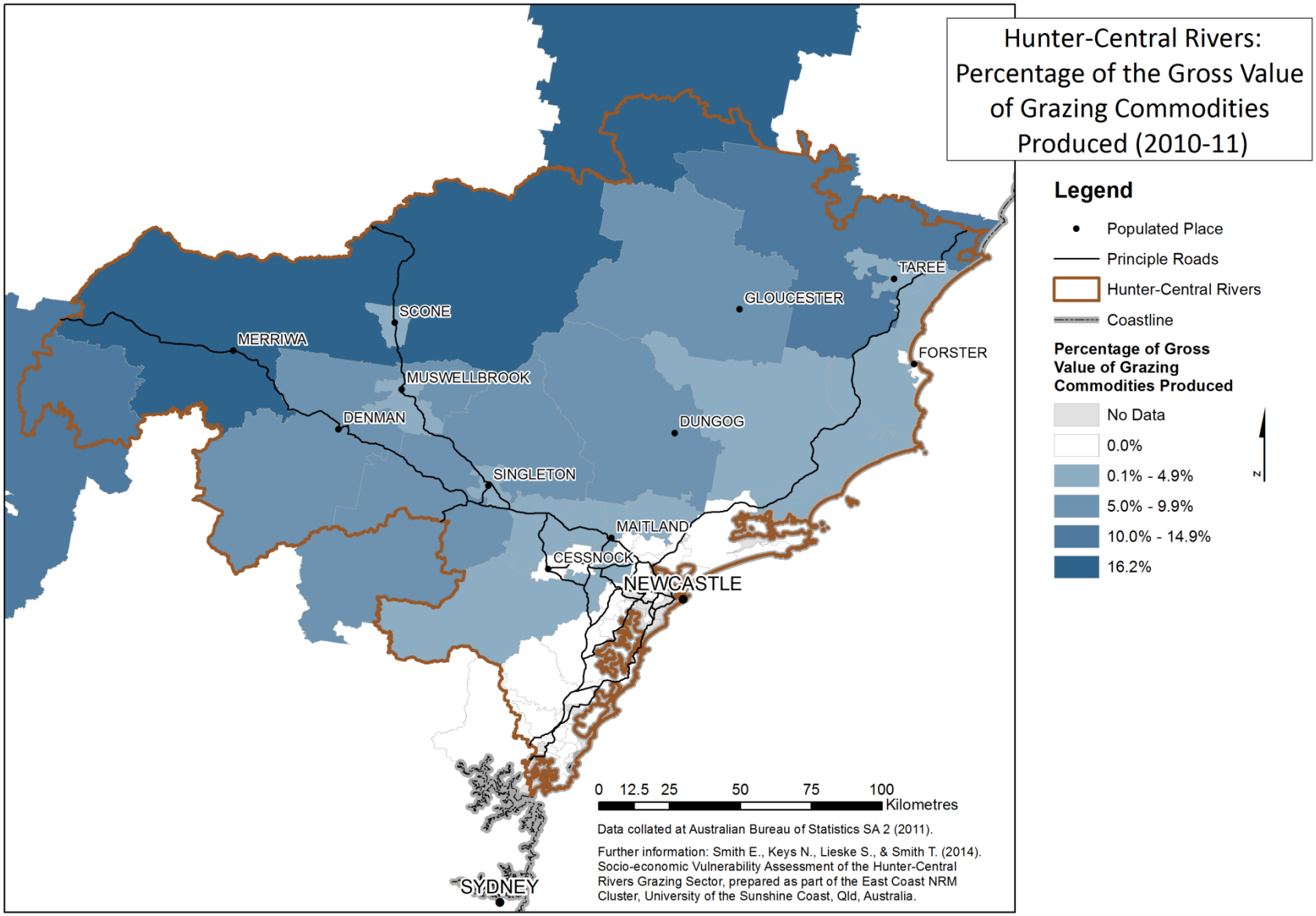
Why consider age? In general, older people may be more vulnerable to climate impacts than younger people because of their increased sensitivity to negative health impacts of climate changes (e.g., increased temperatures) (Vaneckova et al., 2008). Middle-aged owner managers may also be more vulnerable than employees because of reduced adaptive capacity arising from potential adverse climate-related impacts on their business property combined with potential adverse social impacts with their having dependent children (Clemens et al., 2013). For this reason, the age profiles of owner managers are separated from employees, as well as to capture differences/similarities in the age distribution of people who have decision-making responsibility when compared to the wider workforce







Map 6: Percentage of the Gross Value of Grazing Commodities Produced (2010-11)



Map 7: Percentage of the Labour Force Employed in Grazing (2011)