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Social vulnerability to climate change in primary producers: A typology approach

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ABSTRACT

Adaptation of agricultural industries to climate change will make a major difference to the extent of the impacts experienced as a result of climate change. Vulnerability assessments provide the basis for developing strategies to reduce social vulnerability and plan for climate adaptation. Primary industries have been identified as the most vulnerable industry sector globally. We review how primary producers might be socially vulnerable to climate change and develop a 'vulnerability typology' of cattle producers based on survey responses from 240 producers across northern Australia. We measured social vulnerability according to ten indicators of climate sensitivity (resource dependency) and four indicators of adaptive capacity. Using a *K*-means clustering analysis we identified four main 'types' of cattle producers. Type 1 producers (43%) were vulnerable because they had low strategic skills and low interest in changing behaviour. Mean age was 59 years old, they were weakly networked within the industry and businesses were small. Type II producers (41%) had low strategic skills, poorly managed risk and uncertainty, had medium sized businesses and were 51 years old on average. Only 16% of producers (Type III and IV) appeared to have resilience to change. Type III producers (13.4%) had a stronger psychological and financial buffer, were 52 years old on average, were well networked and managed or owned larger businesses. Type IV producers (2.6%) managed risk well, liked to experiment with options and were interested in change. They were 41 years old on average, managed extremely large properties, were well networked, perceived themselves as responsible for the future productivity of their land and were early adopters of new technology. By providing knowledge of the different ways in which people can be vulnerable to climate change, vulnerability assessments can enable decision-makers to prioritise their efforts, provide a basis for early engagement, and tailor a range of adaptation approaches to most effectively accommodate and support the divergent requirements of different "types" of resource-users.

1. Introduction

Primary producers and industries, which include the sectors of agriculture, forestry and fisheries, are especially vulnerable to climate change because they are dependent on highly climate-sensitive natural resources (IPCC, 2007; Stokes and Howden, 2010). In addition to the existing backdrop of conventional drivers including economic, biophysical, institutional, cultural and political pressures, primary resource users are expected to contend with more frequent climate crises (such as drought and flood), increased climate variability (Cooper et al., 2008), environmental degradation (such as eroding soils, increased pests and diseases; Volney and Fleming, 2000), cultural change (such as new practices and climate technology; Darnhofer et al., 2010) and in some instances: climate-related regulatory change (Cabrera et al., 2006).

Humans can influence the impacts of climate change in two ways. The first is mitigation: by reducing global emissions of greenhouse gasses we can deal with the root cause of the issue and limit the magnitude of human-induced global climate change (Howden et al., 2007). The second, and the focus of this paper, is adaptation: by building the capacity of people to adjust climate-sensitive activities to plausible future climate scenarios, we can limit our vulnerability to the climate change that does occur (Wreford and Adger, 2010). The two are linked in that the more effort that is put into mitigation efforts, the less effort will be required for adapting to climate changes (Verchot and Cooper, 2008). While strong arguments exist to stabilise greenhouse gas concentrations before the climate system passes irreversible thresholds, we can also accelerate efforts to prepare for those changes that are inevitable.

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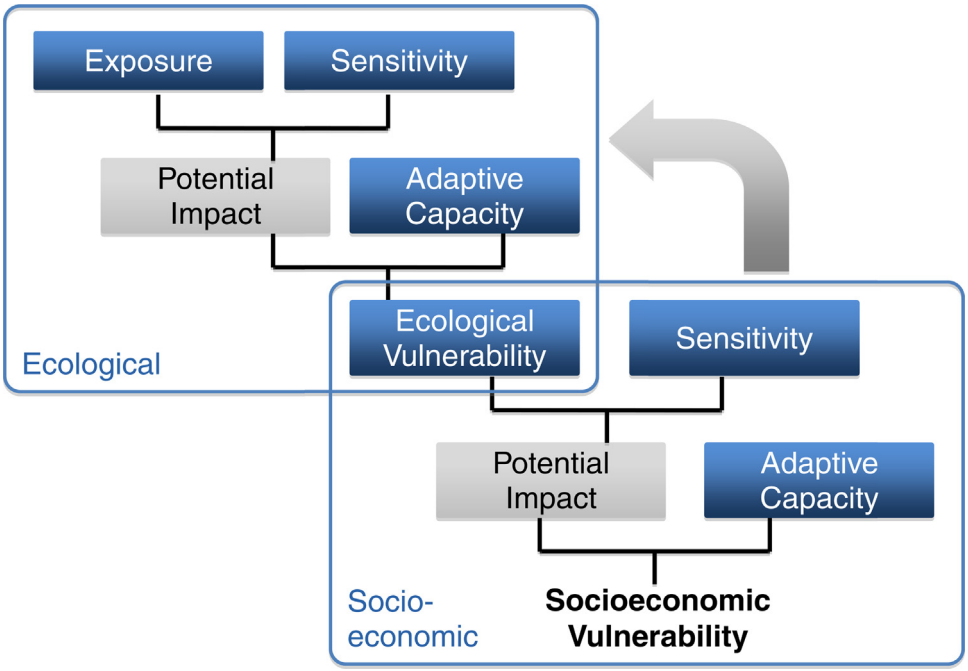

Fig. 1. A framework for conceptualising vulnerability across both ecological and socio-economic (social) domains. In this paper we refer only to social vulnerability, which consists of sensitivity to change (described in the text as "resource dependency") and adaptive capacity. Adapted from Marshall et al. (2013).

Adaptation to climate change will make a major difference to the degree of impact of climate change (Stokes and Howden, 2010; Webb et al., 2013). The specific challenge faced by primary producers will be to build the productivity and profitability of their resource (agricultural) enterprises in the face of climate uncertainty without degrading the ecosystem services on which they depend (McKeon et al., 2004). Climate change will also bring opportunity. Increases in temperature and precipitation in some regions, for example, could open up new and profitable agriculture opportunities (Stokes and Howden, 2010). Flexibility and responsiveness, however, will be needed to realise potential benefits (Howden et al., 2007). Thus, preparing for climate-related changes will not only mean preparing for the worst; in some cases it may also mean preparing to take advantage of new conditions (Fankhauser et al., 1999). Primary producers and industries that are resilient to climate change will be able to both minimise the social and economic impacts and maximise the opportunities. Most importantly, resilient resource industries will be better prepared to manage 'climate surprises' where change is no longer seen as a disturbance, but as a trigger for the reorganisation of resources, and for the renewal of resource-based practices and activities (Darnhofer et al., 2010). However, climate adaptation processes are proving to be less straightforward, as some resource-users appear better able to cope and adapt, whilst some are more vulnerable than others (Marshall, 2010; Marshall and Smajgl, 2013).

Vulnerability assessments are the logical place to start for most industry leaders or policy-makers wishing to direct or support efforts to reduce vulnerability and develop plans for climate adaptation (Moser and Ekstrom, 2010). The intergovernmental panel on climate change (IPCC), amongst others, define system vulnerability as the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes (Smit and Wandel, 2006). Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity (IPCC, 2007; Marshall et al., 2013). These elements are important for assessing vulnerability within both socio-economic and biophysical subsystems and we refer to a modification of the IPCC framework where social vulnerability is explicitly based on the vulnerability of the biophysical components of the system (see Marshall et al., 2013). In social systems, we view 'social vulnerability' as a function of both climate sensitivity (which we characterise here in terms of resource dependency; see 'Components of Vulnerability' below) and adaptive capacity (Fig. 1) (Marshall, 2011). Establishing that resource dependency and adaptive capacity are key components of vulnerability within social and ecological systems can help evaluate the nature and magnitude of a climate change threat, detect key sources of vulnerability and identify actions to help reduce or manage a climate threat (at any point within the system).

The aim of this study was to assess the social vulnerability of livestock producers (herein cattle producers) to climate change across northern Australia and about the extent to which the cattle industry might be vulnerable to climate change. We focus at the scale of the individual, which is often over-looked in the development of regional policies, but which is necessary to complement research and adaptation planning at broader scales.

We represent the vulnerability of primary producers through the concept of 'types'. Typing people provides an opportunity to understand social heterogeneity within a population (Emtage et al., 2006; Valbuena et al., 2008). Climate adaptation plans and other regional natural resource management (NRM) plans and policies often assume that there is an 'average' or 'typical' resource-user on which strategies for long-term sustainability are based (Andersen et al., 2007). However, this assumption does not reflect the full range of diversity among resource-users within a region, thereby risking plans that will be irrelevant and ineffective for some. Understanding social heterogeneity within populations of resource-users is important for effective natural resource management and climate adaptation planning (Andersen et al., 2007). Understanding 'types' based on criteria relevant to natural resource management is a useful way to represent diversity within a region. It provides an opportunity to directly 'match' various potential adaptation options to the full range of individuals on the rangelands and savannas (Marshall and Smajgl, 2013).