Global Environmental Change 50 (2018) 178–189

Contents lists available at ScienceDirect

Global Environmental Change

journal homepage: www.elsevier.com/locate/gloenvcha

Integration anxiety: The cognitive isolation of climate change

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ARTICLE INFO

Keywords:
Climate change adaptation
Mainstreaming
Decision making
Risk perceptions
Conservation agriculture
Mental models

ABSTRACT

Experts recommend that decision-makers in climate-vulnerable sectors integrate, or 'mainstream', climate change adaptation into their decision-making. Farmers are often thought to do so intuitively, because many climate change impacts will manifest in similar ways to the weather and climate variability that farmers have always faced. However, there is little evidence to suggest whether farmers are already doing this, how they should go about it, and how hard it might be. Here we show that commercial grain farmers in South Africa ($N = 90$), as a uniquely informative group, are struggling to mainstream climate change risk management despite their apparent incentive, capacity and willingness to adapt. They perform large-scale, highly mechanized, input-intensive grain farming like their peers in higher-income countries (*e.g.*, the United States, Canada, Europe and Australia), but without the government subsidies, crop insurance and irrigation more common in other regions. They are therefore motivated to adapt proactively because they are more vulnerable to the financial harms of weather and climate risks. Our data show that they are explicitly sensitive to the risks of climate change, generally expressing concern for its potential impacts, reporting observed changes, proposing possible adaptations, and expressing the desire to adapt proactively. However, their mental models of climate change ($n = 30$) are linguistically and structurally isolated from their mental models of weather and other 'normal' risks. They are therefore implicitly insensitive to climate change, making it unlikely that they will adapt proactively and rationally to this uncertain risk that they otherwise appear well-equipped to manage.

1. Introduction

Although the framing of climate change adaptation may sometimes imply that it occurs as distinct process of conscious and planned adjustment (Bassett and Fogelman, 2013), researchers have widely recognized that climate change is only one of many stressors that drive multi- and cross-scalar decisions towards varied and competing objectives (Bassett and Fogelman, 2013; Eakin et al., 2016). The integration, or 'mainstreaming', of climate change adaptation into pre-existing decision-making processes has therefore become an important pre-occupation of the adaptation literature across policy domains and scales (Dovers and Hezri, 2010; Howden et al., 2007). Yet the processes of human judgment and decision-making involved in harmonizing the management of climate change with weather, climate variability and other 'normal' risks are understudied, and therefore poorly understood (Clayton et al., 2015; Grothmann and Patt, 2005).

The mainstreaming of adaptation into *institutional* decision-making is widely perceived as challenging, because climate change has features that are mismatched with those of many other risks (Kunreuther et al., 2013). First, predictions of some climatic variables at the local scale are uncertain in both sign and magnitude; this makes 'perceive-predict-act' approaches hard to design and harder to implement. Second, climate change risks are often mismatched temporally and spatially with concurrent objectives (Hallegatte, 2009). Researchers studying climate change adaptation have therefore suggested various approaches for integrating climate change with other priorities, from the explicit integration of climate change risks through structured and robust decision-making protocols (*e.g.*, Kunreuther et al., 2013) to their more implicit integration through broader resilience, transformation and development agendas (*e.g.*, O'Brien, 2012).

However, climate-adaptive decision-making by *individuals* has received much less empirical treatment, especially in 'real world' situations (Dilling et al., 2015; Grothmann and Patt, 2005). This has led to a general failure to understand whether and how individuals will mainstream, and so adapt to, climate change risks. Commercial farmers are characterized as autonomous and largely rational decision-makers who

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https://doi.org/10.1016/j.gloenvcha.2018.02.010
Received 20 September 2017; Received in revised form 26 January 2018; Accepted 21 February 2018
0959-3780/

are sensitive to weather, climate variability and climate change. They are therefore expected to perceive and mainstream climate change risks more readily than other groups of decision-makers (Grothmann and Patt, 2005; Eakin et al., 2016). Rainfed crop production, in particular, is among the sectors anticipated to be most vulnerable to the impacts of climate change (Lobell et al., 2008). Yet few studies have evaluated farmers' mainstreaming of climate risks, especially *in situ* – that is, within the multi-faceted and uncertain environments in which they actually make risk management decisions.

The commercial grain farmers of South Africa's Western Cape province are, ostensibly, a case in point. Their farming enterprises closely resemble those in higher-income countries (*e.g.*, the United States, Canada, Europe, Australia), as opposed to the smallholder farmers more typical in studies of African agriculture. They perform large-scale, input-intensive, highly mechanized and rainfed grain production (RSA, 2013a) in a semi-arid environment with highly variable rainfall (RSA, 2011). They are relatively well educated, with good access to financial, informational and institutional resources (Wilk et al., 2013). They have also been targeted for more than a decade by risk communication campaigns from local and international agricultural and climate science experts (Findlater, 2013). However, since many are white beneficiaries of South Africa's apartheid legacy, they generally receive little explicit support from government (*e.g.*, few of the subsidies enjoyed by commercial farmers in those higher-income countries and less access to affordable crop insurance) (Bernstein, 2012).

Crucially, these farmers have recently been adopting practices associated with Conservation Agriculture (CA) (RSA, 2013b) – a set of techniques affirmed by the Intergovernmental Panel on Climate Change (IPCC) as contributing simultaneously to climate resilience and food security (Niang et al., 2014). The climate in the Western Cape is expected to become even more variable in the future, with rising temperatures and the potential for decreasing mean rainfall (Ziervogel et al., 2014). Longer and more intense wet and dry spells are strongly anticipated – in fact, the Western Cape is currently experiencing its worst drought in recorded history (City of Cape Town, 2018). These farmers are also less buffered against climate risks than farmers in other South African provinces, who generally have more access to water for irrigation (RSA, 2013a; Wilk et al., 2013). When applied comprehensively, CA's three principles – advanced crop rotations, low soil disturbance (*i.e.*, minimum or no-tillage) and permanent soil cover – tend to increase mean yields (as a function of rainfall), reduce crop yield variability (reducing the risk of crop failure), reduce input costs (*e.g.*, fuel, fertilizer, seed), and increase income diversification (through crop diversification and mixed crop-livestock systems) (Hobbs et al., 2008; Jat et al., 2012; Knowler and Bradshaw, 2007). For these reasons, CA is foundational to the Food and Agriculture Organization's (FAO) Climate-Smart Agriculture and Sustainable Intensification frameworks (FAO, 2013a; FAO, 2013b; Giller et al., 2015).

Driven in part by strong advocacy from the IPCC and FAO, CA has spread quickly in recent years (Kassam et al., 2015). However, preliminary interviews with local experts in the Western Cape suggested that farmers' CA adoption has had little to do with climate risks. Farmers' emphasis on reducing input costs and maintaining livestock has resulted in inconsistent adoption of the three principles, most often sacrificing soil cover and favouring periodic soil disturbance to alleviate surface compaction by animals (Findlater et al., forthcoming). This pattern mirrors the "pragmatic adoption" of CA in other countries with mechanized farming systems (Derpsch et al., 2014; Giller et al., 2015). The dilemma for farmers is that CA's crop yield and climate-resilience benefits take five to ten years to develop, particularly with respect to soil health (*e.g.*, structure, biota, organic carbon), and are undermined by periodic soil disturbance. Where farmers are inconsistent in their practices over time, or fail to adopt the three principles in a coordinated manner, meta-analyses have shown curtailed benefits of CA and even reductions in mean crop yields (Pittelkow et al., 2015; Rusinamhodzi et al., 2011; Van den Putte et al., 2010). For CA to be effective in adapting to climate change, it is therefore imperative that this be a clear objective and that trade-offs be coordinated with other objectives (*e.g.*, livestock, short-term yield maximization). The latter seems unlikely where climate risk management is not mainstreamed.

Here, we shed light on the mainstreaming behaviours of this group of farmers who have the apparent incentive, capacity and willingness to adapt (Bernstein, 2012; Wilk et al., 2013). They are physically vulnerable to climate change (Niang et al., 2014; RSA, 2011), and are gradually adopting a set of CA practices that is nominally climate-resilient if applied proactively and consistently (Pittelkow et al., 2015), but in a manner that undermines its long-term benefits. Using a mental models approach, we test the hypothesis that their perceptions of, and responses to, climate change risks are well-integrated with their management of weather and the myriad other 'normal' risks that present day-to-day challenges in commercial farming. We seek to understand whether they are sensitive to climate change risks – that is, whether they perceive and respond to climate signals. First, we ask whether these farmers are *explicitly* sensitive to climate change risks, as they are to weather ($N = 90$): Do they express concern about climate change risks, along with the willingness to respond to them? Second, we ask whether their decision-making processes are *implicitly* sensitive to climate change risks ($n = 30$): Are their mental models of climate change well-integrated, linguistically and structurally, with those of weather and other 'normal' risks, and thereby actionable?

2. Methods

Using a structured mental models protocol (Section 2.1), we interviewed 90 commercial grain farmers in South Africa's Western Cape province (approximately 10% of the population of such farmers). We first evaluated their *explicit* sensitivity to climate change risks ($N = 90$) by coding their expressed risk perceptions and proposed adaptations (Section 2.2). We then evaluated their *implicit* sensitivity to climate change risks ($n = 30$) by analyzing the extent of linguistic and structural integration between their causal mental models of climate change and those of weather and other 'normal' risks (Section 2.3). The analytical steps are elaborated below and summarized as a flow chart in Fig. S1 in the Supplementary Information. The protocols were designed, piloted and implemented in consultation with partners at the University of Cape Town, Stellenbosch University and the Western Cape Department of Agriculture.

The data were collected by a single interviewer in the two months preceding the grain harvest in late 2013. This corresponded to the end of a three-year period of above-average rainfall, with record wheat yields (RSA, 2013a), so farmers were likely less sensitive to weather and climate change problems than they might otherwise have been. Willing participants were recruited by phone and email through geographically stratified random sampling. Recruitment was facilitated by representatives from the four major co-operatives and agribusinesses that market and distribute grain produced in the region. All interviews were conducted in English. Approximately 20% of those contacted declined to participate, most frequently citing time constraints, but with some suggesting a discomfort with English. None were given any material incentive to participate. All interviews were conducted on participants' farms, in locations where they make decisions about their farming businesses every day.

These farmers generally practiced mixed grain and livestock farming centred on rainfed wheat production. Their ongoing adoption of CA is among the most important changes in practice currently underway in South African commercial agriculture (RSA, 2013b). Participants were scored on their adherence to CA as a measure of climate-resilient best practices, and these scores were incorporated as an independent variable in the statistical analyses described below. In keeping with demographic trends among South African commercial farmers, all of the participants were male, ranging in age from 25 to 62 years ($M = 43.9$, $SD = 9.3$). Their available arable farmland ranged