Eyes on the Horizon: Temporal and Social Perspectives of Climate Risk and Agricultural Decision Making among Climate-Informed Farmers

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ABSTRACT
Climate change adaptation requires that we anticipate future conditions that may deviate from our historical experiences. Our ability to do so is associated with the perceived proximity of decision-outcomes. Through analysis of semi-structured interviews with farmers in the northeastern United States, we conclude that temporal distance (now versus later) and social distance (self versus other) of climate impacts interact to play important roles in climate risk perception. Using Psychological Distance and Construal Level Theory, we identified two distinct temporal perspectives, historically oriented and future oriented. Our analysis suggests that climate-informed farmers use different temporal perspectives depending on whether they are asked to imagine the climate risks through a personal lens versus a lens reserved for the other.

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Introduction
Climate change is defined as a change in weather patterns that occur over long periods of time, typically 30 years (IPCC 2007). Meteorological events that occur within a shorter time scale are classified as weather. Climate change forecasts are most commonly projected to mid-century (2050) and end-of-century (2100) (IPCC 2014). However, most people do not intuitively conceptualize environmental change over these long temporal scales. It has been suggested (though not proven) that this is because humans evolved in environmental and social contexts that required sensitivity to our immediate surroundings in both time and space, as opposed to future-thinking (Pahl et al. 2014). One study suggests that modern humans are able to imagine 15–20 years into the future, after which their concept of the future “goes dark” (Tonn, Hemrick, and Conrad 2006, 817). This cognitive limitation may be compounded by our tendency to use past experiences to imagine future ones (Atance and O’Neill 2001), and the
constructed or reconstructed nature of distal objects or events (Liberman, Trope, and Stephan 2007).

According to Weber (2006), individuals do not experience concern or alarm when future impacts are uncertain or when prior experiences do not adequately prepare us for future experiences. In the context of climate change, this is significant because future environmental conditions will likely be very different (e.g., hotter, drier, wetter) or more variable than those we have experienced previously (Naess 2013). Despite these limitations, it is clear that individuals and communities around the world will need to adapt to changing climatic conditions (Smit et al. 1999). Agroecological communities in particular are vulnerable to the direct impacts of climate change and the associated disruptions to social and economic systems (Hatfield et al. 2020; National Academies of Sciences Engineering and Medicine 2018). Within agroecosystems, near-term and long-term adaptation is necessary and desirable in many circumstances.

A growing number of studies focused on agriculture in industrialized countries have examined farmers’ perceptions of climate risk (Takahashi et al. 2016; Arbuckle et al. 2013; Schattman, Conner, and Méndez 2016), their intended adaptation activities (Niles, Brown, and Dynes 2016; Roesch-McNally, Arbuckle, and Tyndall 2017), and their support for climate-related policies (Haden et al. 2012; Niles, Lubell, and Haden 2013; Chatrchyyan et al. 2017). When applying information about climate change, it has been shown that farmers differentiate between different knowledge systems (e.g., local/distance, scientific/situational experiential) (Holloway, 1999). It has also been shown that future-thinking is associated with pro-environmental behavior among general populations in industrialized countries (Milfont, Wilson, and Diniz 2012), and that different, though interacting variables affect individual versus population level environmental concern (Marquart-Pyatt 2012). Little research, however, has focused on the subset of farmers who are informed about future climate change, for whom we can assume general knowledge is not a limiting factor to adaptation. We define climate-informed farmers as agricultural producers who possess knowledge of climate change and related impacts that are aligned with the current scientific consensus.

Given predictions for climate change-related disruptions in agricultural systems (Howden et al. 2007; Lobell and Field 2007), it is important to understand how farmer decision making is informed by their use of temporal perspective along with their perceptions of climate risk. While there is a robust body of literature focused on temporal cognition and decision making in neurocognitive fields (i.e., addiction studies and risk behavior, for example see Peters and Büchel (2011) and Bickel et al. (2007)), lessons from these disciplines have rarely been explored within the combined contexts of climate change and agriculture. To address this gap, our team developed a qualitative study to identify the time horizons within which climate-informed farmers conceptualized agricultural risks and associated adaptation activities. Specifically, we asked the following research questions:

1. What are the time scales that climate-informed farmers apply to farm management decisions in ecological, economic, and social categories?
2. What is the relationship between (a) temporal and social distance and (b) climate- and weather-related risk perceptions among climate informed farmers?
Using *Psychological Distance* and *Construal Level Theory* as conceptual frameworks, we sought to understand the relationship between climate-informed farmers’ perceptions of climate risk, their management-related adaptation decisions, and the time horizons applied to these decisions. The results of our work contribute an important development in agricultural adaptation studies, moving us beyond a blanket review of adaptation at *any* time scale to better discern between adaptation choices made using different temporal horizons. Doing so can help refine how we think about agriculture adaptation at the farm-scale, the potential limitations of adaptation, and how we deliver educational, technical, and financial assistance programs.

**The Temporal and Social Nature of Decision Making**

*Psychological Distance* proposes that an individual’s experience in the present moment provides an egocentric “zero distance point,” which serves as a reference for all “other times, places, experiences, people, and hypothetical alternatives to reality” (Liberman, Trope, and Stephan 2007, 353). According to this frame, there are four dimensions of distance: temporal (as investigated by Stephan, Liberman, and Trope 2011), spatial (Fujita et al. 2006), social (Hess, Carnevale, and Rosario 2018), and likelihood (i.e., hypotheticality) (Liberman, Trope, and Rim 2011). As distance increases along any of these four dimensions, individuals perceive objects and events with higher-level construal (i.e., abstract representation). The dimensions are not mutually exclusive, and indeed have been shown to interact with one another (Maglio 2020). Trope and Liberman (2003) apply psychological distance through *Construal Level Theory* (CLT), which proposes that individuals’ evaluations of information is influenced by the degree to which that information pertains to temporally distant verses proximate events. Both historical and future temporal distance can affect construal, risk perception, and ultimately behavior. This has been tested in a wide array of studies and confirmed by Soderberg et al. (2015) through meta-analysis. For the purposes of this study, we have employed the temporal and social dimensions of Psychological Distance, which we describe in more detail below.

**Temporal discounting** describes how individuals discount the value of future decision outcomes and exhibit a preference for temporally proximate outcomes. Trope and Liberman (2003) argue that decisions that have distant outcomes are abstracted and parsimonious, while those that are proximate are rich and detailed. **Hyperbolic discounting** refers to the subjective value of decision outcomes over time, which declines in a hyperbolic curve (Kable and Glimcher 2010) due to the rapid decrease in value that individuals assign to future outcomes, followed by a more gradual decline as the temporal distance further increases (Trope and Liberman 2003). It is expected that individuals demonstrate temporal discounting at varying rates due in part to differences in temporal perspective, defined as the “ways in which people view and relate to issues concerning past, present, and future” (Block 1990, 27).

Variation in the temporal perspectives of different individuals is likely the result of personality traits as well as the cognitive and socio-environmental contexts in which these individuals make decisions (Peters and Büchel 2011). The ability to practice future thinking has been associated with a decrease in risk behavior such as risky driving,
smoking, and drug use (Atance and O’Neill 2001). The cognitive and socio-environmental context in which individuals make decisions likely influences the degree of temporal discounting these individuals practice (Peters and Büchel 2011). Stage of neurocognitive development (e.g., adolescence through various stages of adulthood) (Green, Fry, and Myerson 1994), positive or negative nature of an outcome (Shelley 1994) and the attractiveness and magnitude of the risk or the reward (Lovallo and Kahneman 2000) all have influence on the degree to which an individual discounts a potential future outcome.

The socio-environmental context in which an individual operates includes the degree of risk they face associated with any given decision. In agriculture, producers face risks from outside the farm (e.g., changing markets, shifting regulatory environments, labor shortages), as well as risk associated with their individual circumstances (e.g., personal injury, sickness) (Harwood et al. 1999). It is generally accepted that risk reduction is an important strategy used in the United States by government agencies, conservation districts, and others, for encouraging the adoption of conservation or other environmentally-friendly on-farm practices (Botterill and Mazur 2004). Over time, it is likely that temporal perspective plays a role in farmers’ risk perception and by extension their decision making.

Because of the future-oriented nature of climate risk on agriculture, we are particularly interested in how CLT can be applied to increase adaptation and mitigation behavior among farmers. Similar questions have been asked to a limited degree in agriculture and other land management sectors. For example, Hoogstra and Schanz (2009) found that foresters’ ability conceptualize management time horizons were limited to within 15 years, even while it is assumed that decisions in forest management are made on longer time horizons. Huff et al. (2017) applied psychological distance in the context of timber harvesting of private woodland owners, finding that shortening multiple dimensions of distance can lead to opportunities for sustainable forest management. Kolandai-Matchett and Armoudian (2020) reviewed approaches to reduce psychological distance (spatial and temporal) in order to increase public awareness and concern about degraded marine environments. In their study of smallholder farmers in Iran, Azadi et al. (2019) found that among the four dimensions of Psychological Distance, only temporal distance had a significant influence on climate change adaptation behavior.

Additional research has further probed the significance of social distance (self versus other) on climate change perceptions and concern, testing the assumption that personal experience leads individuals to allocate more weight to climate-related risk in their adaptation-related decision making (Spence, Poortinga, and Pidgeon 2012; Weber 2011; Haden et al. 2012; Carlton et al. 2016). However, the relationship between psychological proximity of climate impacts and individual behavior is not straightforward (Brügger, Morton, and Dessai 2016; Brugger and Crimmins 2015; Whitmarsh 2008; Schattman et al. 2018). Personal experience with climate-related weather extremes can lead to fear and distress (O’Neill and Nicholson-Cole 2009; Feinberg and Willer 2011), whereas highly localized messaging about climate impacts may actually reduce concern about climate-risk in some cases (Mildenberger, Lubell, and Hummel 2019). Despite these conflicting findings, a review of research that addresses experiential proximity and climate change perceptions concludes that proximity is indeed “a powerful vehicle for
acceptance and commitment – and psychological adaptation” (Reser, Bradley, and Ellul 2014, 533). To expand upon this conclusion, we propose that a more specific focus on temporal and social proximity and their overlapping effects is needed to further illuminate the relationship between proximity and climate adaptation decisions in agroecosystems.

**Methods**

**Study Site**

The northeastern United States is a historically agricultural region (Albers 2002), characterized by a growing number of new farms (USDA-NASS 2014; National Sustainable Agriculture Coalition 2014), and smaller, more diversified farms when compared to those in other U.S. regions (Macdonald, Korb, and Hoppe 2013). The Northeast is home to a large urban population, with over 50 million people who live within the Boston-to-Washington D.C. corridor (U.S. Census Bureau 2018). This large population is an important market for many specialty crops producers in the region, though development pressure makes land access challenging (Livanis et al. 2006).

The likely impacts of climate change on the northeastern United States include rising average temperatures, increased heavy rainfall events, and more precipitation overall (Dupigny-Giroux et al. 2018). Since 1970, the pace of rising temperatures has increased in this region, with nighttime low temperatures increasing more quickly than daytime high temperatures (Kunkel et al. 2013; Wolfe et al. 2018). It is expected that increases in extreme weather events and more frequent short-term droughts will lead to declining yields for key agricultural crops (Hatfield and Takle 2014, Wolfe et al. 2008). Dry periods in late summer have already led to high rates of crop loss in recent years (Sweet et al. 2017), while long wet springs have challenged farmers to prepare fields and plant in a timely manner. Prior research on the climate change perceptions of Northeast farmers (Chatrchyan et al. 2017; Schattman, Conner, and Méndez 2016) suggests that a higher degree of agreement with scientific consensus on climate change and its causes than agricultural stakeholders in other parts of the United States (Prokopy et al. 2015).

This study was conducted in Vermont, a small Northeast state with a population of ~620,000 (U.S. Census Bureau 2018) and 6,808 farms representing a variety of sectors (USDA-NASS 2019). Vermont ranks third in the region and 18th in the nation in gross dairy sales (505,426,000 USD in 2017), and ninth in vegetable and small fruit (23,853,000 USD), tree fruit (19,417,000 USD) and poultry/eggs sales (11,729,000 USD) (USDA-NASS 2019). Though commodity dairy is by far the largest agricultural industry in Vermont, the state is also known for diversified local agriculture. Twenty-seven percent of Vermont farmers report selling some or all of their products directly to consumers (USDA-NASS 2019). Additionally, there has been recent growth in value-added sectors that utilize Vermont grown products (e.g., hard cider, hemp) (Becot, Bradshaw, and Conner 2018, Kolodinsky, Lacasse, and Gallagher 2020). This study sought to capture the perspectives and practices of a variety of Vermont farmers working in several agricultural industries.
Interviews

We conducted 22 in-depth, semi-structured interviews in 2015–2016 with 24 farmers (two interview sessions involved farmer pairs, instead of single interviewees) who lived and worked in Vermont (see Table 1). Contacts were solicited from professionals from the University of Vermont Extension and College of Agriculture and Life Sciences, the Vermont Vegetable and Berry Growers Association and the Vermont Farms Association (independent industry associations), the USDA Natural Resources Conservation Service, and a farmers’ watershed group. Solicitation continued until our team was unable to secure additional participants. Through this sampling process, we sought to represent the diversity of agricultural enterprises present in Vermont, and by doing so enhance the validity of the study (Glaser 1992; Stenbacka 2001). Participants were compensated at a rate of 50 USD per hour for their time.

Previous work by our team suggested that our target population of farmers were likely to be climate-informed. While we made efforts to solicit participation in our study from individuals with a wide range of perspectives, we were explicit that climate change topics were included in the interview. Participant knowledge about climate change was assessed through a short series of structured questions about the causes and effects of climate change, and compared to the National Climate Assessment (USGCRP 2018). This approach allowed us to focus on variation in temporal perspectives and avoid diversions related to climate change skepticism. Our research, therefore, is clearly not intended to generalize about farmers broadly, but rather a subgroup of farmers who are engaged in thinking about climate change risks and how it pertains to their individual context. Human subject approval was granted by the University of Vermont.

The majority of participants were engaged in full-time commercial farming, either as an owner or custom operator (n = 17). The remainder held a part-time off-farm job.

Table 1. Participant demography, n = 24.

<table>
<thead>
<tr>
<th>Participant code</th>
<th>Agricultural sector</th>
<th>Acreage operated</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Orchard, agritourism</td>
<td>275</td>
<td>M, F</td>
</tr>
<tr>
<td>3</td>
<td>Vegetable and meat</td>
<td>3</td>
<td>F</td>
</tr>
<tr>
<td>4</td>
<td>Vegetable and meat</td>
<td>150</td>
<td>M, F</td>
</tr>
<tr>
<td>5</td>
<td>Fiber and meat</td>
<td>80</td>
<td>M</td>
</tr>
<tr>
<td>6</td>
<td>Formerly vegetable</td>
<td>5</td>
<td>F</td>
</tr>
<tr>
<td>7</td>
<td>Vegetable</td>
<td>50</td>
<td>M</td>
</tr>
<tr>
<td>8</td>
<td>Vegetable</td>
<td>5</td>
<td>F</td>
</tr>
<tr>
<td>9</td>
<td>Cheese</td>
<td>32</td>
<td>M</td>
</tr>
<tr>
<td>11</td>
<td>Meat</td>
<td>300</td>
<td>M</td>
</tr>
<tr>
<td>12</td>
<td>Agritourism</td>
<td>300</td>
<td>F</td>
</tr>
<tr>
<td>18</td>
<td>Vegetable</td>
<td>150</td>
<td>M</td>
</tr>
<tr>
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<td>Vegetable</td>
<td>70</td>
<td>M</td>
</tr>
<tr>
<td>22</td>
<td>Vegetable</td>
<td>300</td>
<td>F</td>
</tr>
<tr>
<td>24</td>
<td>Vegetable</td>
<td>6</td>
<td>F</td>
</tr>
<tr>
<td>26</td>
<td>Specialty animal products</td>
<td>350</td>
<td>M</td>
</tr>
<tr>
<td>27</td>
<td>Dairy</td>
<td>400</td>
<td>M</td>
</tr>
<tr>
<td>28</td>
<td>Dairy</td>
<td>3000</td>
<td>M</td>
</tr>
<tr>
<td>30</td>
<td>Dairy and custom operator</td>
<td>200</td>
<td>M</td>
</tr>
<tr>
<td>32</td>
<td>Dairy</td>
<td>372</td>
<td>M</td>
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<tr>
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<td>Vegetable</td>
<td>70</td>
<td>M</td>
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<td>35</td>
<td>Vegetable</td>
<td>21</td>
<td>F</td>
</tr>
<tr>
<td>36</td>
<td>Vegetable</td>
<td>1</td>
<td>M</td>
</tr>
</tbody>
</table>

*Owned or leased, not necessarily in production at the time of the interview. Note that participant codes 1 and 4 include two participants for each interview (both farm managers of a single farm).
or had recently retired from farming \((n = 1)\). This sample is similar to the full-time/part-time farm employment profile of Vermont farmers, where 24% of principle farm operators report working off-farm 200 days or more a year (USDA-NASS 2012). Farm size as measured by acres in operation varied widely, even among participants within the same agricultural sector.

The interview guide was designed to capture the scope of the participants’ current farming operation as well as their past farming experiences. Participants identified the most important risks that fell into social (e.g., neighbor relationships), ecological (e.g., flood potential), and economic (e.g., return on investment) categories, including when they first became aware of the risks, what the impacts have been thus far, and their perceived capacity to address the risks. Additional questions allowed for elaboration on management decisions, the length of time it took to put those management decisions into practice, and what participants hoped to do in the future to better address future risks of a similar nature. We also asked participants to report the timescale used for making farm management decisions in social, ecological, and economic contexts (e.g., daily, weekly, monthly, seasonally, yearly, 5-years ahead, 10-years ahead, or other), and how quickly they could respond if something unexpected happened.

We then about participants’ knowledge related to climate change and the degree to which they did or did not believe climate change posed a risk to their farm. Participants were asked to report whether they thought climate change was important in their decision making now versus in the future. To gauge interview participants’ concern about climate- and weather-related risks, our team asked them to fill out a short questionnaire during the interview, adapted from the Climate Change in the American Mind study (Leiserowitz et al. 2015). Agriculturally specific questions were added to the version of the questionnaire used in our study.

Our team pretested the interview instrument with three farmers prior to the full launch of the study. As the transcripts resulting from these pilots remained relevant to the investigation, they were included in our final analysis. A complete version of our final interview instrument is available in SOM1.

**Analysis**

To ensure that our analysis was both insightful and robust, we utilized a Grounded Theory approach (Strauss and Corbin 1990), applying a discrete set of pre-articulated themes along with additional emergent themes. We conducted an iterative codebook development process (Roberts, Dowell, and Nie 2019). A priori themes were developed based on the interview instrument, using (a) two dimensions of psychological distance (temporal and social) (Liberman, Trope, and Stephan 2007), (b) perceptions of climate-risk assessed in prior studies by our team (Schattman, Conner, and Méndez 2016), and (c) notations collected from interview field notes (Patton 2002). Through a double-coder, constant comparison approach we developed a full codebook (SOM1), including specific practices employed by research participants, as well as themes that described participants’ personal experiences and temporal qualities of decision making. Coding was conducted using HyperRESEARCH 4.5.1. (Researchware Inc. 2013).
After an initial meeting to discuss themes, coders worked independently on sets of six to eight interviews. We shared an online document that allowed us to simultaneously add emergent codes to our codebook and clarify interpretations via in-text comments. We met three times during the analysis period to discuss divergent interpretations, review emergent themes and codes, and refine our approach. This allowed us to validate our analysis while connecting both pre-conceptualized and emergent concepts (Boeije 2002; Thorne 2000). Early transcripts were re-coded following the completion of the codebook, thereby increasing the stability of our analysis (Campbell et al. 2013; Glaser and Strauss 1967).

We then applied codes to complete a biographical, narrative analysis of our data (Creswell 2013), using descriptive quotations to support a thick description of participant perspectives on climate change risk, temporal horizons, and conceptualizations of both temporal and social distance. Saturation was assessed in on a per transcript basis, meaning each transcript was reviewed through multiple reviews and discussion. Once our team believed we fully understood the interviewee’s perspective, the interview was considered saturated. At a study level, we reached a priori saturation for a select set of pre-determined themes and emergent themes when new codes no longer emerged (Saunders et al. 2018). Saturation was not achieved for some codes and themes, but these were not included in the presented analysis.

**Results**

**Timescales Applied to Farm Management**

To explore temporal perspectives applied to on-farm adaptation decisions in ecological, economic, and social categories, we first considered the distribution of timescales as reported by the research participants. We identified short-time horizons as those spanning less than one year, medium-time horizons as those spanning between one and five years, and long-time horizons as those spanning six or more years. This breakdown was
informed by investment decisions farmers commonly make: supplies that are used in one year or less are generally not financed, small investments (e.g., tractors, high tunnels, and other equipment) can often be purchased with five-year loans, and large investments (e.g., land, buildings) are regularly financed over longer periods of time. When discussing ecological decisions, participants often discussed decisions along long-time horizons, while economic decisions tended to be evenly distributed between long- and medium-time horizons. Social decision making was split between short- and long-time horizons, as shown in Figure 1.

All interview participants reported making decisions on multiple timescales, sometimes simultaneously. Even within the decision categories (e.g., ecological, economic, social), it was clear that participants moved fluidly between temporal horizons. For example, a dairy farmer described the relationship between short- and long-term economic planning:

We are constantly trying to balance the budget on a weekly basis, but when we evaluate what we do with our money and how we try to keep our farm solvent, we’re certainly planning over a ten, twenty-year time frame. [Farm partner] and I have no plans to retire in the next 15 years [but] I would say [we’re] trying to perpetuate the economic opportunities on this farm for a couple more generations. (Participant 12)

According to interview participants, the temporal nature of decision making was complicated by the lag time between some decisions and their effects. For example, livestock producers or those who grew perennial crops reported long-time horizons and delayed realizations associated with some management decisions. As one dairy farmer stated: “You can’t just say “I’m going to milk more cows.” If you raise them, it takes two years. It’s not something you can switch on and off… it takes time to change what you need to do” (Participant 27). Another farmer noted the lag time associated with planning and experimentation, demonstrating a desire to “test the waters” before committing to commercial production of new agricultural products:

We’re looking at the future of agriculture on our farm … We’re exploring ways we don’t have to flip the soil. An example would be mushrooms. Or we’ve been pasturing pigs for a few years for ourselves and we’re exploring [expanding commercially]. That’s where we’re headed. (Participant 8)

**Climate Change Knowledge, Temporal and Social Distance, and Risk Perception**

We identified three themes relevant to temporal and social distance in the context of climate-related risk perception: (1) knowledge about the agricultural risks associated with climate change and associated adaptation strategies; (2) temporal approaches to conceptualizing climate change (e.g., historical or future-oriented); and (3) variation among participants’ concern related to current and future perceived risks.

First, we examined participants’ perspectives on agricultural risks associated with climate change, and the strategies they use to address these risks. Participants described the future impacts of climate change on agriculture in the Northeast in their own words; their knowledge was generally aligned with climate change vulnerability assessments conducted in the Northeast United States (Wolfe et al. 2018; Tobin et al. 2017),
as would be expected considering the sampling technique utilized in this study. As one participant noted:

Nobody can deny that the climate's been making some weird swings… Through the winter months we don’t get a lot of rain or snow, and then … we don’t the spring rains that we had. It’s been fairly dry, and that’s made it great for getting crops in the ground, but it’s actually been too dry for them … And then it starts to rain and it just doesn’t stop raining. It just continues to rain, and then it turns incredibly dry again. Those are real challenges. (Participant 11)

Common themes identified by participants included rising temperatures, changing precipitation patterns, changing ecological communities, more frequent extreme weather events, and disrupted access to public services. The most commonly cited adaptation strategies were cropping strategies, water management, diversification, and financial
management (see Table 2). The strategies cited have many co-benefits in addition to climate-risk reduction, as has been noted in prior studies (Schattman, Conner, and Méndez 2016).

Second, we observed two temporal perspectives among participants. The first was aligned with farmers’ personal historical experience and observations. For example, a participant reported concern over the effect of reduced snowpack on perennial crops based on their experiences growing these crops over several years:

I think we’re going to lose consistent snowpack in the winter … It’s just out of the norm and the snowpack is a big deal. Because if we don’t have it, our perennials aren’t protected and I think that will change the environment … last year without the snowpack we had damage. (Participant 36)

Another cited the positive effects of precipitation changes and a longer growing season compared to his experience as a dairy farmer over many decades. Specifically, these changes introduced the potential for additional hay harvests: “Someone just told me on the news they saw someone cutting a fourth cut of hay just a couple weeks ago” (Participant 4). Historically-oriented participants were sometimes reluctant to imagine future conditions or their implications. For example, when asked about what climate- or weather-related changes he expects to see in the future, one dairy farmer replied: “It could change. It may not get warmer; it may actually get colder. The jury is out to say if we are going to be affected and in what ways” (Participant 30). The second perspective was future oriented. Those who demonstrated a future oriented perspective integrated personal past experience (i.e., a historical perspective) with outside climate change information. Future-oriented participants sometimes demonstrated concern and anxiety for the wellbeing of future generations. For example, a vegetable producer stated:

I used to think that these changes would be more relevant to me in my life, [but] now I’m thinking they’re not. They’re going to be [relevant to] the next generation … there are some bigger things on the horizon that I don’t even know how to think about. (Participant 8)

Figure 2. Interview participant perceptions of climate risk, as demonstrated through response to statements ($n = 22$).
Lastly, we applied two dimensions of psychological distance by exploring concern related to current and future perceived risks. Participants reported agreement or disagreement with statements selected to describe different forms of distance, specifically (a) self versus other (social), and (b) now versus later (temporal). As shown in Figure 2, most participants (18 out of 22) responded to the short questionnaire on this topic and reported concern that climate change is currently harming people in the United States. In response to the statement climate change will harm people in the United States, which connotes a moderate future condition, the overall level of agreement decreased only slightly (17 out of 22). When asked if they agreed with the statement climate change will harm future generations, which connoted a stronger future condition (as well as a less-personalized, more socially distant perspective), fewer interview participants agreed overall. Few interview participants believed that climate change would benefit people in the United States in the future. Notably, a larger proportion of participants agreed or strongly agreed that climate change will benefit people in the United States (24%) than the proportion that agreed or strongly agreed that climate change will benefit future generations (10%).

We additionally asked participants: How important is climate change to you when you make farm management decisions now?, and How important do you think climate change will be to you when you make farm management decision in the future? Most participants (16 out of 22 who answered this question) reported the same level of importance in the present and the future. Of these, only four indicated that climate change was already very important to them, and therefore could not become more important: “It’s almost always on the top of the pile now... it’s very hard to go up from there” (Participant 7). The remaining six participants indicated that climate change would likely become more important to them in their future decisions. For example, a vegetable grower stated that in the future climate change would play a bigger role in decisions about crops and planting decisions:

I think [climate change] is going to keep playing an increasingly big role ... I think when the season starts ... I might start saying, “you know something? I just not going to plant cucumbers anymore because they just get decimated now.” Instead I’m going plant more sweet potatoes because they’re doing better than ever. (Participant 7)

Of the farmers who noted that climate change would likely become more important to them in the future, several described it as being one of a long list of factors that influence their current decision making.

Discussion

Our study suggests that climate informed farmers hold accurate knowledge about the climate- and weather-related risks, and are actively engaged in addressing these risks. Prior research shows that agricultural producers work to meet their farming objectives by managing a diversity of external factors (Kandlikar and Risbey 2000; Warner 2016), including but not limited to climate- and weather-related risks. We show that producers make decisions at multiple timescales across multiple categories (e.g., ecological, economic, social), often simultaneously. These decisions and the external conditions that drive them are necessarily interwoven. Robert et al. (2018) characterize similar
overlapping timescales of decision making, specifically related to on-farm water management in the following manner: **strategic** (e.g., investments made over a 10-year period), **tactical** (e.g., yearly decisions, such as an updated cropping plan responsive to changes in average rainfall), and **operational** (e.g., daily decisions, responsive to the immediate agronomic context). Future research should explore these themes further, and in doing so push the timescale of **strategic** decision making beyond the ten-year timescale.

Temporal perspectives of climate risk as it applies to an individual’s farm can either be **historically oriented** or **future oriented**. It has been shown that individuals who exhibit a **future time orientation** (Pahl et al. 2014), are able to apply subjective ideas about the future to personal goals. As suggested by Milfont, Wilson, and Diniz (2012), individuals with this perspective may be more likely to think about and act on environmental problems, including climate change, than those with a historically oriented perspective. Our results suggest that individuals with a **historical perspective** lean heavily on personal experiences when considering future conditions, while those with a **future time perspective** supplemented personal experience with outside information. However, it is likely that climate change will cause environmental shifts that depart from those most farmers will have experienced within their lifetimes (Naess 2013), and that a lack of experience with the scale of future climate impacts may lead to a lack of concern (Pahl et al. 2014). Climate change is not just statistically and meteorologically constructed, but our sense of “normal” is also socially constructed (Hulme et al. 2009; Howe and Leiserowitz 2013) and is informed by memory. Memory is also associated with our ability to normalize climate risk and associate it with concrete adaptation strategies (Findlater et al. 2018). Yet farmers’ memory of climate conditions have been show to deviate from meteorologically recorded climate conditions (Niles and Mueller 2016). Effects of overreliance on historical perspectives of climate and weather conditions can be detrimental to agricultural production (Risbey et al. 1999).

Temporal perspectives of climate risk may diverge depending on whether a climate-informed farmer is thinking about their own future or the future of other people (social distance), and whether they are thinking of the near or distant future (temporal distance). Our results suggest that perceptions of **personal** risks in the present and in the imagined future may not differ as much as we expected. In this case, Liberman, Trope, and Stephan’s (2007) temporal “zero distance point” does not appear to be very different from a hypothetical future. This aligns with past research showing that temporally proximity does not have significant effect on individuals’ willingness to respond to climate change (Brügger, Morton, and Dessai 2016; Spence and Pidgeon 2010). However, when participants’ responded the risks that climate change will pose to **future generations** (an interaction between temporal and social distance), high levels of construal become evident. There is also a greater uncertainty about what the fate of these socially distant **others** will be, indicated by the proportion of our participants who reported that they neither agreed nor disagreed with the statement **climate change will harm future generations**. Our findings reinforce the central assumption of **Construal Level Theory**, that higher level construal is generalized and decontextualized, while low-level construal is more concrete and detailed (Trope and Liberman 2003).

In short, our work suggests that considerations of temporal distance (**now versus later**), when combined with social distance (self versus other) of climate impacts, does
play a role in climate risk perception, supporting findings by Fiedler et al. (2012). As noted by Huff et al. (2017), assessing the influence of psychological distance on individuals’ perceptions and behavior is difficult, due to the degree to which it is moderated by attitudes, beliefs, opportunities, and constraints. Further, it has been shown that the four dimensions of psychological distance are not independent of one another, suggesting specifically that temporal and social distance interact with one another and alter levels of construal (Rickard, Yang, and Schuldt 2016). Further research on the moderating factors that interact with temporal and social proximity and risk perception will allow for a more complete understanding of how these perspectives do or do not limit farmers’ ability to gauge climate-related risks. By extension, clarity about these relationships can lead directly to programmatic interventions designed to increase the psychological proximity of climate risk, thereby making risks more concrete and nuanced.

**Conclusion**

Through qualitative analysis of interviews with 24 climate-informed farmers, we find that climate risk perceptions differ depending upon whether a climate-informed farmer imagines the risk to be personal versus experienced by others. We also find that temporal and social distance likely play an interactive role in climate-risk perception, and climate-related risk applied to the self (versus others) is relatively stable. However, the perception of risk decreases with greater temporal and social distance. This points to a divergence between study participants’ perspectives and those held by most climate scientists. While many of the former may be unsure about the level of risk that climate change poses to agriculture in coming decades, the consensus among the latter is that risk will increase (to varying degrees) in many agricultural regions.

We conclude that while temporal perspective plays an important role in climate risk perceptions and agricultural adaptation decisions, we do not yet fully understand the nuances of these interactions.

As climate change impacts become more frequent and/or severe in the coming decades, adaptation will increase in importance. Significant resources have been dedicated to helping farmers reduce weather-related risk in the United States and around the world, through governmental, institutional, and community-based programing and education. Further investigations related to the cultivation of future-oriented temporal perspectives can support these efforts, as well as those seeking to leverage agricultural climate change mitigation, by enhancing climate communication and targeted intervention. By transforming themes identified through this qualitative analysis into verifiable variables, these themes could be tested more broadly through surveys, program evaluations, or policy impact assessments. This would allow for a broader understanding of how temporal and social proximity and distance do or do not influence farmer adaption decisions, and what moderating influences affect the strength of their association.

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**References**


