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Do advisors perceive climate change as an agricultural risk? An in-depth examination of Midwestern U.S. Ag advisors' views on drought, climate change, and risk management

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Abstract
Through the lens of the Health Belief Model and Protection Motivation Theory, we analyzed interviews of 36 agricultural advisors in Indiana and Nebraska to understand their appraisals of climate change risk, related decision making processes and subsequent risk management advice to producers. Most advisors interviewed accept that weather events are a risk for US Midwestern agriculture; however, they are more concerned about tangible threats such as crop prices. There is not much concern about climate change among agricultural advisors. Management practices that could help producers adapt to climate change were more likely to be recommended by conservation and Extension advisors, while financial and crop advisors focused more upon season-to-season decision making (e.g., hybrid seeds and crop insurance). We contend that the agricultural community should integrate long-term thinking as part of farm decision making processes and that agricultural advisors are in a prime position to influence producers. In the face of increasing extreme weather events, climatologists and advisors should work more closely to reach a shared understanding of the risks posed to agriculture by climate change.

Keywords: adaptation, health belief model, protection motivation theory, drought, qualitative

Abbreviations: GDP Gross domestic product; **HBM** Health belief model; **PMT** Protection motivation theory; **US** United States

Introduction

Long-term shifts in precipitation, temperature, and humidity, weather extremes, and increased flood, drought, and fire risk are just some of the predicted future impacts of climate change (Hatfield et al. 2011). Potential consequences for agriculture are particularly sobering given the sector's sensitivity to climate shifts and subsequent impacts (NRC 2010). Over the past four decades, climate disruptions to United States agricultural production have increased, and are projected to continue to increase over time. Water quality and quantity issues, increased in soil erosion, reduced productivity of crops and livestock, and increased pest and pathogen pressures are potential agricultural-specific impacts of a changing climate (Howden et al. 2007; Walthall et al. 2013). These impacts pose immediate and localized economic risks to agricultural producers (Arbuckle et al. 2013) which may also contribute to wider impacts throughout the agricultural supply chain.

Because threats to agriculture are expected to have subsequent impacts from local to global scales, calls for agricultural adaptation and mitigation strategies have become ever more urgent (e.g., Howden et al. 2007). Some argue that increasingly unpredictable weather will compel producers to reevaluate farm management to adjust to climate uncertainty. However, a debate continues about the future net effect on production in climates like the US, which are presently temperate (e.g., Walthall et al. 2013). Local growing conditions vary widely, and thus it is arguable that climate change at the national or global scale will present opportunities as well as threats. Adaptation may therefore involve a response that tries to limit climate change damages or conversely, an attempt to take advantage of new possibilities (e.g., a longer growing season) (Smit and Wandel 2006). For the Midwestern US, producers have already begun to experience increasing annual mean temperatures and a longer growing season. However, it is predicted that the Midwest will experience impacts from weeds and pests, as well as increased extremes and intensity in terms of precipitation, rain and streamflow which will impact crop yields (Walthall et al. 2013). Long-term climate adaptation will need transformative measures in order to ensure a robust and resilient agricultural system (Tomich 2011).

Numerous authors contend that motivation to adopt adaptive behaviors as a climate change response is dependent on the level of threat perceived from the phenomena (Weber 1997; Grothmann and Patt 2005). If climate adaptation in the agricultural sector is to be encouraged, it will thus be important to first identify and understand how and whether climate change is being portrayed and perceived as a threat. While several studies have considered agricultural producers' climate change beliefs and adaptive intentions, this research focuses upon the agricultural advisors for whom US producers rely on for an array of information (e.g., fertilizer type and timing, seed planting rates, marketing information, nutrient retention, etc.). Indeed, information from agricultural advisors has been shown to influence producers' decision making (Arbuckle et al. 2015; Prokopy et al. 2015a). Despite the demonstrable trust and influence of these advisors, there has been little research into their perceptions of climate change and their climate-adaptive practice recommendations (Mase et al. 2015).

One fairly recent extreme weather event occurred in 2012; almost half of the US corn crop experienced extreme or exceptional drought during that growing season. Average corn yields fell from 147.2 bushels per acre in 2011 to 123.4 bushels per acre in 2012 (USDA NASS 2013). Following the 2012 drought, we sought to assess the extent to which US Midwestern agricultural advisors perceived climate change as a threat. In addition, we explored if and how experiencing this extreme weather event influenced advisors' own behaviors (e.g., climate-adaptive or conservation management advice given), as well as advisors' reports on the behaviors of the producers they advised (e.g., climate-adaptive practices implemented). In the following pages, we address the following three research questions:

1. How do agricultural advisors appraise climate change risk?
2. How do advisors' risk appraisals affect their advice to producers?
3. Does the combined Health Belief Model and Protection Motivation Theory framework explain differences in advisors' assessments and advice?

Our research contributes to filling a deficit in literature about agricultural advisors. We explore their perceptions of agricultural climate risk, while adding to a broader literature on how coping with an extreme weather event influences climate-adaptive behaviors. We agree with Lemos et al. (2014) that agricultural advisors are important intermediaries of agricultural information to producers, and thus have the potential to also be conduits for climate risk information and conservation adaptation strategies. This research will provide a better understanding of how advisors perceive climate change and how these perceptions may influence the advice they impart to agricultural producers.

Background

Perceptions of climate change

Despite scientific consensus about anthropogenic climate change (Carlton et al. 2016), there is not consensus about climate change in the agricultural sector. For example, in Gramig et al.'s (2013) study of Indiana corn and soybean producers, 31% of producers surveyed were neutral in their belief in human caused climate change (neither belief nor disbelief). Over a third of respondents (34%)

thought climate change was an invention to "scare people" (Gramig et al. 2013, p. 162). Climate change framing may also play a role in the formation of perceived impacts, risks and willingness to adapt. For example, Haden et al. (2012) found that producers' willingness to adopt new irrigation practices (described by the authors as an adaptive practice) was related to concerns over local, near-term risks with the potential for personal impact (e.g., reduced crop yield). Moreover, research has found that producers who believed in anthropogenic climate change are more concerned over climate change impacts and support adaptation and mitigation strategies (Weber and Stern 2011; Barnes and Toma 2012). Conversely, producers who believed climate change was due to natural causes, or questioned its occurrence, were less supportive of adaptive and mitigative action and policy (Arbuckle et al. 2013).

There are a multitude of inputs that go into producers' farm management decisions and many different motivations that feed into decisions to implement climate-adaptive practices. In addition to perceived climate risk as described above, some motivations for practice adoption include financial incentives, increased profits, commodity prices, on-farm improvements, a stewardship ethic, and off-farm benefits (e.g., Crane et al. 2010; Reimer et al. 2012; Rosenberg and Margerum 2008). Yet another decision making input is whether and how to utilize weather and climate information. Such information is available from weather/climate services and decision support tools (provided by a company, university, or government agency), weather/climate information provided by agricultural advisors, and weather forecasts provided through the television or internet. Producers tend to use short-term weather information for immediate decisions. Although seasonal climate forecasts are seen by scientists, researchers, and some advisors as a climate-risk management strategy (e.g., Carlton et al. 2014; Crane et al. 2010), producers are less likely to use longer-term weather or seasonal climate forecasts due to the perceived unreliability of the information (e.g., Crane et al. 2010; Jagtap et al. 2002). Mase and Prokopy (2014) suggest that improving weather/climate information and tool reliability and relevancy might increase their use, but that increasing trust in the information and tools is perhaps a more important factor in their potential uptake.

People look toward trusted institutions for decision making guidance under conditions of uncertainty or imperfect knowledge (Dietz et al. 2007). Agricultural advisors are an example of a trusted institution made up of agricultural Extension staff operating out of land grant universities, government agencies (such as the state's Department of Agriculture, the Natural Resources Conservation Service, and Soil and Water Conservation Districts) and for-profit groups and individuals (such as seed and fertilizer salespeople, certified crop consultants, and bankers and lawyers). Agricultural advisors assist producers in making day-to-day decisions and thus are in a good position to act as climate information intermediaries. In this role they could influence producers' use of climate science when advising on short and long-term decisions (Lemos et al. 2012, 2014; Mase and Prokopy 2014).

Some research has pointed to the need for more cross communication between scientists, advisors, and producers in relation to climate adaption and mitigation strategies (Prokopy et al. 2015b). Much research has focused on the US Cooperative Extension Service (e.g., Breuer et al. 2010; Burnett et al. 2014). There has been less focus on the role of private sector advisors and science communication (Breuer et al. 2010; Buizer et al. 2010; Mase and Prokopy 2014). What little research that has been done to date suggests that there is some skepticism among agricultural advisor groups about the existence of climate change and anthropogenic causes (Prokopy et al. 2015a; Mase et al. 2015). Haigh et al. (2015) found willingness to provide advice based on climate information depends on the type of advice given. For example, advisors who provided agronomic advice were more likely to have a positive attitude toward giving advice based upon climate information than financial advisors.

This research informs the ongoing evolution of the agronomic sector and its actors. We use a combined theoretical framework—the Health Belief Model (HBM) and Protection Motivation Theory (PMT)—as a lens through which to understand agricultural advisors' perceptions of climate change and the advice given to producers as related to adaptive conservation practices.

Theoretical framework

The National Safety Council defines risk as simply "a measure of the probability and severity of adverse effects" (Inouye 2014, p. 2). These ideas of susceptibility and severity form the basis of the more detailed HBM. However this model also acknowledges the roles that perceived self-efficacy, benefits, barriers, and social cues play in peoples' decisions whether or not to take action to adapt to or mitigate risk (Semenza et al. 2011). Self-efficacy refers to an individual's belief that they are capable of taking action and maintaining a new behavior (Straub and Leahy 2014). A cue to action refers to any information or observation that leads to the realization that a change in behavior would be beneficial; the effects of which relate to risk perception. The higher the level of perceived threat, the smaller the cue to action required to instigate a behavioral change (Janz and Becker 1984; Heimlich and Ardoin 2008).

Like the HBM, PMT developed by Rogers (1983), gives credence to the roles of severity and susceptibility of threats, as well as benefits and barriers to change, by bringing in two major elements: (1) threat appraisal: a person's assessment of the likelihood a threat will occur and its potential to damage something valued if a given behavior does not change; (2) coping appraisal: a person's evaluation of their capacity to avert a threat or to cope with the effects, as well as any costs likely to be incurred as a result. Grothman and Reusswig (2006) contend that considering people's threat and coping appraisals, including their perceptions of the effectiveness and cost of alternative behaviors, can provide guidance into their risk assessment and response.

While 'cues to action' are not always included in PMT, there is value in recognizing the influence social factors have on risk perception and appraisal (e.g., Gergen 2009). Cues to action facilitated through media channels impact an individual's threat and coping appraisals, and ultimately their decision to maintain or alter their behavior. Figure 1 is a conceptual framework developed by the authors, based upon a literature review, which combines elements of the HBM and PMT.

Although both the HBM and PMT emerged for use in the health field (e.g., to understand a patient's decision to continue or quit smoking), their application to environmental risks and behaviors is increasingly common (e.g., Reser and Swim 2001; Semenza et al. 2011; Straub and Leahy 2014). Solutions to health and environmental risks revolve around undertaking volitional behaviors to prevent a negative state. Such a change results from a decision that negative consequences are severe and likely to occur. Furthermore, to achieve long-term positive effects, behavior change may involve accepting immediate consequences such as time, inconvenience, and financial difficulties. It follows that fear of consequences associated with climate change and extreme weather events could be utilized to address climate change vulnerability and communicate climate-adaptive responses (e.g., McBean 2004; Cismaru et al. 2011).

Researchers have already found that PMT variables have an influence on climate change behaviors (Nisbet 2009; Pike et al. 2010). Indeed, Lemos et al. (2014) commented specifically on the reduced willingness of agricultural advisors to provide advice on climate information when their own perceptions of risk to agriculture (from climate) is low. Even accounting for the Lemos et al. (2014) study, there is recognition that there is a lack of literature on risk perception and subsequent behavioral change focusing specifically on agricultural advisors, which we address here. In the following pages, interview results are presented through a discussion of each of the components of the above combined HBM and PMT theoretical framework.

Methods

In the wake of the 2012 drought, this research sought to capture climate change and climate risk attitudes of agricultural advisors operating in the US Midwest. To elicit rich data capable of capturing the nuances in perceptions of climate change and subsequent response behavior, we carried out in-depth, semi-structured interviews with four different types of agricultural advisors from two Midwest Corn-Belt states— Indiana and Nebraska. At opposing east–west extremes of the Corn Belt, these states are considered typical in terms of the region's agricultural production, and also contain the four categories of advisors sought. Indiana and Nebraska produce similar crops (corn and soybeans) with similar production methods. In 2015, Indiana's top two commodities were corn and soybeans (USDA ERS 2017a) and Nebraska's top three were cattle/calves, corn, and soybeans (USDA ERS 2017b). It follows that the types of advice and advising given by agricultural crop advisors would be similar across the two states. Percent of irrigated cropland is one difference between

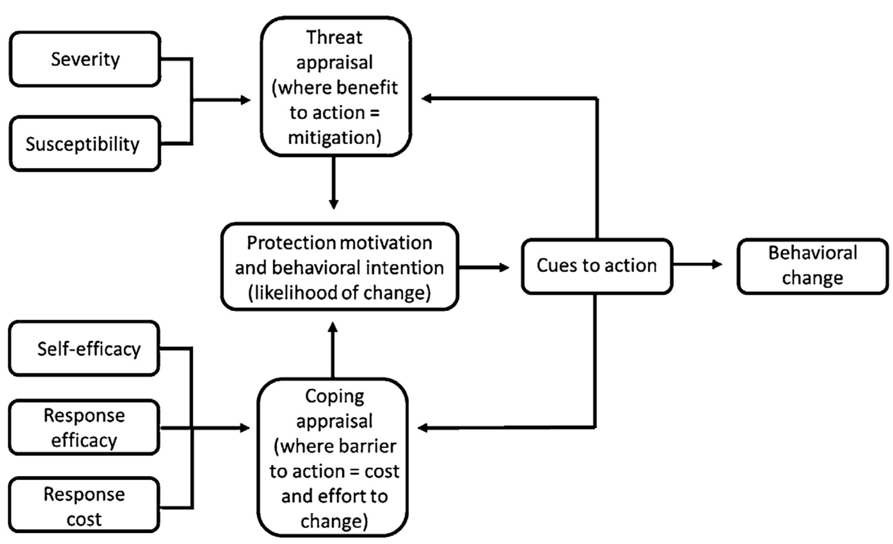

Fig. 1 A combined health belief and protection motivation framework.

Indiana and Nebraska. In 2012, Indiana irrigated 3.3% of its cropland (USDA ERS 2017a) while Nebraska irrigated 38.1% (USDA ERS 2017b).

Potential interviewees were identified from a 2012 advisor survey (Prokopy et al. 2013) which produced 1354 cumulative responses from the two states. Survey respondents comprised crop advisors (e.g., seed, fertilizer), conservation agency staff (Natural Resource Conservation Service and Soil and Water Conservation District staff), financial advisors (agricultural bankers and lenders), and university Extension educators. Only advisors based in corn producing counties and answering "yes, I advise producers" on the survey were included in our interview sampling frame. Beginning in late 2012, a random sampling procedure was used to identify interviewees from each advisor group. Interviews continued until data saturation occurred across all advisors (n = 36), where no new ideas or themes were heard when a new participant was interviewed (Bowen 2008). The majority of advisors were male (n = 34). The advisors had an average of 19.5 years of experience advising producers (ranging from 3 to 36 years of experience) and most had either grown up on a farm and/or were still farming in some capacity. The number and distribution of interviews is summarized in Table 1.

Table 1. Advisor roles and locations

	Indiana	Nebraska	Total
Crop advisors	10	3	13
Conservation	4	3	7
Financial	3	6	9
Extension	4	4	8
Total	21	15[a]	36

a. One advisor from Nebraska is categorized as both "Crop advisor" and "Extension."

The beginning of the interview guide focused on generic questions—e.g., "What do you see as the biggest risk facing agriculture in the Midwest?" and "What are the chief concerns expressed by the producers who come to you?"— rather than questions specific to climate change and extreme weather risk. This line of questioning helped to contextualize the perceived risks from climate change relative to other risks, and also to determine how advisors and their clients prioritize between short and long-term risks. Subsequent questions asked whether advisors believed in climate change, if they thought weather was becoming increasingly variable, and if so what they believed to be the cause of the variability. In addition, advisors were asked directly whether they were concerned about climate related impacts on agriculture in their region, whether climate change was responsible for the 2012 drought, and a series of questions on their climate change risk management strategies (advice given to producers), and action taken (by producers advised). Pretesting of the interview guide was carried out with three advisors in Indiana. The resulting transcripts were retained for subsequent analysis. Following pretesting, minor modifications were made to the guide to improve the clarity of questions and eliminate unnecessary prompts.

Analysis procedure

We began data analysis by providing six researchers access to the transcripts and asking each to suggest themes from their reading. The suggested coding themes were discussed during a group call, at which point it was agreed to integrate the HBM and PMT due to their relevance to climate change adaptation and applicability to risk perception and willingness to act. The primary researcher made the agreed upon adjustments to the codebook. Twelve transcripts were then distributed among the six researchers to assess the codebook's suitability and completeness (Gorden 1992). In addition to coder feedback, we utilized Cohen's Kappa coefficient as an intercoder reliability measure (Cohen 1960). Values above 0.7 signified a satisfactory level of agreement among coders (Gardner 1995). The initial round of the intercoder reliability process produced an unacceptable average Kappa coefficient (0.69). The codebook was thus revised through a series of deliberative meetings until each of the coders were able to consistently interpret and apply the codebook (Miles and Huberman 1994). A subsequent coding round produced an average Kappa coefficient of 0.91. The primary researcher then applied the broad level codes to the remaining transcripts (Campbell et al. 2013). Although only one code—"Cues to Action"—is named to reflect our theoretical framework, the other broad codes were applied to the relevant theories. We use these theories as a framework for understanding climate change risk behaviors by analyzing motivations and adaptive action among agricultural advisors and their producers (as reported by advisors). Table 2 shows the coding framework (broad codes and subcodes) and related aspects of the HBM and PMT. Unless otherwise specified, the quotations used throughout, represent perceptions communicated across all types of advisors.

Results

Threat appraisal

To explore how agricultural advisors and the producers they advise (as described by the advisors), appraise the threat of climate change (perceived severity and susceptibility), we first considered the possibility that not all believed the phenomena to be occurring. Because studies have shown that the perceived cause of events and

Table 2. Coding framework and related theory components

Coding framework	Theory
Perceptions of climate change	Threat appraisal
Belief	
Cause(s)	
Recollections of extreme/variable weather	
Opinion on whether weather is becoming more extreme or variable	
Perceived impacts of climate change	Threat appraisal
Extreme weather impacts, drought, flooding, etc.	Coping appraisal
Spread of disease/invasive species	
Changes in yield and profitability	
Impacts on the market, etc.	
Impact on the Ag sector in general	
Cues to action	Cues to action
Personal observations	
Communication with other professionals	
Media, websites, tools, and apps	
Client testimonies	
Uncertainty/insufficient information available to act	
Climate change risk management strategies	Coping appraisal
Crop insurance	Advice and behavior
Scientific/technological advancement (e.g., hybrids, GMOs, new equipment, decision making tools)	
Changes to farm operation (e.g., diversification, conservation practices, irrigation)	
Prioritization of other risks/goals	
Willingness/resistance to climate change risk management strategies	
Changes in advice sought and given	
Ability (or lack of) of producers to offset impacts of climate change/extreme, variable weather using climate change risk management strategies, or in general	
Ability (or lack of) of advisors to provide risk management advice and motivate change	

scenarios has implications for how the threat is appraised (Weber 1997; Saleh Safi et al. 2012; Arbuckle et al. 2013) it is important to clarify what advisors believe to be the underlying mechanisms of climate change and extreme weather events. We found some financial and crop advisors, and a majority of conservation and Extension advisors, accepted that climate change is occurring. Many of the advisors interviewed believed this to be a symptom of a long-term natural cycle. This also proved to be the case when asked about changes in weather variability and the incidence of extreme weather events.

> I'm not a big believer in climate change. I think we have climate extremes…we go through natural ebbs and flows to our weather patterns…it goes all the way back as long as we've been tracking the weather…— Indiana based crop advisor

Perhaps because the term "climate change" is often interpreted as "anthropogenic climate change", it is possible for an individual to profess disbelief about the phenomena while concurrently expressing concern about the extreme weather events regarded by experts to be synonymous with climate change (e.g., Hatfield et al. 2011). Related to climate change beliefs, the majority of conservation and Extension advisors— but only a few crop and financial advisors—believed that extreme weather events were occurring more frequently in their area. That being said, as extreme weather events are more assured and tangible, threat appraisals were more commonly constructed around their impacts rather than around gradual, long-term changes associated with "climate". In addition, while the 2012 drought predictably arose in discussions on volatile, extreme and variable weather, other past and present examples also played into most advisors' threat appraisals.

> …in '89, '90 and '91…we had some torrential rains… in 2008 we had heavy rainfall events in the fall and crops were about ready to come out…the floods of '92, 3, and 4…Rainfall…doesn't seem to be general like it used to be…it might rain in one mile and not the next, or they're more of a short duration high intense rainfalls that come through…we need to be able to get guys geared up so they can handle that intense rain storm…with minimal damage to their cropland.— Nebraska based conservation advisor

While the advisors were not in unanimous agreement on the nature/cause of climate change or the increasing frequency of extreme weather events, a vast majority of those interviewed recognized that Midwest agriculture is susceptible to extreme events. However, few of the advisors interviewed considered climate and weather related risks to be the principal concern for themselves or their clients. Pests, weeds and disease, environmental sustainability, increased regulation and farm succession all featured as examples of concern for Midwestern agriculture as expressed by advisors. Water availability, commodity prices, and marketing emerged as the most serious and commonly cited examples.

> The most challenging thing right now is the price of corn and soybeans has dropped significantly. Break-even cost on corn production are about where their expenses are…trying to figure out how they can still produce a crop and hopefully stay in business…— Indiana based crop advisor

Whereas commodity prices and marketing were typically considered to be isolated issues, some advisors expressed concern that water management issues could be exacerbated by climate change and extreme weather events.

> …the water [issue] is always going to be a concern as we deal with increasing population because we're going to be dealing with higher use rates per acre with an urban population than…on the agricultural landscape… water is definitely…one that I'm concerned about and will be a continual concern - even if climate stabilizes.—Nebraska based Extension

Relative to more assured short-term threats (e.g., commodity prices, immediate drought recovery), uncertainty over the manifestation of climate change impacts appeared to contribute to the way advisors prioritized different risks to their clients. Indeed, we found three reasons why changes in climate and weather were dismissed as a risk. First, some advisors believed that an increase in carbon dioxide and mean annual temperatures will have a net positive impact on agricultural production. This opinion may have been bolstered by their observations that even in the purported "extreme" drought of 2012, many of their producers were still able to attain satisfactory yields.

> Actually, climate change from a soybean standpoint is a good thing. Because we produce more CO_2 into the air, yields go up…as the globe warms we increase the amount of arable land we can grow crops on.—Nebraska based crop advisor

Second, the extensive uptake of crop insurance over the last decade was widely regarded by financial, crop, and Extension advisors (but very few conservation advisors) as a solution to reduced corn yield and profitability associated with risk from extreme weather impacts.

> …I don't know of any other way [to manage climate change risk] other than praying it's going to rain…If it doesn't, I have crop insurance to manage my downside risk on my productivity.—Indiana based crop advisor

Finally, there was a pervasive attitude among most of the advisors interviewed that no matter how impacts manifest, producers and industry will be able to adapt as necessary.

> …I think we're adapting…It's…something we're going to have to deal with, but I'm not concerned to the point where I see no future in agriculture or farming because of climate change.—Nebraska based crop advisor/Extension

Beliefs that there is not a risk (denial) or that there is limited susceptibility to the threat (wishful thinking) are examples of non-protective responses among agricultural advisors, which serve to weaken an individual's threat appraisal and subsequent protection motivation and behavioral intention (Grothman and Reusswig 2006).

Coping appraisal

The coping appraisal reflects how able and willing individuals are to alter their behavior based on the perceived ease, cost, and effectiveness of recommended changes. Advisors described a range of behaviors that could reduce climate and weather related risks to agriculture: insuring crops, selecting an appropriate hybrid seed, effectively managing water, adopting conservation practices, and modifying other farm operation decisions (varying timing of activities and diversifying crops). Advisors were clear that crop insurance and hybrid seed selection were already commonplace before the 2012 drought, due to crop production and financial benefits. The majority of our interviewees indicated that hybrid seed selection and crop insurance advice were driven by crop and financial advisors, effectively negating the need for practice appraisal by the producers themselves. This was not the case for risk management strategies centered on water management and conservation practice adoption. Advisors who spoke about conservation practices told us they require careful assessment on a farm by farm basis in order to weigh the pros and cons of a particular practice. Moreover, thoughts about implementing new irrigation to ensure productivity and profitability varied with advisors' climate change perceptions, as well as a particular farm's characteristics. Advisors who expressed more confidence that climate change was occurring and that it would have detrimental impacts on Midwestern agriculture appeared to be less risk averse toward irrigation investment. However, this was tempered by geographical context. Although irrigation was a fairly common risk management strategy suggested by all advisor types interviewed, Nebraska interviewees (which has a fairly long history of irrigation), were more uniformly likely to suggest it as a strategy than Indiana interviewees.

> I would be hesitant to say you should invest in irrigation at this point because it's very expensive and we don't have solid information that we're having continued droughts.—Indiana based crop advisor

> We have this seemingly limitless ocean of water in the Ogallala aquifer... the impact of weather at least around here gets muffled a little bit because we can make a lot of our own water.—Nebraska based crop advisor

In terms of advisors' coping appraisal, the statements above reflect the importance of acknowledging producers' financial response cost when deciding whether to recommend irrigation as a risk management practice. We also found that producers' self-efficacy played a role in advisors' decision making processes. For example, some interviewees described the introduction of an irrigation system as "a pretty big learning curve" that needed "different management techniques [which] takes a while to learn". Conservation practices such as no-till and cover crops were commonly cited by conservation and Extension advisors as a means to establish climate and weather resilient soils. By building sufficient organic matter, advisors told us these conservation practices help ensure crops have access to water in times of drought, and are able to resist erosion caused by heavy rainfall and high winds. Yet, like irrigation investment, the adoption of conservation practices coincided with farm management and farm business costs.

> Those guys that had no-till corn had a lot better yield...if you incorporate cover crops...it even gets a little better...What they don't like about no-till and cover crops is the slow warm up in the spring.—Indiana based Extension Farmers...don't necessarily want to be putting on cover crops or start trying to change someone's soil, and then lose their lease in 3 years...—Indiana based conservation advisor

These examples involve the deliberation of pros and cons to adoption. They demonstrate that the decision to implement practices capable of mitigating climate and weather risks often rely on threat appraisals distinct to the threats posed by climate change and extreme weather. The importance of the cost appraisal (relative to the threat appraisal) became elevated because of the uncertainty advisors face in terms of whether climate and extreme events are worsening (or even occurring), and perhaps more importantly, the lack of predictability over how and where an impact will manifest. Although the coping appraisal is an assessment of the perceived ease, cost, and effectiveness of recommendations, the appraisal becomes compromised if advisors decide not to provide such recommendations because of uncertainty.

> It just tries the farmers' production methods. Because he doesn't know if he's going to get a drought and so he doesn't know what population to plant the corn. In 2012 if the farmers would've known we were going to have a serious drought they would have dropped their plant population drastically.—Indiana based crop advisor

Finally, in terms of risk and impacts from weather and climate change, a small number of advisors described what Grothmann and Resswig (2006) refer to as fatalism—a form of determinism that portrays events as unavoidable or inevitable, regardless of the efforts or changes made by human beings.

> I think climate change is moving too fast for the ground and the ability to handle it. Part of me wants to just buy a bunch of farmland in South Dakota and North Dakota.—Nebraska based financial advisor

> With the [2012] drought, we just really didn't have as many people come in. It was like 'you know, it's bad, but it's life.—Indiana based conservation advisor

Such attitudes may represent a feeling among some advisors that climate change is too great a problem to tackle (low efficacy)—a psychological phenomenon previously described by Reser and Swim (2011) in relation to climate change mitigation. This, along with perceptions of climate change uncertainty, steep learning curves involved with changes in farm management practices, and costs associated with change, feed into advisors' tacit coping appraisal and subsequent threat response.

Cues to action

Cues to action are social factors that influence threat and coping appraisals, as well as behavior change. We found that not all information to which advisors were exposed represented a cue to action, even if that was its explicit purpose. For example, some advisors were inherently skeptical of information presented under the theme of climate change, which consequently was not a cue to action for many interviewees. In addition, a large proportion of advisors noted that they needed accurate weather projections in order to proactively provide risk management advice to their producers (i.e., information about the future rather than the past). However, advisors frequently described modelling and forecasting approaches, as well as the people who interpret and present weather projections, as mistrusted. This mistrust was due in part to past negative experiences, as well as to conventional wisdom that weather forecasts are inaccurate.

> I don't trust anything long-term. You look at a ten day forecast now and it'll change five times or

> more... Today there's a situation. Tomorrow it's a potential situation, three days out maybe. So maybe three days out, then the rest is bogus.—Indiana based crop advisor

In addition, many advisors described sources of information that dismissed climate change—what might be thought of as cues to inaction.

> They talk about global warming and I've read several articles written by scientists that are saying we are in about a fifteen-year pattern of cooling.—Nebraska based financial advisor

This is not to say that all advisors distrusted all reports on climate and weather related risks and coping strategies. In parallel to previous work (e.g., Prokopy et al. 2015a) university, Extension, and other sources were viewed as independent of a product or motive. They were thus frequently cited as trusted sources whose outputs influenced the information and advice advisors passed on to producers.

> I will disagree with them [Extension] on climate change, but if they're saying this practice will help protect against climate change...I'm going to call it weather...We just disagree on the extremes or the terminology, but the practice is still valid or has benefit.— Indiana based crop advisor

In addition to cues from others, advisors described the importance of producers' self-cues, driven by personal observations. For the advisors we interviewed, these cues to action appeared to be influential catalysts in altering producers' attitudes and practices. The 2012 drought and other recent extreme events that had resulted in widespread and easily perceptible crop damage, were readily identified as impactful cues in terms of using weather information or adopting conservation practices.

> Both 2011 and 2013...it was in both those years we had more people taking interest in no-till because they could clearly see that land next door...drained better and dried out faster than their land. Both of those years had the severe rain event that caused a big influx of people coming in to ask questions about our practices and advice.—Nebraska based conservation advisor

These findings suggest that while advisors may be trusted by producers (Prokopy et al. 2015a) they are only one piece of their decision-making process—e.g., climate denial information, as well as many of the financial and efficacy decisions discussed previously. Through the eyes of the advisors we interviewed, producers' own observations may be an important cue to action, which advisors could capitalize upon as a platform to build dialogue and offer climate-adaptive practice advice.

Advice and behavior

Despite the recognition climate change and extreme weather events pose threats to agriculture, most advisors reported that their advice to producers remained unchanged in the wake of the 2012 drought. For some, this lack of behavioral change stemmed from a belief that their pre-drought advice and risk management strategies were, and remain, sufficient. For example, financial advisors already believed producers were sufficiently protected through crop insurance and conservation advisors were already promoting practices such as no-till and cover crops.

> [The 2012 drought has] probably changed word choice when I talk to growers and thinking more long-term instead of knee jerk reaction. But from an advice standpoint, nothing's really changed.— Nebraska based crop advisor

For other advisors, a lack of behavioral change reflected limited efficacy, either as a result of perceptions that the strategies themselves would fail to be impactful, or because of a belief that their advice would not be utilized.

> ...I don't think anybody has enough information to try and sway people for what's going to be out there 20 or 30 years from now...there could be famines, there could be natural disasters, there could be all kinds of things and we would be wasting our time trying to prepare for something 20 years from now.— Indiana based crop advisor

For some advisors, uncertainty that climate change is occurring and how it might manifest, undoubtedly underlie a perceived inability to provide useful advice to producers. However, it was also clear that for a minority of advisors, the omission of climate related risk management strategies was a case of absolved responsibility. In these cases, threats and coping strategies were considered the domain of climatologists, other advisors, or the producers themselves.

> I do not think it's my role to tell a farmer how to adapt to climate change. That might be for someone [else]...as far as the marketing of the grain, the climate just doesn't fit into the advice.—Indiana based crop advisor

These responses demonstrate that a reluctance to provide advice cannot be solely attributed to a lack of belief in climate change. A desire to remain as specialists able to provide advice on a particular topic, or to focus on more immediate and assured issues, also contributed to advisors' decisions whether or not to provide advice. This echoes Haigh et al.'s (2015) suggestion that advisors are more likely to incorporate climate information into advising if it is related to their particular specialization. Thus, the advice provided reflected producers' needs, which advisors described as concern over the current or upcoming growing season. As many producers remain skeptical of climate change, advisors open-minded about the benefits of climate-adaptive behavior expressed difficulty in using potentially contentious climate change language in client discussions. Advisor responses suggest that engendering climate-adaptive behaviors among producers therefore requires advisors not only to be perceptive of the threats from climate change, but also mindful of communicating threats (as a cue to action) without besetting those opposed to the term or notion of climate change.

> ...probably the industry is recognizing it [climate change] and believes it's true...They probably don't advertise it because they know their customers... I personally believe it but I try to be objective and provide good information without saying...'you're wrong'...—Indiana based Extension

While some advisors were content to avoid discussions on climate change to retain harmonious relations with their clients, others took advantage of observable impacts and growing attention climate change had received. Conservation and Extension advisors in particular, used extreme weather events as an opportunity to suggest climate-adaptive behavior that may previously have been promoted without regard for climate and weather risks.

> [In the 2012 drought] we had a teachable moment here to try to get them to try new things that will hopefully make their crops, their fields, more sustainable.—Indiana based Extension

Through this approach, advisors could communicate environmental benefits of conservation, while also addressing producers' primary concerns—yield and profitability. Again, these findings support research that suggest advisors' expertise influences their use of climate information (Haigh et al. 2015). That is, utilizing climate adaptation messaging to incorporate conservation advice fits with conservation advisors' advising specialization. Beyond issues of advisor expertise, perhaps through the experience of weather extremes combined with effective communication, the adoption of climate-adaptive practices could become as commonplace as participation in crop insurance schemes and the planting of hybrid seeds.

> There were certainly some people who did not suffer as much [during the 2012 drought], and we held them up as poster children like, 'this is how well their farm did by doing more sustainable practices'.—Nebraska based conservation advisor

A few of our interviewees had begun to recognize the potential of climate and weather tools in contributing to improved understanding of associated climate and weather risks. Access to climate and weather information allowed advisors to tailor their risk management advice, whether by altering the amount of money a producer was permitted to borrow, or in advocating a set of on-farm management decisions. For these advisors, being open to altering their advice was a first step in improving services that could insulate their clients' physical and monetary resources from climate related threats.

> We have incorporated...a higher degree of probability for volatile weather conditions into our overall rating...We are now working on a separate set of risk criteria specifically for...the ag industry...these weather considerations are one part of that overall risk evaluation.—Indiana based financial advisor

While some advisors' farm management advice did not change after the 2012 drought, others utilized their own cues to action such as "observable impacts" (personal observation) of extreme weather events (i.e., impacts of climate change) to impart advice that might influence producers' behavior. This reflects Carlton et al.'s (2016) findings that advisor perceptions of drought risk increased following the 2012 US Midwestern drought; perceptions which had a significant association with positive adaptation attitudes. Such cues to action also exemplify the range of advisor behavior and their subsequent advice to producers we found in our interviews. Despite this range of behavior, an overall theme emerged. That is, there is a desire for advisors to provide services their producers' need, which then preserves advisors' trusted status. Indeed, as we will discuss, our research suggests that agricultural advisors' advice both reflects their own beliefs and expertise, as well as the beliefs and needs of the producer.

HBM and PMT framework

We combined the HBM and PMT into a framework through which to understand and describe the mechanisms that influence agricultural advisors' risk response and behavioral action. Through our analysis, we unfolded an in-depth picture of the relative weighting of advisors' perceived climate threats and response costs, which together with cues to action influenced advice imparted to producers. Table 3 summarizes our results through the determinants of behavioral change illustrated in Fig. 1. Table 3 includes the elements contained within the HBM and PMT and provides examples of the cognition behind the decision to alter behavior (or not). The "Results" column describe the overall results reported in this paper and generally represent the majority views of the advisors interviewed across advisor types. The framework assisted us in demonstrating

Table 3. Determinants of behavior change in response to risk derived from HBM and PMT: application of research results

	Examples of cognition	Results	Example quotations
Threat appraisal			
Severity	Does a threat exist?	Yes, but it's a symptom of a long-term natural cycle	"…if you go back through history a long time, there's always times when there is either heats or cools… I guess I don't see that it's man made necessarily."
		Other extreme events have occurred in the past	"If you're going to have drought years then you're going to have really concentrated periods of rain some years…"
	How serious are the effects?	Related to impacts and ability to adapt	"…we need to be able to get guys geared up so they can handle that intense rain storm, and do it with minimal damage to their cropland."
Susceptibility	How imminent and widespread is the threat?	Not a concern relative to short-term threats: uncertainty ,possible benefits, crop insurance as a safety net, producers will adapt	"…I think we're adapting to the drought resistance…I'm not concerned to the point where I see no future in agriculture… because of climate change."
	Am I likely to be personally affected?	Related to lack of concern. No concern: no impact or will to adapt (although access to water was a concern)	"…if drought continues…the biggest battles we would have at some point would be over water, that situation will definitely come to light."
Coping appraisal			
Response efficacy	Will a change in my behavior reduce the threat?	Lack of will to respond is related to climate change uncertainty, including fatalism	"I can't control the weather risks…something that I can actually help the grower with I'm going to worry about versus climate and weather that I don't have any control over."
	Are others also required to change for the threat to be reduced?		"The hard thing is to change… 'I'm just one person so what's it going to matter if I change…it's not going to make any difference.' Well we have to get more people to agree that we have to change the way we're doing things."
Self-efficacy	Is it possible to change my current behavior? Am I capable of enacting the recommended changes?	Learning curve for climate-adaptive practices may be too large to surmount, especially with climate change uncertainty	"…different management techniques take a while to learn…"
Response cost	How much time, money and effort are needed to enact change?	Cost/benefit analysis, particularly with irrigation Common adaptation approaches with little cost and more security are more likely to be implemented	"I would be hesitant to say you should invest in irrigation at this point because it's very expensive and we don't have solid information that we're having continued droughts."
	How do costs differ between behavior 1 and behavior 2?	Threat appraisal takes into account more than climate/weather threats: competition; difficulty integrating new systems	"Farmers…don't necessarily want to be putting on cover crops or start trying to change someone's soil, and then lose their lease in 3 years…"

(continued)

Table 3. (continued)

	Examples of cognition	Results	Example quotations
Cues to action			
Cues from others	How are threats and coping strategies being reported?	Mistrust in information disseminated	"I don't trust anything long-term….So maybe 3 days out, then the rest is bogus."
		Some information negates risk	"They talk about global warming and I've read several articles written by scientists that are saying we are in about a 15-year pattern of cooling."
		Trusted information sources may be heeded	"I watched the [US] Drought Monitor maps pretty closely to see if those areas were shrinking or swelling or moving."
Self-cues	What have I observed myself?	Seeing how a practice affected others	"…it was in both those years [2011 and 2013] we had more people taking interest in no-till because they could clearly see that land next door…it had more ponding on it initially but drained better and dried out faster than their land."
		Personal experience may open minds to conversations about conservation and long-term weather predictions	"… after 2012 and the impact that had on our productivity, I would say most guys are open to having that discussion."

the large degree of variation in the way advisors perceive and act on risks from climate change and extreme weather events. Perhaps more importantly, the framework helped to build an understanding of the underlying reasons for disparate views and actions, and thus provides a starting point to consider what might be done to combat misinformation, ambivalence or inaction.

Discussion

Advisors' climate change risk appraisal

Overall, we found that agricultural advisors had mixed views about the existence of climate change. The majority of conservation and Extension advisors stated that climate change is occurring, while only some financial and crop advisors expressed this belief. We found that there was widespread acceptance that extreme weather events are a risk for US Midwestern agriculture. This was despite beliefs, generally, that climate change was perceived to be part of a long-term natural cycle. That there was greater acceptance that extreme weather events pose a threat to agriculture highlights the importance language can make in the threat appraisal process; a similar conclusion was made by Arbuckle et al. (2013). Perhaps the storyline of climate uncertainty negates perceptions of risk from climate change to a greater degree than perceptions of risk surrounding extreme weather impacts that most advisors and their producers have experienced. Indeed, Moser (2010) notes that the complexity of climate change has had a subsequent effect on climate change communication—the manifestation and potential impacts of climate change are uncertain. Moser further suggests that direct experience (e.g., of an extreme weather event) can instigate urgency surrounding similar events more so than acting on what seems to be an ambiguous threat (climate change). Moser (2010) as well as Pidgeon and Fischhoff (2011) stress the importance of mental models in communicating risk. Our results suggest that the threat from extreme weather (a symptom of climate change) is a concrete and understandable risk inherently more salient than the more abstract concept of climate change.

Risk interpretation is complex and comprised of a variety of inputs and decision making points (e.g., Eiser et al. 2012). We found that advisors' threat appraisals for climate and weather risk were tempered by the existing widespread use of risk management strategies—namely crop insurance and hybrid seeds—as well as the knowledge that the region's producers have weathered many previous wet and dry extremes in the past. These factors, in combination with widespread skepticism about the ability of the scientific community to provide spatially and temporally explicit weather and climate predictions, led many advisors to develop what Grothman and Reusswig (2006) term non-protective responses such as wishful thinking (everything will be ok) and fatality (whatever will be will be). Related to the notion of mental models discussed above, threat appraisals for climate and weather related risks were palliated through preoccupation with more immediate, more assured and more tangible threats. Indeed, tangible threats appear to be an important aspect of risk perception and risk response. For example, increased risk perception due to tangible threats reflects Mase et al.'s (2017) finding that producers' concern about on-farm risks such as extreme weather events was a significant predictor of adaptation behavior. Moreover, in a content analysis of agricultural trade publications of articles published during the 2012 US Midwestern drought, Church et al. (2017) found that the vast majority of articles reported drought impacts (and recovery) rather than climate-adaptive management strategies—a cue to action that emphasized short-term versus long-term risk management strategies.

Advisors' risk appraisals and conservation advice

Climate-adaptive practices such as no-till and cover crops, generally recommended by conservation and Extension advisors, represent a longer-term approach to farm resiliency. These advisors' recommendations for climate-adaptive farming strategies corresponded with their acceptance of climate change as a threat. In contrast, financial and crop advisors were less likely to accept climate change as occurring and their risk management advice tended to rely on season-to-season decision making—which hybrid seeds to use, and how much crop insurance to purchase.

If looking through the lens of the HBM and PMT, the issue becomes more complex. These widely adopted coping strategies (hybrid seeds and crop insurance) were perceived to come with very little cost while at the same time providing financial security and yield benefits. Both had become so established that the need for associated advice or appraisal scarcely existed amongst the advisors interviewed. In contrast, an advisor's willingness to recommend—and producers' willingness to install—irrigation remained dependent on factors such as perceived economic benefit, soil type, access to water reserves, and a steep learning curve. With respect to the HBM and PMT, the challenges associated with these coping strategies and adaptive behavior align with the response cost (expense and inconvenience) and self-efficacy (perceived ability to implement a recommendation correctly). These are two aspects of adoption that have been shown to have both positive and negative correlations to conservation adoption (Carlisle 2016; Prokopy et al. 2008).

While most advisors stated they had not altered their behavior as a result of the 2012 drought, their interview responses suggested subtle changes towards greater risk management. This subtlety was conveyed primarily through statements that that indicated increased awareness of drought risks which instigated thoughts of risk monitoring and response. For example, by illustrating the changing extent of the 2012 drought using maps from the US Drought Monitor (a trusted information source), advisors told us their producers were challenged to rethink concepts of severity and susceptibility. Moreover, a few advisors highlighted the relative success, coming out of the drought, of producers who had implemented conservation practices; thus demonstrating a feasible and effective coping mechanism. This latter point highlights the importance of producer leaders in the diffusion of change (e.g., Church and Prokopy 2017).

To some extent these subtle changes in risk management advice were instigated by the demands and interests of producers, which corresponded to the widely-reported attitude among advisors that their concerns were a reflection of their clients' concerns. While this approach is a logical means of ensuring clientele remain satisfied, it raises questions about advisors' effectiveness at conveying and addressing climate and weather related risks highlighted by the scientific community. Their role in this communication chain was further compromised by the aforementioned widespread cynicism towards weather and climate related predictions, as well as the reluctance of some advisors to discuss the potentially contentious subject of "climate change" with their producers. Lemos et al. (2014) similarly found that advisors who have little trust in climate information sources are unlikely to incorporate such information into their advice. These strategies sidestep the conflicts associated with defining the threat, therefore providing a cue to action based on very tangible impacts and solutions. In doing so, what the scientific community considers a symptom of a long-term threat, instead related to producers' immediate and localized concerns such as yields and profitability—again, a symptom of producer and advisor concern over the current growing season and short-term risk management or immediate impact recovery.

These issues are compounded by the strong relationship between advice given and the self-perceived role of the advisor. Indeed, advisors' statements about their role (or non-role) in helping producers adapt to climate and weather related risks demonstrates that advisors prefer to operate within their particular field of expertise, where their efficacy for assisting producers to adapt in a particular way can be expected to be at its highest (e.g., Haigh et al. 2015; Lemos et al. 2012). The consequence of this approach is that those advisors who are disinterested in climate and weather related risks, or who feel that such risks are intrinsically unpredictable, may absolve themselves of any responsibility for helping producers to adapt. On the other hand, confirming Haigh et al. (2015) conclusions, Extension agents and certified crop advisors—advisors who deal with a variety of farm management decisions—were more likely to report advising on a range of risk management strategies.

Recommendations

Our results point to issues surrounding science communication and short-term, season-by-season coping strategies that address immediate and localized concerns. As other research has found, including ours, agricultural advisors desire to be a useful resource for their clients, yet viability of agriculture over the long-term is arguably in the clients' interest. Our findings suggest that in order to transition producers to increased use of climate-adaptive management practices, advisors should discuss these solutions in terms of risk management for extreme weather impacts (e.g., drought, high heat, and flooding) rather than impacts from climate change or global warming. Although we recognize that the advisors we interviewed were unlikely to explicitly articulate risks due to climate change, we are hesitant to recommend ignoring or hiding risks from climate change. Agricultural advisors are in a prime position to integrate long-term thinking and climate change risk into their advice to producers. We thus contend that the agricultural community should integrate long-term thinking as part of farm decision making processes. For example, our interviewees described exemplary farms that utilized climate-adaptive or conservation management practices to demonstrate reduced impacts from the 2012 drought. Such examples should be used in conjunction with discussions on scientifically based climate projections and related impacts—increased weather extremes are expected (both drought and flooding), climate is changing rapidly, and climate-adaptive practices can mitigate impacts and improve farm resilience. Moreover, we suggest that encouraging advisors and climatologists to convene and network could prove an important step in improving the quantity, quality, and usefulness of climate information and associated risk management strategies that filter down to producers. Going forward, the use of new weather and climate tools and information sources among advisors and producers is a measure that could lead to improved on-farm decision making and more realistic assessments of producers' financial risks. From collaborations with companies specializing in weather and climate modelling to freely available smartphone apps, we suggest that this new behavior could better prepare the agricultural sector for both long and short-term risks, while simultaneously serving as an additional cue to act on any perceived threats the information brings to light.

Health belief model and protection motivation theory framework

We contend it is feasible to use the HBM/PMT framework to explain the emergence of potential climate adaptation behaviors. This emergence would be based upon how interviewees appraise the severity of and their susceptibility to risk (threat appraisal), their perceptions of the efficacy and costs/benefits of a climate-adaptive or conservation management response (coping appraisal), and their response to a multitude of cues to action (self-cues and cues from others) that do or do not reinforce the proposed behavior change. For example, conservation and Extension advisors were more likely to believe in climate change, see that climate change risk warranted climate change adaptation, and advise climate-adaptive management practices to mitigate future impacts from weather and extreme events. It is however, difficult to predict behavioral intent and change. We argue the framework suggests a path from risk perception (e.g., belief in climate change and that if poses a risk to agriculture) to behavior (e.g., climate-adaptive management advice). Further, it highlights aspects of risk that may be worth further exploration in order inform science communication. For example, relating climate change risk to financial risk may be an effective means to nudge financial advisors to consider incorporating climate and weather tools into risk management advice. Indeed, seen as a means of improved service to clients (protection of producers' monetary resource), we found that a few financial advisor interviewees incorporated risks from climate and weather risk as part of determinations surrounding borrowing or climate-adaptive management advice. In addition, using the framework highlighted the complexities of risk perception and behavior. For example, low perceptions of climate change risk combined with mistrust in weather/climate information negated climate-adaptive action. In contrast, personal experience with the 2012 drought (self-cues), along with cues from others (farms who weathered the drought successfully due to the use of climate-adaptive or conservation management practices) appeared to be a catalyst for change (e.g., using those experiences to exemplify the benefits of climate-adaptive or conservation management practices).

Overall, we suggest the HBM/PMT framework can be utilized by researchers to consider how to communicate climate science and climate risk to influence advisors' and producers' threat and coping appraisals, and contribute to cues to action that lead to adaptive behaviors. Moreover, the framework revealed the importance of considering advisors' expertise and desire to meet producers' needs. For advisors who already recommend climate-adaptive practices, this framework could be used to determine communication strategies to producers; for example, advisors could help producers work through various coping appraisals that incorporate long-term, resilience thinking. In addition, the framework could be used to determine how to better communicate climate change risk in a way that increases the reality of climate as a threat and subsequent coping strategies.

Limitations and future research

This study poses at least two limitations, which point to future research. First, the interview guide was originally developed to understand risk management as related to weather/climate tools, which limited potential responses as related specifically to the HBM/PMT. In using an analysis that allowed for emergent findings (e.g., Bernard and Ryan 2009), we have pointed to the potential efficacy of utilizing this framework in program development and research. Future research could apply this framework to more explicitly target agricultural stakeholder coping appraisals and cues to action. Moreover, future research efforts could use the qualitative findings reported here to operationalize variables and develop survey research questions to test the HBM/ PMT as a predictive model. Second, although this research suggests that the words ‘climate change’ should be avoided in terms of climate-adaptive or conservation management advice, we contend that perceptions of and attitudes toward climate change are ever changing and we would not recommend hiding the underlying cause of increased weather extremes. Thus future research should explicitly test how climate change message framing influences advisors’ willingness to recommend climate-adaptive practices, and producers’ willingness to adopt. Finally, due to the value of utilizing weather/climate information in on-farm decision making, future research could explore new tools developed alongside producers and climatologists to evaluate trust and use (e.g., Prokopy et al. 2017).

Conclusions

This research explored an understudied stakeholder group in the agricultural supply chain—agricultural advisors. Through the lens of the HBM and PMT, we analyzed interviews of 36 agricultural advisors to understand their appraisals of climate change risk, related decision making processes and subsequent risk management advice communicated to producers. We found that the utility of the HBM and PMT was most successful in helping to suggest what may be underlying reasons for differences in advisors’ climate-adaptive practice advice relative to climate change risk appraisals of threat and coping strategies. Through this understanding, it may be possible to develop appropriate communication strategies that address advisors’ and producers’ threat and coping appraisals, with subsequent cues to action that may lead to increased climate-adaptive behaviors in the agricultural community.

We conclude that while the 2012 drought served to highlight the importance of risk management strategies, it has neither altered climate change beliefs nor the advice imparted for most advisors. Instead the drought reinforced the need for strategies and behavior which preceded the event. Indeed, for many the drought represented ‘just another extreme event’ rather than a catalyst for radical change. Despite this, there is some evidence to suggest that producers’ own observations together with the influence of advisors resulted in new risk management behavior beyond the existing participation in crop insurance schemes and the planting of hybrid seeds. However, at present the value of these new strategies including increased irrigation and conservation practices remains contested within the advisor community, largely due to their potential to negatively impact producers’ short-term profits. The result is that these behaviors are only likely to be adopted where advisors are inclined and able to convince producers of the need for long-term risk management strategies. To understand the importance of this task, climatologists should work more closely with crop advisors to develop a shared understanding of the likely impacts of climate and extreme weather events. Although there is clearly disparity in beliefs surrounding the cause and terminology associated with these events, such semantics should not be seen as an insurmountable barrier to instilling climate-adaptive behavior. After all, the widespread uptake of crop insurance and hybrid seeds has already occurred across the Midwestern US despite a degree of skepticism of a changing climate among advisors and producers alike. That being said, overall, we contend that the incorporation of long-term considerations of risk appraisal and cues to action (including discussions of climate change) could engender a transition to climate-adaptive farm management practices that will contribute to a more resilient agriculture sector.

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References

Arbuckle, J. G. Jr, L. S. Prokopy, T. Haigh, J. Hobbs, T. Knoot, C. Knutson, A. Loy, A. S. Mase, J. McGuire, L. W. Morton, and J. Tyndall. 2013. Climate change beliefs, concerns, and attitudes toward adaptation and mitigation among farmers in the Midwestern United States. *Climatic Change* 117 (4): 943–950.

Arbuckle, J. G. Jr, L. W. Morton, and J. Hobbs. 2015. Understanding farmer perspectives on climate change adaptation and mitigation: The roles of trust in sources of climate information, climate change beliefs, and perceived risk. *Environment and Behavior* 47 (2): 205–234.

Barnes, A. P., and L. Toma. 2012. A typology of dairy farmer perceptions towards climate change. *Climatic Change* 112 (2): 507–522.

Bernard, H. R., and G. W. Ryan. 2009. *Analyzing qualitative data: Systematic approaches*. Sage Publications, Inc.

Bowen, G. A. 2008. Naturalistic inquiry and the saturation concept: A research note. *Qualitative Research* 8 (1): 137–152.

Breuer, N. E., C. W. Fraisse, and V. E. Cabrera. 2010. The cooperative extension service as a boundary organization for diffusion of climate forecasts: a 5-year study. *Journal of Extension* 48 (4): 4RIB7.

Buizer, J., K. Jacobs, and D. Cash. 2010. Making short-term climate forecasts useful: Linking science and action. *Proceedings of the National Academy of Sciences* 113 (17): 4597–4602.

Burnett, R. E., A. J. Vuola, M. A. Megalos, D. C. Adams, and M. C. Monroe. 2014. North Carolina cooperative extension professionals' climate change perceptions, willingness, and perceived barriers to programming: An educational needs assessment. *Journal of Extension* 52 (1): n1.

Campbell, J. L., C. Quincy, J. Osserman, and O. K. Pedersen. 2013. Coding in-depth semistructured interviews problems of unitization and intercoder reliability and agreement. *Sociological Methods and Research* 42 (3): 294–320.

Carlisle, L. 2016. Factors influencing farmer adoption of soil health practices in the United States: A narrative review. *Agroecology and Sustainable Food Systems* 40 (6): 583–613.

Carlton, J. S., J. R. Angel, S. Fei, M. Huber, T. M. Koontz, B. J. MacGowan, N. D. Mullendore, N. Babin, and L. S. Prokopy. 2014. State service foresters' attitudes toward using climate and weather information when advising forest landowners. *Journal of Forestry* 112 (1): 9–14.

Carlton, J. S., A. S. Mase, C. L. Knutson, M. C. Lemos, T. Haigh, D. P. Todey, and L. S. Prokopy. 2016. The effects of extreme drought on climate change beliefs, risk perceptions, and adaptation attitudes. *Climatic Change* 135 (2): 211–226.

Church, S. P., and L. S. Prokopy. 2017. The influence of social criteria in mobilizing watershed conservation efforts: A case study of a successful watershed in the Midwestern US. *Land Use Policy* 61: 353–367.

Church, S. P., T. Haigh, M. Widhalm, S. G. de Jalon, N. Babin, J. S. Carlton, M. Dunn, K. Fagan, C. L. Knutson, and L. S. Prokopy. 2017. Agricultural trade publications and the 2012 Midwestern US drought: A missed opportunity for climate risk communication. *Climate Risk Management* 15: 45–60.

Cismaru, M., R. Cismaru, T. Ono, and K. Nelson. 2011. Act on climate change": An application of protection motivation theory. *Social Marketing Quarterly* 17 (3): 62–84.

Cohen, J. 1960. A coefficient of agreement for nominal scales. *Educational and Psychosocial Measurement* 20: 37–46.

Crane, T. A., C. Roncoli, J. Paz, N. Breuer, K. Broad, K. T. Ingram, and G. Hoogenboom. 2010. Forecast skill and farmers' skills: Seasonal climate forecasts and agricultural risk management in the southeastern United States. *Weather, Climate, and Society* 2 (1): 44–59.

Dietz, T., A. Dan, and R. Shwom. 2007. Support for climate change policy: Social psychological and social structural influences. *Rural Sociology* 72 (2): 185–214.

Eiser, J. R., A. Bostrom, I. Burton, D. M. Johnston, J. McClure, D. Paton, J. Van Der Pligt, and M. P. White. 2012. Risk interpretation and action: A conceptual framework for responses to natural hazards. *International Journal of Disaster Risk Reduction* 1: 5–16.

Gardner, W. 1995. *On the reliability of sequential data: Measurement, meaning, and correction. The analysis of change*. 339–359. Mahwah: Erlbaum.

Gergen, K. J. 2009. *An invitation to social construction*. 2nd ed. London: Sage.

Gorden, R. 1992. *Basic interviewing skills*. Itasca: F. E. Peacock.

Gramig, B. M., J. M. Barnard, and L. S. Prokopy. 2013. Farmer beliefs about climate change and carbon sequestration incentives. *Climate Research* 56 (2): 157–167.

Grothmann, T., and A. Patt. 2005. Adaptive capacity and human cognition: the process of individual adaptation to climate change. *Global Environmental Change* 15 (3): 199–213.

Grothmann, T., and F. Reusswig. 2006. People at risk of flooding: Why some residents take precautionary action while others do not. *Natural Hazards* 38 (1–2): 101–120.

Haden, V. R., M. T. Niles, M. Lubell, J. Perlman, and L. E. Jackson. 2012. Global and local concerns: What attitudes and beliefs motivate farmers to mitigate and adapt to climate change? *PloS ONE* 7 (12): e52882.

Haigh, T., L. W. Morton, M. C. Lemos, C. Knutson, L. S. Prokopy, Y. J. Lo, and J. Angel. 2015. Agricultural advisors as climate Information intermediaries: Exploring differences in capacity to communicate climate. *Weather, Climate, and Society* 7 (1): 83–93.

Hatfield, J. L., K. J. Boote, B. A. Kimball, L. H. Ziska, R. C. Izaurralde, D. Ort, A. M. Thomson, and D. Wolfe. 2011. Climate impacts on agriculture: implications for crop production. *Agronomy Journal* 103 (2): 351–370.

Heimlich, J. E., and N. M. Ardoin. 2008. Understanding behavior to understand behavior change: A literature review. *Environmental Education Research* 14 (3): 215–237.

Howden, S. M., J. F. Soussana, F. N. Tubiello, N. Chhetri, M. Dunlop, and H. Meinke. 2007. Adapting agriculture to climate change. *Proceedings of the National Academy of Sciences* 104 (50): 19691–19696.

Inouye, J. 2014. *Risk perception: Theories, strategies, and next steps*. Campbell Institute.

Jagtap, S. S., J. W. Jones, P. Hildebrand, D. Letson, J. J. O'Brien, G. Podestá, D. Zierden, and F. Zazueta. 2002. Responding to stakeholder's demands for climate information: from research to applications in Florida. *Agricultural Systems* 74 (3): 415–430.

Janz, N. K., and M. H. Becker. 1984. The health belief model: A decade later. *Health Education and Behavior* 11 (1): 1–47.

Lemos, M. C., C. J. Kirchhoff, and V. Ramprasad. 2012. Narrowing the climate information usability gap. *Nature Climate Change* 2 (11): 789–794.

Lemos, M. C., Y. J. Lo, C. Kirchhoff, and T. Haigh. 2014. Crop advisors as climate information brokers: Building the capacity of US farmers to adapt to climate change. *Climate Risk Management* 4: 32–42.

Mase, A. S., and L. S. Prokopy. 2014. Unrealized potential: A review of perceptions and use of weather and climate information in agricultural decision making. *Weather, Climate, and Society* 6 (1): 47–61.

Mase, A. S., H. Cho, and L. S. Prokopy. 2015. Enhancing the Social Amplification of Risk Framework (SARF) by exploring trust, the availability heuristic, and agricultural advisors' belief in climate change. *Journal of Environmental Psychology* 41: 166–176.

Mase, A. S., B. M. Gramig, and L. S. Prokopy. 2017. Climate change beliefs, risk perceptions, and adaptation behavior among Midwestern US crop farmers. *Climate Risk Management* 15: 8–17.

McBean, G. 2004. Climate change and extreme weather: A basis for action. *Natural Hazards* 31 (1): 177–190.

Miles, M. B., and A. M. Huberman. 1994. *Qualitative data analysis: An expanded sourcebook*. Sage.

Moser, S. C. 2010. Communicating climate change: history, challenges, process and future directions. *Wiley Interdisciplinary Reviews: Climate Change* 1 (1): 31–53.

National Research Council (NRC). 2010. *Adapting to the impacts of climate change: America's climate choices*. National Academies Press, Washington, DC.

Nisbet, M. C. 2009. Communicating climate change: Why frames matter to public engagement. *Environment* 51: 12–23.

Pidgeon, N., and B. Fischhoff. 2011. The role of social and decision sciences in communicating uncertain climate risks. *Nature Climate Change* 1 (1): 35–41.

Pike, C., B. Doppelt, M. Herr, and Climate Leadership Initiative. 2010. *Climate communications and behavior change: A guide for practitioners*. The Resource Innovation Group and The Climate Leadership Initiative Institute for a Sustainable Environment, University of Oregon.

Prokopy, L. S., K. Floress, D. Klotthor-Weinkauf, and A. Baumgart-Getz. 2008. Determinants of agricultural best management practice adoption: Evidence from the literature. *Journal of Soil and Water Conservation* 63 (5): 300–311.

Prokopy, L. S., T. Haigh, A. S. Mase, J. Angel, C. Hart, C. Knutson, M. C. Lemos, Y. J. Lo, J. McGuire, L. W. Morton, and J. Perron. 2013. Agricultural advisors: A receptive audience for weather and climate information? *Weather, Climate, and Society* 5 (2): 162–167.

Prokopy, L. S., J. S. Carlton, J. G. Arbuckle Jr, T. Haigh, M. C. Lemos, A. S. Mase, N. Babin, M. Dunn, J. Andresen, J. Angel, and C. Hart. 2015a. Extension's role in disseminating information about climate change to agricultural stakeholders in the United States. *Climatic Change* 130 (2): 261–272.

Prokopy, L. S., L. W. Morton, J. G. Arbuckle Jr., A. S. Mase, and A. K. Wilke. 2015b. Agricultural stakeholder views on climate change: Implications for conducting research and outreach. *Bulletin of the American Meteorological Society* 96 (2): 181–190.

Prokopy, L. S., J. S. Carlton, T. Haigh, M. C. Lemos, A. S. Mase, and M. Widhalm. 2017. Useful to Usable: Developing usable climate science for agriculture. *Climate Risk Management* 15: 1–7.

Reimer, A. P., A. W. Thompson, and L. S. Prokopy. 2012. The multidimensional nature of environmental attitudes among farmers in Indiana: implications for conservation adoption. *Agriculture and Human Values* 29 (1): 29–40.

Reser, J. P., and J. K. Swim. 2011. Adapting to and coping with the threat and impacts of climate change. *American Psychologist* 66 (4): 277.

Rogers, R. 1983. Cognitive and physiological processes in fear-based attitude change: A revised theory of protection motivation. In *Social psychophysiology: A sourcebook*, eds. J. Caccioppo, and R. Petty, 153–176. New York: Guilford.

Rosenberg, S., and R. D. Margerum. 2008. Landowner motivations for watershed restoration: Lessons from five watersheds. *Journal of Environmental Planning and Management* 51 (4): 477–496.

Saleh Safi, A., W. James Smith, and Z. Liu. 2012. Rural Nevada and climate change: Vulnerability, beliefs, and risk perception. *Risk Analysis* 32 (6): 1041–1059.

Semenza, J. C., G. B. Ploubidis, and L. A. George. 2011. Climate change and climate variability: personal motivation for adaptation and mitigation. *Environmental Health* 10 (1): 46.

Smit, B., and J. Wandel. 2006. Adaptation, adaptive capacity and vulnerability. *Global Environmental Change* 16 (3): 282–292.

Straub, C. L., and J. E. Leahy. 2014. Application of a modified health belief model to the pro-environmental behavior of private well water testing. *Journal of the American Water Resources Association* 50 (6): 1515–1526.

Tomich, T. P., S. Brodt, H. Ferris, R. Galt, W. R. Horwath, E. Kebreab, J. H. Leveau, D. Liptzin, M. Lubell, P. Merel, and R. Michelmore. 2011. Agroecology: A review from a global-change perspective. *Annual Review of Environment and Resources* 36: 193–222.

USDA ERS. 2017a. United States Department of Agriculture Economic Research Service. State Fact Sheets. Indiana. https://data.ers.usda.gov/reports.aspx?reportPath=/StateFactSheets/StateFactSheets&StateFIPS=18&ID=17854#Pcdea0e5a28a1483f9342ad5d94a118ce_2_428iT15C0x0

USDA ERS. 2017b. United States Department of Agriculture Economic Research Service. State Fact Sheets. Nebraska. https://data.ers.usda.gov/reports.aspx?reportPath=/StateFactSheets/StateFactSheets&StateFIPS=18&ID=17854#Pcdea0e5a28a1483f9342ad5d94a118ce_2_428iT15C0x0

USDA NASS. 2013. *Crop production 2012 summary*. United States Department of Agriculture.

Walthall, C. L., C. J. Anderson, L. H. Baumgard, E. Takle, and L. W. Morton. 2013. *Climate change and agriculture in the United States: Effects and adaptation*. USDA.

Weber, E. U. 1997. Perception and expectation of climate change. In *Psychological perspectives to environmental and ethical issues in management*, eds. P. Slovic, M. H. Bazerman, D. M. Messick, A. E. Tenbrunsel, and K. A. Wade-Benzoni, 314–341.

Weber, E. U., and P. C. Stern. 2011. Public understanding of climate change in the United States. *American Psychologist* 66: 315–328.

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