



Research article

Relating farmer's perceptions of climate change risk to adaptation behaviour in Hungary



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ABSTRACT

Understanding how farmers perceive climate change risks and how this affects their willingness to adopt adaptation practices is critical for developing effective climate change response strategies for the agricultural sector. This study examines (i) the perceptual relationships between farmers' awareness of climate change phenomena, beliefs in climate change risks and actual adaptation behaviour, and (ii) how these relationships may be modified by farm-level antecedents related to human, social, financial capitals and farm characteristics. An extensive household survey was designed to investigate the current pattern of adaptation strategies and collect data on these perceptual variables and their potential antecedents from private landowners in Veszprém and Tolna counties, Hungary. Path analysis was used to explore the causal connections between variables. We found that belief in the risk of climate change was heightened by an increased awareness of directly observable climate change phenomena (i.e. water shortages and extreme weather events). The awareness of extreme weather events was a significant driver of adaptation behaviour. Farmers' actual adaptation behaviour was primarily driven by financial motives and managerial considerations (i.e. the aim of improving profit and product sales; gaining farm ownership and the amount of land managed; and, the existence of a successor), and stimulated by an innovative personality and the availability of information from socio-agricultural networks. These results enrich the empirical evidence in support of improving understanding of farmer decision-making processes, which is critical in developing well-targeted adaptation policies.

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1. Introduction

Agriculture is one of the most vulnerable sectors to climate change and associated extreme weather events (Pachauri et al., 2014). Shifts in precipitation, temperature and other weather patterns may change the suitability of crop varieties to their present agro-ecosystems, change the need for pest and disease management, and increase the turnover of soil organic matter and the associated risk of nutrient loss (Olesen et al., 2011). Extreme weather events (e.g. floods, storms and droughts) may also lead to reductions in areas suitable for agriculture, damage to

infrastructure and higher yield variability (Olesen and Bindi, 2002). These negative consequences from climate change pose a direct threat to the success of agriculture and farmers' welfare at local and global scales. However, quantifying the full array of potential impacts and their effects on farmers' welfare is highly complex and uncertain (Gornall et al., 2010). The vulnerability of farmer welfare (Metzger et al., 2006) depends on the nature and severity of the climate signal, non-climate related stressors and the ability of farmers to cope or adapt in any given technological and regulatory environment. An increasing number of studies emphasise the importance of focusing on adaptation to climate change within the agriculture sector, in particular improving understanding of farm-level decision-making processes to advance the estimation of economic impacts and develop well-targeted policy responses e.g. Below et al. (2012, 2014), Comoé and Siegrist (2015), Howden et al.

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(2007), Menapace et al. (2015), Reid et al. (2007), Reidsma et al. (2010), and Wheeler et al. (2013).

It has been hypothesised that farmers who have observed, or have knowledge about, phenomena related to climate change are more likely to believe in the potential of future risks, including risks associated with high-end climate changes, and consequently are more likely to adopt adaptation practices (Akerlof et al., 2013; Menapace et al., 2015). Existing studies on climate change risk perception have focused on associations between personal experience and belief in climate change risks by the general public (Bain et al., 2012; Brulle et al., 2012; Myers et al., 2013; Spence et al., 2011). While research investigating farmers' perceptions of climate change risks is growing (c.f. Menapace et al. (2015), and reference therein), most of these studies are descriptive in nature. The causal links between climate change risk perception and adaptation have rarely been examined and quantified. One of the few examples that have attempted to examine these perceptual links is the study by Wheeler et al. (2013), which stems from the theory of planned behaviour (Ajzen, 1991) and explores the role that climate change beliefs play in influencing planned and actual farm adaptation strategies in three Southern Basin states of Australia. A further study by Menapace et al. (2015) uses the exchangeability method (Baillon, 2008) and identifies that climate change beliefs and past experiences with crop losses are critical to farmers' agricultural risk perceptions in northern Italy. 'Risk' is often considered as a generic term, without distinguishing its determinants, i.e. the hazard and its probability of occurrence (Cardona et al., 2012). A risk-based approach could help to shed light on the underlying perceptual links and causalities between farmers' awareness of climate change-related phenomena, their beliefs in future climate change and actual adaptation behaviour. This insight could contribute to more effective future communication and response strategies for agricultural climate change adaptation.

In addition to climate change risk perception, actual farm adaptation behaviour may be determined by adaptive capacity, which is further associated with personal and non-climate related environmental factors concerning human, financial and social capitals, and farm characteristics (Deressa et al., 2009; Yohe and Tol, 2002). Existing adaptation literature, as reviewed in Wheeler et al. (2013), focuses on the biophysical responses and economic valuation of crop yield, whilst assessment of adaptation behaviour at the farm level is less developed and perception is often treated as one of many endogenous variables. For example, Below et al. (2012) developed an activity-based adaptation index for farmers as a regressive function of perception of weather-related problems, characteristics of the household and farm, institutional framework conditions and infrastructure. Esham and Garforth (2013) found that farmers' perceptions of climate change risk significantly affect actual agricultural adaptation actions in Sri Lanka. Personal and non-climate environmental factors that may cause changes in not only farmers' climate change perception, but also the relationships between perception and adaptation behaviour, remain little understood. Such factors could provide useful guidance to policy-makers in identifying individuals and social groups who are more likely to be concerned about the situation and engage in adaptation and help spread good adaptation practice within local agricultural networks.

The study presented here aims to bridge these knowledge gaps by (i) examining the possible perceptual relationships between the awareness of climate change phenomena and belief in risks that underlie farmers' adaptation behaviour, and (ii) identifying human, financial, social and farm-level antecedents of actual adaptation and these perceptual relationships. An extensive household survey was designed for this study in collaboration with the Central

Statistical Office of Hungary (KSH) to investigate the current pattern of adaptation strategies and to collect data on the potential antecedents of future adaptation from private landowners in Veszprém and Tolna counties of Hungary. The survey data were analysed using path analysis since this approach provides unique insights into the causal connections between variables (Loehlin, 2004). The analysis focused on (i) the significance and magnitude of hypothetical perceptual relationships between farmer's awareness of climate change related phenomena, their belief in climate change risks and the need for adaptation and (ii) how factors associated with human, financial and social capitals, and farm characteristics may affect adaptation and modify the significant perceptual relationships identified.

2. Conceptual framework

Failure to incorporate meaningful hypotheses within a model of structured decision making may result in uncertainty being incorrectly or insufficiently represented, leading to management strategies that are less useful and informative (Williams, 2011). In this study, a conceptual framework was developed based on current climate change and adaptive management literature. It covers a comprehensive set of hypotheses representing the possible sources of uncertainties in the decision making processes of farmers, each of which was then tested with path models for its importance.

2.1. Basic perception model: climate change awareness, belief and adaptation

Farmers may be aware of climate change based on personal experience or via professional and social communications. We hypothesize that such awareness will increase farmers' belief in climate change risk and motivate actions for "adaptation" (H0a-c).

In the basic theoretical model, three sets of climate change-related phenomena relevant to the two Hungarian counties are considered: water stress, extreme events and climate warming. Agriculture depends heavily on water availability, especially annual and seasonal totals. Farmers monitor the growth of plants and measure water demand and, hence, are more likely to be concerned about phenomena related to water shortage, such as decreases in precipitation or the frequency or severity of drought (H0a). Extreme weather events (e.g. flooding, heatwaves or storms) generally have a small frequency of occurrence. However, when they do occur, they often cause severe damage and significantly influence decision making on adaptation (H0b) (Weber, 2010). By contrast, climate change related warming unfolds over longer time scales, and can be difficult to detect based on personal experience (H0c) (Akerlof et al., 2013). The three sets of phenomena (water stress, extreme events and climate warming) can coexist. Taking note of one set may indicate that a farmer has gained some climate change-related awareness and knowledge and, from the same source of knowledge (personal experience or professional/social communications), he/she is more likely to be aware of other climate change-related phenomena. Hence, the awareness of any of the three sets is hypothesised to be positively associated with awareness of the other sets (H0d-f).

In a recent special report by the IPCC (Cardona et al., 2012), three determinants of risk are defined: "hazard" refers to the possible occurrence of unfavourable events, "exposure" refers to the inventory of elements in an area where hazard events may exist and "vulnerability" refers to the susceptibility of exposed elements being adversely impacted by hazard events. Following this approach, three components of farmers' belief in climate change risk were identified: beliefs in climate change hazards, exposure of local agriculture to climate variability and individual farmer

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