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Perceiving to learn or learning to perceive? Understanding farmers' perceptions and adaptation to climate uncertainties

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ABSTRACT

Perception not only shapes knowledge but knowledge also shapes perception. Humans adapt to the natural world through a process of learning in which they interpret their sensory impressions in order to give meaning to their environment and act accordingly. In this research, we examined how farmers' decision making is shaped in the context of changing climate. Using empirical data (face-to-face semi-structured interviews and questionnaires) on four Mediterranean farming systems from a case study located in Oristano (Sardinia, Italy) we sought to understand farmers' perception of climate change and their behaviors in adjustment of farming practices. We found different perceptions among farmer groups were mainly associated with the different socio-cultural and institutional settings and perceived relationships between climate factors and impacts on each farming systems. The research findings on different perceptions among farmer groups can help to understand farmers' current choices and attitudes of adaptation for supporting the development of appropriate adaptation strategies. In addition, the knowledge of socio-cultural and economic factors that lead to biases in climate perceptions can help to integrate climate communication into adaptation research for making sense of climate impacts and responses at farm level.

1. Introduction

Climate change (CC) is raising significant issues for European agricultural development strategies. European agriculture will face serious challenges in the coming decades, such as competition for water resources (Koutroulis et al., 2013), combating invasive exotic plant species, pests and microbes (Bardsley and Edwards-Jones, 2007), rising costs due to environmental protection policies, and uncertainty in the effectiveness of current policies as CC adaptation strategies (Olesen and Bindi, 2002).

Farming activities are strongly shaped by local climate conditions, since impacts of changes in climate and bio-physical factors are perceived by farmers through their daily interaction with environment. The emerging reality of CC potentially increases the level of farmers' concern about the sustainable agricultural practices needed for mitigating greenhouse gases emissions as well as for adapting to the impacts of CC (Fleming and Vanclay, 2010). However, farmers' decisions about managing their farming activities in the framework of sustainability are plagued with uncertainty. They need to undertake continuous adjustments to their practices to adapt to an uncertain future, and uncertainty can lead farmers to perceive their farming activities as unpredictable, hence likely constraining their income (Dono et al., 2013), willingness and/or capacity to respond (Islam et al., 2013).

Farmers' decisions are traditionally made based on the aim of maximizing the profit of farming activities taking into account the market, subsidies, grants and restrictions. In the context of changing climate, farmers face difficulties in making decisions for their farming activities simply because CC is an uncertain and wicked issue that is difficult to foresee (Abildtrup et al., 2006; Audsley et al., 2006). Farmers perceive their environment and make decisions accordingly and this can result in mal-adaptations due to biased perception, cognition and lack of information (Etkin and Ho, 2007; Mubaya et al., 2012). Farmers may feel uncertain about addressing investments for their activities. Unpredictability may push farmers

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to adopt/not adopt agricultural practices, introduce/not introduce new changes in technologies, and maintain the same farming practices over time and space or abandon farming activities.

Farmers' adaptation to CC occurs within a socio-ecological context, and their perception determines the acceptability of adaptation measures posed by policy domains (Tam and McDaniels, 2013). Understanding farmers' perceptions of CC helps to understand their behaviors about adjustments they made/will make in their farming practices in order to respond to CC consequences (Tambo and Abdoulaye, 2013). Such understanding can help researchers to better orientate the agronomic research on adaptation at farm level's and policy makers to develop adaptation policies (Habiba et al., 2012).

In this research, we analyzed how farmers' decision making is shaped by their perceptions of climate change. Using empirical data from a local case study on the four most representative farming systems (i.e., intensive dairy cattle farming, extensive sheep farming, rice farming and horticulture) in the province of Oristano (Sardinia, Italy), we sought to answer the following questions: (1) What are farmers' perceptions of CC? (2) Are there any differences of perceptions of CC among different farmer groups? (3) How does farmers' perception influence their farming decisions and their willingness and capacity to adapt to climate uncertainties?

2. Theoretical framework: perceiving the environment and adaptation to climate change

Human systems are adapting and will have to adapt to climate change. Developing active adaptive responses to CC implies perceiving, learning and acting adaptively. Human beings explore and observe the world around them and act according to what they see (Slegers, 2008). To understand farmers' adaptation to climate change, it is important to understand farmers' perceptions of CC. Perceived CC has been identified as the main motivator for adaptation (Frank et al., 2011; Tompkins et al., 2010). The most dramatic climate-related stimuli are important for motivating adaptation responses in human systems (Berrang-Ford et al., 2011).

Perceiving is a cognitive process by which humans learn and interpret their sensory impressions on the basis of their interest, historical background, knowledge, experience and attitudes in order to give meaning to their environment and act accordingly (Robbins and Judge, 2012). Perception generates humans' experience of the environment as well as it enables them to act within the same environment.

There are two families of perception theories. According to the direct theory of perception of Gibson (1966, 1986), the information is picked up directly from the environment and lies on the conception of "visual learning", which is a process of turning the perceptual system to become more sensitive to information occurring in the stimulus. This theory emphasizes the close link between haptic perception and human senses. Perception is, quite simply, the detection of information, not the elaboration of it. A second family of theories conceives perception as mediated or indirect (e.g. Gregory, 1970, Rock, 1983) — and it is so called because perception is thought to involve the intervention of memories and representations. Humans see the world through experiencing, interacting and experimenting with the world. Cognitive processes are important in enriching and making sense of visual stimuli. In fact, perception not only needs to be learned by information picked up directly from environment, but it involves a complex set of elaboration to make it rich, meaningful and accurate.

Adaptive actions start from perceptual learning (Gibson, 1963) that continuously occurs in everyday life. Perceptual learning involves relatively long-lasting changes to an organism's perceptual system that improve its ability to respond to its environment and are caused by its environment (Dinse et al., 2008; Goldstone, 1998). There are two senses of perceptual learning, i.e. perceiving to learn and learning to perceive. According to Gibson (1963, 1969), perceptual learning has a sense of "perceiving to learn" rather than "learning to perceive". Information taken at the level of sensory receptors is sufficient to obtain knowledge of the world, and hence there is no need to learn about how to perceive, rather, humans need to perceive in order to learn. Perceptual learning is key to the knowing process (Adolph and Kretch, 2015; Pick, 1992). However, perception not only shapes knowledge, but knowledge also shapes perception. As human systems adapt to the natural world through a learning process, they become better at discriminating between different stimuli. Perceptual learning – experience-induced changes in the way perceivers extract information – plays a larger role in complex cognitive tasks (Kellman and Massey, 2013). Perceptual learning forms important foundations of complex cognitive processes and interacts with other kinds of learning to produce perceptual expertise (Goldstone, 1998). People are better able to perceptually identify unclear or quickly presented stimuli when they had been previously exposed to them.

Therefore, to adapt under climate changing conditions, perceiving to learn about the direct environmental problems and learning to perceive accurately their impacts and understand them are both essential processes to support decision making on how to respond to those changes (Park, 1999). Adaptation is a cognitive process involving two stages: perceiving/learning and adapting. Perceiving involves the early step of learning through sensory observation and information processing. Key climate extreme events, socio-cultural political and economic conditions (Granderson, 2014, Orlove, 1980), background experiences and knowledge, and conducive situations for knowledge mobilization (Newell and Dale, 2015) can influence these early processes (Kellman and Massey, 2013). Adapting involves adoption of action strategies by practicing, experiences, knowledge and technologies (UNFCCC, 2006) to improve response-abilities in order to mitigate environmental change impacts and/or improve performances of the system of interest under changed contextual conditions. However, from perceiving to adapting is a dwindle exercise: learning is much, understanding is less, practicing is lesser and transforming to be robust and resilient under uncertain situation like climate change is least (Fig. 1).

3. Case study

The study area is located in the province of Oristano in Sardinia, Italy (Fig. 2). The province consists of 88 municipalities within a total area of 3040 km^2 and a total population of about 168,500. Oristano is located in the center of the Campidano plain and along the west coast of Sardinia. The province includes 62 km^2 of wetlands (lagoons), 29 km^2 of lakes and 104 km of river length.

The province of Oristano is characterized by typical Mediterranean climate, i.e. rainfall is concentrated in autumn and winter, summer is dry and winter temperatures are rarely below 0 °C (Aschmann, 1973). In the last 50 years, the lowest monthly average max and min temperature (T) occurred in January with 14.1 °C and 5.5 °C, respectively, while the highest in August with 31.0 °C of mean max T and 18.1 °C of min T. The average rainfall for the period 1959–2011 is around 570 mm per year, but unevenly distributed. November and December are generally the wettest months and some 70% of the annual rainfall occur between October and March.

Several activities take place in Oristano (including dairy cattle production, cropping, industry, aquaculture and tourism) and this implies multiple stakeholders acting in the same area. Agriculture is the dominant livelihood of the local population. The main agricultural systems are intensive dairy cattle farming, extensive dairy sheep farming, horticulture, intensive rice production. Arborea, one of Oristano municipalities, has become one of the most productive agricultural sites in Sardinia, and the productivity of its dairy cattle system is considered one of the highest in Europe (Manca, 2009). Arborea has been designated by the Sardinian Regional Agency of Environmental Protection (ARPAS) as the only Nitrate Vulnerable Zone in Sardinia because of groundwater nitrate pollution of agricultural origin (Demurtas et al., 2016).