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Farmers show complex and contrasting perceptions on ecosystem services and their management

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ABSTRACT

Agricultural systems are complex socio-ecological systems that are managed by farmers to achieve desired outcomes, including food production and other ecosystem services (ES). While farm management is a key factor for ES provision, farmers may widely differ in their awareness, ambition and skills to manage their systems. Currently there is a lack of understanding of farmers' perception on ES, and how this is related to their management. We studied the management and perception of large scale farmers, conventional family farmers and agroecological family farmers in the Zona de Mata region in Brazil. Farmers were interviewed and constructed fuzzy cognitive maps (FCM) of their perception on ES. The FCM analysis revealed that in general, the perception of farmers on ES is highly complex and interconnected. Yet, agroecological family farmers showed a more complex perception on ES, which is associated with more diversified and autonomous agroecosystems. Both agroecological and conventional family farmers had a strong peasant identity, recognising more cultural ecosystem services than large scale farmers and relied more on production for consumption. Initiatives that aim to strengthen on-farm ecosystem services provision should be sensitive to farmer's perceptions and may need to consider using specific strategies for different farmer types.

1. Introduction

With the expansion of human-dominated land use (Foley et al., 2011), agroecosystems hold an increasing share of the global biodiversity (Baudron and Giller, 2014). This has also consequences for the associated provision of ecosystem services (ES), which are broadly defined as the benefits people obtain from nature (MEA, 2005). The ES framework can be useful to systematically identify the multiple benefits provided by agroecosystems, while accounting for the interests of different stakeholder groups, encompassing ecological and social dimensions and exploring the linkages between science, policy and practice (Braat and de Groot, 2012). According to the preferences and aspirations of social actors, the provision of particular ES can be recognised and prioritized (Lamarque et al., 2014, Cáceres et al., 2015). Since farmers are directly responsible for taking decisions and managing agroecosystems, strategies for promoting the delivery of multiple ES should consider their needs and perceptions to be socially acceptable and transformative (Duru et al., 2015; Bernués et al., 2016). Yet, farmers constitute a very diverse group of actors (Torquebiau et al., 2012) and their management is influenced by a myriad of factors, including assets, ambitions, social networks, policies, markets, but also by their understanding and perception of the functioning of their agroecosystem. Although farmer's mental constructions may have a great influence on their practices (Vuillot et al., 2016), little is known about farmer's perceptions of ES and how this is related to agroecosystem management (Lamarque et al., 2014; Smith and Sullivan, 2014; Lescourret et al., 2015).

Farmers often have deep experimental knowledge of their systems, in which multiple ES are managed simultaneously. This is challenging because of the many positive, negative and non-linear relationships among different ES and management practices (Lescourret et al., 2015). Managing multiple ES requires a knowledge-intensive, holistic approach that takes into account the interactions among economic, social, cultural and ecological aspects (Smith and Sullivan, 2014; Tancoigne et al., 2014). Although research efforts have increasingly focused on integrated assessments of ES bundles (Boerema et al., 2016; Costanza et al., 2017), the factors underlying the social-cultural valuing of multiple ES and their interactions remains underexplored (Cáceres et al., 2015; Costanza et al., 2017). The social-cultural

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valuing is especially relevant for supporting, regulating and cultural ES, because these services are more difficult to quantify in economic terms (Chan et al., 2012) and their valuation can vary more strongly according to perceptions of social actors (Hein et al., 2016).

The study of farmers' perceptions of ES in relation to their management practices should take their personal aspirations, values and beliefs into account, as well as the functional and structural variables of the farm, such as production orientation and farm size (Vuillot et al., 2016). This requires methodologies that can capture the most important ES and their interactions according to farmers, as well as to identify relevant management and socio-ecological variables (Díaz et al., 2011; Bennett et al., 2015). Here we used fuzzy cognitive maps (FCM) as an integrated research tool to assess how farmers perceive and value the entire bundle of multiple and interconnected ES, and how this perception and valorisation influences their management of the agroecosystem. FCM is a semi-quantitative modelling tool that has been developed to assess and compare knowledge from non-technical experts (Özesmi and Özesmi, 2004) and has been successful in integrating social and ecological sciences (Kok, 2009; Papageorgiou and Salmeron, 2013; Jetter and Kok, 2014). FCM are simple to use in participatory settings (van Vliet et al., 2010), and suitable to deal with inherently complex and subjective concepts (Reyers et al., 2013; Chan et al., 2012).

The objectives of this study were (i) to understand farmers' perceptions on the management and provision of multiple ecosystem services, (ii) to contrast perceptions among farmers belonging to different farm types, and (iii) to explore the linkages between farmers' perceptions, agrobiodiversity and production orientation. For this purpose, the FCM was combined with a farm characterization and on-farm assessment of agrobiodiversity indicators to link farmers' perceptions with farm structural and functional variables.

2. Material and methods

2.1. Study area

The study was conducted in the Zona da Mata region, in the South-Eastern part of Minas Gerais, Brazil. It is located in the Atlantic rainforest biome, which is considered the fifth biodiversity hotspot in the world, hosting many unique endemic and threatened species (Myers et al., 2000). The landscape is hilly and is commonly described as a 'sea of hills', because of its geomorphology (Greenfield, 1977). In the eighteenth century, the existing indigenous communities in Zona da Mata faced several conflicts, were colonized and nearly extinguished by the Portuguese invaders. After the colonization, in the nineteenth century, Brazilian aristocratic landlords from other parts of the country were granted great portions of land and established, among other crops, coffee plantations based on slave labour. In the initial growing years, coffee was intercropped with annual crops, such as maize, rice and beans. Since the abolishment of slavery, diverse social dynamics led to the division of land, mainly due to heritage processes as well as land acquisition by landless rural workers (Valverde, 1958). Nowadays, there is a predominance of family farmers, who diversify the use and management of the land in the Zona da Mata. As a result, the region consists of a mosaic of different land uses: pasture, which is often extensive and degraded; coffee, the most important and labour intensive cash crop, commonly intercropped with maize, beans, cassava and other crops; and forest fragments, often located in protected or less accessible areas. Although homegardens usually only occupy small areas of the farm, they are important for the food sovereignty of the families and host a high diversity of plant and animal species (Oliveira, 2015). There are a variety of national and state public policies targeting family farmers that provide access to credits, market, land and education. However, the development of these policies is challenging and their effectiveness is limited because of bureaucracy, limited involvement of farmers in the creation process, and uncertainty about the continuity of these policies due to governmental changes.

The study was conducted in the three municipalities Araponga, Divino and Espera Feliz, which connect two nature conservation areas: the state park "Serra do Brigadeiro" and the National Park "Caparaó" (Fig. 1). The municipalities have a unique history of participatory

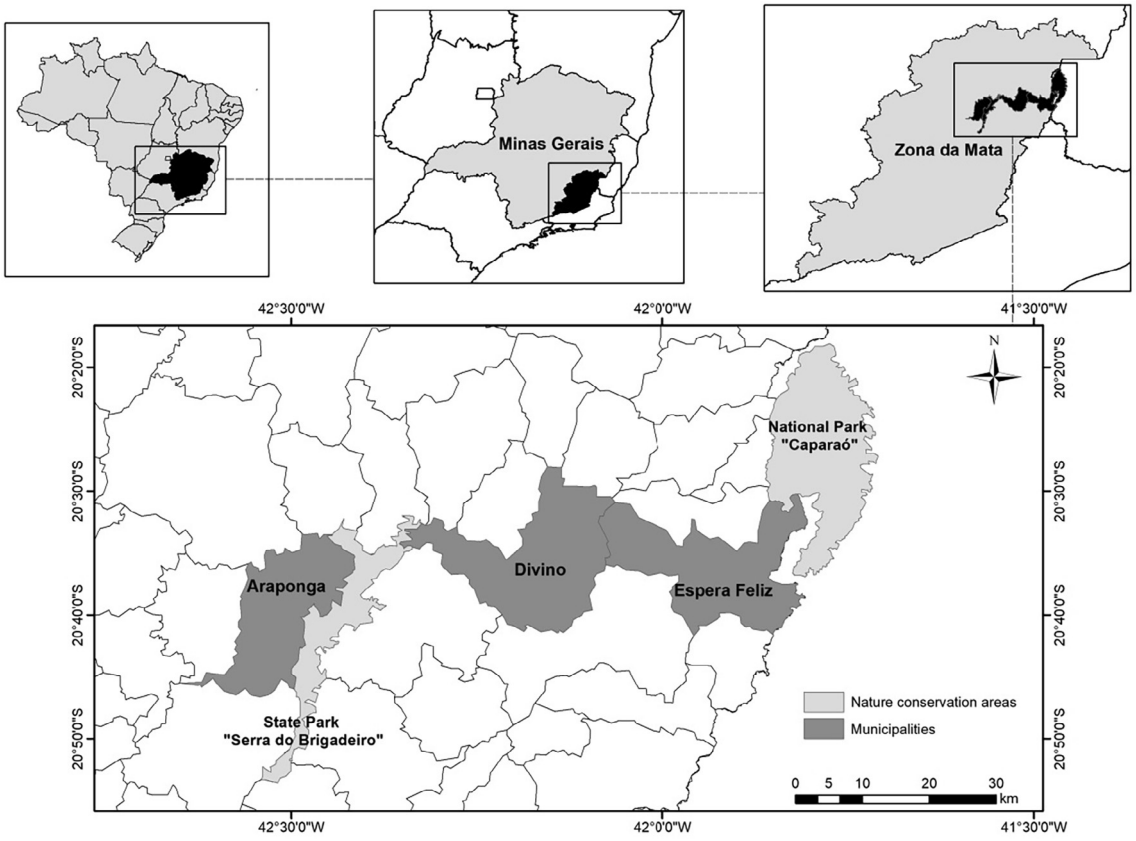

Fig. 1. Map of studied municipalities in Zona da Mata and areas of nature conservation.