Assessing linkages between ecosystem services, land-use and well-being in an agroforestry landscape using public participation GIS

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ABSTRACT

While a number of studies have applied public participation GIS (PPGIS) approaches to the spatial assessment of ecosystem services, few have considered the associations between the spatial distribution of ecosystem services and the context-specific nature of self-reported well-being. In this study, we engage the general public to identify and map a range of ecosystem services that originate in place-based, local knowledge and explore the context-dependent nature of subjective well-being. We conducted a PPGIS survey with 219 local residents in a Spanish agroforestry (*dehesa*) landscapes and analysed the spatial patterns of mapped ecosystem services, their relation to land cover, protected area and common land patterns. In addition, we explored the landscape values contributing to people's well-being; and the relationships between ecosystem services in different land covers, landscape values and socio-demographic characteristics. A mosaic of landscape types (i.e., the landscape) provided more ecosystem services (especially cultural and provisioning) to people compared with the individual land system of agroforestry. However, land tenure and public access significantly guided the spatial practices and values of the people beyond the preferred landscape types. The contribution of the landscape to well-being is largely related to values based on interactions among people and the landscape, as tranquillity/relaxation and people-people interactions such as being with family and friends. We discuss the specific contribution of agroforestry landscapes to the provision of ecosystem services and human well-being. We conclude that the integration of the applied methods of social-cultural assessment on the one hand links to ecosystem services frameworks but on the other hand represents a more holistic conceptualisation of people's benefits from landscapes.

1. Introduction

Assessment and mapping of ecosystem services contributes to understanding the supply and demand of services, to supporting stakeholders in decision-making, and to informing political priorities for environmental sustainability, for example in the European Union (Maes et al., 2012). Whilst biophysical mapping and economic assessment remain a focus of ecosystem services research

(e.g. Reyers et al., 2013), emerging research further integrates social-cultural perspectives (e.g. Scholte, van Teeffelen, & Verburg, 2015). Recent studies consider social complexity, analysing issues of benefit distribution, values and interests and power around ecosystem services (Daw, Brown, Rosendo, & Pomeroy, 2011; Felipe-Lucia et al., 2015). Research is also directed toward a deeper understanding of the links between ecosystems and human well-being (e.g. Berbés-Blázquez, 2012; Bieling, Plieninger, Pirker, & Vogl, 2014; Hausmann, Slotow, Burns, & Enrico, 2015; Villamagna & Giesecke, 2014).

Participatory approaches are particularly useful to explore stakeholders' knowledge, preferences, practices, perceptions and values around ecosystem services (Villamor, Palomo, Santiago,

Oteros-Rozas, Hill, 2014). In particular, public participation GIS (PPGIS) and a range of other participatory mapping approaches enable an assessment of the social complexity of ecosystem services (Brown & Fagerholm, 2015; Raymond, Kenter, Plieninger, Turner, & Alexander, 2014), including multiple place-based practices and values, emerging from everyday embodied subjective experience and accumulated knowledge (Ingold, 1993; Stephenson, 2008; Williams & Patterson, 1996). They communicate the assigned environmental values, i.e. the judgements regarding the worth of objects such as places, ecosystems and species with benefits for landscape management (Ives & Kendal, 2014; Seymour, Curtis, Pannell, Allan, & Roberts, 2010; Van Riper & Kyle, 2014).

While a number of studies have used PPGIS to elicit ecosystem services (see Brown & Fagerholm 2015 for a recent review), few studies have considered the spatial associations between the spatial distribution of ecosystem services and human well-being. Human well-being is a multi-dimensional concept which has a fundamental role in the ecosystem services framework (Villamagna & Giesecke, 2014). The Millennium Ecosystem Assessment (MA) recognised five dimensions of well-being: 1) basic material for a good life; 2) freedom of choice; 3) health; 4) good social relations, and; 5) security (MA, 2005). These aspects represent three core domains in which humans benefit from the environment: physically, psychologically and socially. Recent research has highlighted the importance of assessing the context-specific nature of self-reported well-being. Well-being is strongly associated with perceived environmental qualities (as measured by marking of negative and positive qualities on a map using PPGIS) in both urban and suburban contexts (Kyttä, Broberg, Haybatollahi, & Schmidt-Thomé, 2015). Weber and Anderson (2010) compared the perceived well-being benefits that park users obtained from regional and urban parks. Across both contexts, common preferences included enjoying nature, escaping personal/social pressures, escaping physical pressures and enjoying the outdoor climate. In a study of short interviews, Bieling et al. (2014) studied ways that natural surroundings and everyday landscapes contribute to people's well-being and the kind of linkages that emerge to ecosystem services and landscape values, revealing an outstanding importance of cultural values.

Social-cultural assessment of ecosystem services and their contributions to people's well-being have received limited attention in multifunctional agroforestry landscapes (Fagerholm, Torralba, Herzog, Burgess, & Plieninger, 2015). Agroforestry is the deliberate human management of trees/shrubs with agricultural crops or livestock (Mosquera-Losada, McAdam, Romero-Franco, Santiago-Freijanes, & Rigueiro-Rodríguez, 2009). Agroforestry aims to integrate commodity production with sustainability issues (in particular related to poverty alleviation, food security and soil and biodiversity conservation), while striving to be compatible with local farming practices (Nair, 2007). In fact, agroforestry systems provide multiple ecosystem services, ranging from the provision of food, feed and fibre through to non-commodity outputs, such as climate, water and soil regulation and recreational, aesthetic and cultural heritage values (e.g. McAdam, Burgess, Graves, Rigueiro-Rodríguez, & Mosquera-Losada, 2009; Smith, Pearce, & Wolfe, 2013). In Europe, agroforestry has frequently shaped highly appreciated cultural landscapes with long traditions (Eichhorn et al., 2006; Plieninger et al., 2015) and has significant potential to advance sustainable rural development (http://www.agforward.eu).

Many researchers have been concerned about the insufficient focus on the social-cultural sphere and associated processes in understanding the contributions that nature's services provide to humans (e.g., Chan, Satterfield, & Goldstein, 2012; Schröter et al., 2014; Setten, Stenseke, Moen, 2012). This concern is particularly apparent in agroforestry landscapes. Studies involving local people and other stakeholders defining agroforestry-related ecosystem services have been documented only in limited case study research (Fagerholm et al., 2015). One exception is Hartel et al. (2014) who interviewed rural inhabitants in an area of Romania about their perceptions of ecosystem services in changing silvopastoral landscapes. Provisioning services such as firewood, water and crops, but also healthy soils were particularly valued. Oteros-Rozas et al. (2014) surveyed attitudes and perceptions of ecosystem services regarding a Spanish transhumance network with residents and visitors with the most important services revealed as fire prevention, air purification and livestock. Preferences have also been studied with the use of landscape photographs, for example by Pinto-Correia Barroso, Surová, Menezes (2011) in a study eliciting visual preferences for Portuguese *montado* agroforestry landscapes. García-Llorente et al. (2012) performed a comparative analysis between different typical landscapes in Spain, including the *dehesa* agroforestry landscapes, with the result that *dehesa* is among the highest valued by people in terms of visual preference and in willingness to pay for conserving it, and also among the landscapes with more capacity to supply multiple ecosystem services.

In summary, agroforestry systems provide great potential for environmental conservation and sustainable rural development, but the ecosystem services of European agroforestry and their contributions to human well-being have not been scrutinized from a social-cultural perspective (Fagerholm et al., 2015). In this study, our aim is to understand the importance of ecosystem services from agroforestry for local people in a spatially explicit way at the landscape scale, and to reveal the contribution of agroforestry landscapes to subjective well-being. We present a first social-cultural assessment of ecosystem services provided by a European type of agroforestry through PPGIS methods. Furthermore, the relationships between contribution of a landscape to subjective self-reported well-being and spatially explicit mapping of landscape practices and values have not been explored before. The particular focus of this paper is the Spanish *dehesa* − a traditional, low-input, extensive agroforestry system composed of open, heterogeneous canopies of holm oak (*Quercus ilex*) and cork oak (*Quercus suber*) with a shrub or annual herbaceous understory. *Dehesas* are estimated to cover about 2.3 million ha in Spain (Moreno & Pulido, 2009).

Our specific objectives are:

1. to quantify and map the spatial distribution, patterns and intensities of ecosystem services perception by local people and explore the differences between different actors;
2. to compare and contrast the number and type of ecosystem services identified and their spatial relation to land cover, protected areas and common land patterns;
3. to identify the linkages between the perception of landscape and subjective well-being;
4. to explore the relationships between the ecosystem services demanded in different types of land covers and identified landscape values attached to subjective well-being and socio-demographic characteristics;
5. to elucidate the specific contribution of agroforestry systems to the provision of ecosystem services.

2. Methods

2.1. Study area

The study was carried out within the Llanos de Trujillo plains in Cáceres Province, south-western Spain (39° 31′ 50″ N, 5° 56′ 04″

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