Impacts of Land-use and Management Changes on Cultural Agroecosystem Services and Environmental Conflicts – A Global Review

Abstract

As an outcome of interactions and interdependencies with people, agroecosystems provide cultural ecosystem services (CES), such as traditional knowledge, recreation, and places for social gatherings. Today however, agroecosystems undergo biophysical changes because of land-use and management changes (LUMC), such as intensive agriculture, urbanisation, and land abandonment. Typically, environmental conflicts emerge between stakeholders with differing interests in land areas around the LUMC. Cumulatively, these changes and conflicts have substantial influence on the CES appreciation of the farmland, triggering different types of responses, including social mobilisation and resistance.

A comprehensive analysis of these processes was missing in the literature. Here we present a systematic review of CES provided by agroecosystems at the global level, we explore their interconnections through network analysis, and analyse the interrelation between LUMC, CES and environmental conflicts. The review includes 155 peer-reviewed articles, representing empirical data from 81 countries. Twenty main categories of CES and their subcategories delivered by agroecosystems are identified. Through the network analysis we demonstrate how CES are interrelated, with agricultural heritage as a connecting core. In a comprehensive map, we further identify which LUMC types have influence upon specific CES categories, and what are the causes, outcomes of, and responses to environmental conflicts that emerge from these processes. CES and agroecosystems cannot be seen separately from one another, as a reflection of secular or recently-created relationships people have with their environments. While these relationships are dynamic, LUMC may lead to their impairment or even loss, with ensuing impacts on biocultural diversity. The resulting environmental conflicts push most frequently for greater participation of actors involved in farming, and socio-cultural revalorisation of farmland activities and the promotion of multi-functionality.

Keywords: *Agroecosystems, Cultural ecosystem services, Land-use management changes, Environmental conflicts*

1. Introduction

The social-ecological interactions in the farming landscapes commonly result in agroecosystems with exceptional cultural benefits. These benefits are commonly referred as Cultural Ecosystem Services (CES) (Calvet-Mir et al., 2012b; Chan et al., 2012; Plieninger et al., 2015; Zorrilla-Miras et al., 2014). While being associated to intangible values (e.g. Milcu et al., 2013), CES can involve several tangible, material values, such as the access to wild products or agro-tourism development (Daugstad et al., 2006; Plieninger et al., 2015). While CES' potential role in enhancing ecosystem management is significant (Plieninger et al., 2015), their assessment and implementation into landscape planning is challenging (De Groot et al., 2010; Nieto-Romero et al., 2014; Satz et al., 2013).

CES in agricultural landscapes is still poorly investigated in comparison to other ES categories (Dominati et al., 2014; Fagerholm et al., 2016; Milcu et al., 2013). Focusing on only provisioning or regulating services from agro-ecosystems and disregarding CES and their interactions carries consequences, such as inequalities in power relations (Kull et al., 2015). CES may be strongly correlated with other ES categories in human modified landscapes (Reyes-García et al., 2015).

Many scholars argue however that CES may be undervalued or "invisible" (e.g. Aspe et al., 2016; Bernués et al., 2014; Bouahim et al., 2015; Frank et al., 2012; Grunewald et al., 2014; Nahuelhual et al., 2014), even within economic valuations. For example existing economic valuations of CES often leave unnoticed the socio-cultural attachment people have with their environment (Chiesura and De Groot, 2003; Ruoso et al., 2015; Zhang et al., 2015). Consequently, this may underestimate the important contribution that CES make to total ES delivery (Van Berkel and Verburg, 2014). Indeed, human non-materialistic needs, and the cognitive and the emotional components of the relations with ecosystems have a central role in shaping environmental attitudes

(Chiesura and De Groot, 2003; Costanza et al., 1997). Thus, their cultural value is of interest in science and policy (Merlín-Uribe Yair et al., 2012; Pretty, 2008).

Agricultural areas permanently undergo changes due to socio-economic and socio-political drivers, thus leading to coupled environmental and cultural transformations (Ribeiro Palacios et al., 2013). Both biophysical and cultural changes affect the CES delivery capacity of the farming landscape, and the CES appreciation by stakeholders. Changes in the biophysical and functional properties of agroecosystems (Pedroli et al., 2016) will in turn shape the capacity of these ecosystems to deliver CES for the human societies (Munteanu et al., 2014).

Land use and management changes (LUMC) are one of the major causes of the biophysical changes of agroecosystems, typically through intensification and homogenization (Munteanu et al., 2014; Zorrilla-Miras et al., 2014). Since the structural heterogeneity of the landscape correlates with its aesthetic and recreational values (Hahn et al., 2017), a simplification of structure due to intensification may result in the decrease of the CES delivery of the farming landscapes (Pilgrim and Pretty, 2010).

The CES appreciation of the farming landscapes can also be influenced by the access to- and control of natural resources by different land users (Brown and Raymond, 2014; Kumar Paul and Røskaft, 2013; Pacheco and Sanches Fernandes, 2016; Svampa, 2015). Only a few academic articles based on ES framework have specifically stated how access to- and benefits from ES varies across space and different groups (Wieland et al., 2016). An inclusive view of stakeholders is important in the interests of social justice, because values and interest of the most vulnerable and powerless are often excluded from the environmental management decision making (Jorda-Capdevila and Rodríguez-Labajos, 2014; Martinez-Alier, 2014; M. S. Reed et al., 2009).

With this in mind, the major goal of this paper is to provide a comprehensive review on how LUMC influences CES in agroecosystems and what conflicts are arising from these changes. As we analyse these connections, we also categorise the CES related to agroecosystems, as well as types of environmental conflicts in agricultural management,

both topics of relevance that, so far, lack a systematic assessment at the global scale. The following sections outline the background of CES, LUMC and conflicts. After that, we describe the methodology of the review and present and discuss the main results.

2. Cultural Ecosystem Services in Agroecosystems

Agroecosystems in farming landscapes are multi-functional (Allan et al., 2015; Fibrank et al., 2013; Pretty, 2003) and culturally shaped (Power, 2010). CES in agroecosystems may include education, traditional knowledge, cultural gatherings, recreation or tourism, as well as traditional land use and seed exchange. Agricultural places and products are present in traditional rituals and customs that bond human communities (Power, 2010; Zorrilla-Miras et al., 2014). Knowledge about CES can be considered essential for understanding cultural identity, environmental sustainability and survival in different cultures (Brown and MacLeod, 2011; Tengberg et al., 2012).

While there is a growing interest in ES provided by agroecosystems (Calvet-Mir et al., 2012b; Milcu et al., 2013), CES until recently received little attention in empirical studies (Chan et al., 2012; Schaich et al., 2015). The challenges of quantifying, valuing and mapping CES play against their effective integration in the assessments (Casalegno et al., 2013; Nahuelhual et al., 2014). In fact, based only on economic valuation of CES, the relationship people build with their environment is overlooked (Ruoso et al., 2015).

Connectedness to nature is important to the extent of improving cognitive functions in humans (Berman et al., 2008). CES however, are sometimes referred to as “additional” services (Swinton et al., 2007). Yet, CES of a community cannot be captured by economic analyses alone (Carrasco et al., 2014). The relationship between agricultural revenues or cultural services is more complex than contingent valuations can indicate (Ruijs et al., 2013). CES are strongly interrelated, so the decline of one CES and its value might influence the value of another CES (Tilliger et al., 2015). In addition, standardised measuring of landscapes aesthetic value (e.g., tidal flats) is difficult, because every region differs in characteristics and culture (Kim, 2013). Thus, CES are closely linked to personal and local value systems (Nahuelhual et al., 2014).

In this respect, CES in agro-ecosystems remain largely unknown and under-appreciated (Aspe et al., 2016; Cerqueira et al., 2015), and have consequently been invisible in planning and management (Barrena et al., 2014). There is a need for better understanding of the ways in which societies use and shape ecosystems and relate it to cultural, spiritual and religious belief systems. Cultural landscapes are the place where culture and nature meet, such as centuries old tangible and intangible patrimony, cultural and biological diversity (Tengberg et al. 2012). Improving understanding of this linkage is still a key point of the agricultural and ES research agenda (Swinton et al., 2007).

3. Land Use and Management Changes in Agro-ecosystems

The literature distinguishes three main drivers of LUMC. Two are related to either direct or indirect impacts of climate change, and one is driven by socio-economic changes (Briner et al., 2013). These drivers are the outcome of a complex mixture of economic, policy, institutional and market forces (Munteanu et al., 2014; Zorrilla-Miras et al., 2014).

In many rural regions today, as a consequence of extreme temperatures, LUMC might be manifested in droughts with water shortages, desertification, floods and land runoff. These negative processes also have a high pressure on agroecosystems' services delivery (Fu et al., 2017). A recent study in Chile showed how natural cycle fires have increased due to climate change, with a considerable impact on traditional vine production, and historical aesthetic beauty of the local vineyards (Martinez-Harms et al., 2017). Climate change has also a significant impact on spirituality and cultural identity of local communities, because the spiritual rituals are closely connected to glaciers and water sources in regions experimenting environmental change (Palomo et al., 2014).

Regarding the socio-economic changes, agricultural intensification, scale enlargement and abandonment led to significant changes in landscapes (Pedroli et al., 2016). Main influences and drivers of LUMC in general include decline in rural populations and migration from rural to urban areas; development and new agricultural techniques; regional, national, and international market forces; or regional and national

governmental initiatives which subsidise monocultures and finance large scale infrastructure, such as irrigation systems; or effects of policies implementation, such as the Common Agricultural Policy (CAP) of the European Commission (García-Ruiz and Lana-Renault 2011). Agricultural land abandonment, for instance, is at present the major issue occurring in Europe (Tarolli et al., 2014; Zakkak et al., 2015).

Changes in agriculture go beyond crop management. A study on land use changes of wood-pasture landscapes of Northern Lesbos shows a shift from traditional grazing and terraced arable fields to a more intensified and pure livestock grazing system, leading to an abandonment of arable farming and to a sharp decline in cultivation patterns (Schaich et al.,2015). Other LUMC with impacts on CES occurring in the last decade are urban, as well as rural development policy programs. Spain, for instance, experienced one of the most significant LUMC in all of Europe, with enormous economic and socio-cultural consequences (Quintas-Soriano et al., 2016). Widely homogeneous agricultural landscapes lead to the cultural standardisation imposed by the global market. As a result, many cropping systems of great ecological, historical and cultural value are under the threat of vanishing (Guarino et al., 2017).

Human-environment relationship refers to a process where culture and identity are simultaneously shaped, but are under threat from land abandonment, intensification, and urbanisation (Fernández-Giménez, 2015). Relatively little is known about how individuals in the system experience the changes or the impact on local culture (Fernández-Giménez, 2015). According to Quintas-Soriano et al. (2016) and Fernández-Giménez (2015) only a few studies have examined the impact of these changes on local communities and CES (e.g., Iniesta-Arandia et al., 2014; López-Santiago et al., 2014; Szücs et al., 2015). Thus, studies on how land use changes affect ES, and CES that are particularly vital to the maintenance of human well-being, are of great scientific importance (Quintas-Soriano et al., 2016).

4. Environmental Conflicts

Environmental conflicts are often seen as a contention between different actors about natural resources. The narrative of this being just a hierarchical binary, such as the one confronting local or indigenous perspectives against scientists or conservationists

positions on how to manage scarce or vulnerable resources, has been progressively challenged (Breslow, 2014). Nowadays environmental conflicts are rather seen as "*related to the access and control over natural resources and territory, which suppose divergent interests and values between opposing parties, in the context of a great asymmetry of power"* (Svampa, 2015, p.68). Environment is a primary source of livelihood for poor rural populations, whose values, interests and participation are often marginalised and neglected (Martinez-Alier, 2014).

Most of the cultural benefits provided by agroecosystems are seen as non-marketed externalities generated by land managers (De Groot, 2006). However, they are essential for communities' spiritual enrichment, rituals, or their cultural identity (Hobbs et al., 2014). Yet most studies on agroecosystem services do not involve stakeholders in the assessments of CES (Nieto-Romero et al., 2014). In this respect, a study on agricultural intensification and expansion in Argentina concluded that ES research without effective stakeholder participation entails the risk of scientific information serving to legitimise policies with narrow consensus. This leads to poor compliance and powerful stakeholders may have more influence on land use policy decisions (Mastrangelo et al. 2015). This positions ES research as highly political, and calls for a close attention to cultural narratives, distribution of power and institutional barriers (Kull et al., 2015; Breslow, 2014). Equity is one of the most important elements in the implementation of ES-related policies (Pascual et al., 2010; Corbera et al., 2007).

Environmental conflicts for accessing natural resources (e.g., land and water) or about the benefits people are obtaining from ecosystems may take different levels, forms and degrees of intensity. They do not necessarily always appear as an open direct clashes between different social groups, and often take the form of hidden conflicts or more latent tensions (Ariza-Montobbio and Lele, 2010; via Dahrendorf, 1958).

Conventional ES assessment, mainly based on biophysical modelling and monetary valuation, may not detect these type of tensions beyond the identification of trade-offs (De Groot, 2006; Fagerholm et al., 2016). There is an urgent need to include socio-cultural approaches in the land use conflicts study (Plieninger et al., 2014). It is important that environmental conflict studies not only rely on open conflicts, but latent

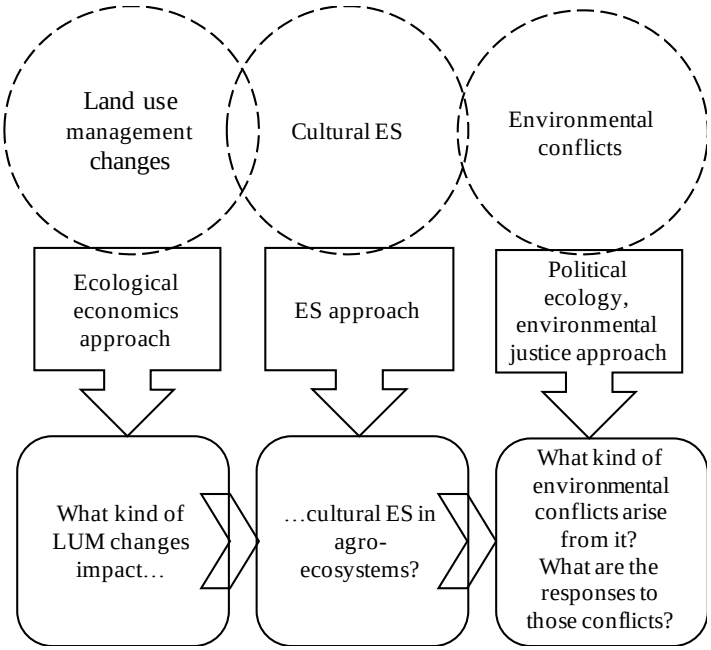
conflicts also, because in that way we gain a deeper look into processes that are stopping social responses (Beltrán M., 2016). Thus, conflicts – manifested and hidden – are important considerations in future sustainable agroecosystems management practices (Ariza-Montobbio and Lele, 2010; Jose and Padmanabhan, 2016).

5. Methodology

The conceptual framework used to develop this research is presented in Figure 1. It acompasses concepts and approaches used for the qualitative analysis of LUMC, CES and conflicts. On the left-hand side, the concept of LUMC was approached from the ecological economics perspective, in order to identify which were most prominent changes reported within the literature. With this, we gained the look into the contemporary economy and ecology relations, and identified cause-effect relationship and dynamic socio-economic processes (van den Bergh, 2001). The centre of the figure shows how the ES approach was used to gain a deeper insight on types of CES provided by agroecosystems.

On the right-hand side of the figure, political ecology and environmental justice approaches were used for analysing conflicts that are taking place due to the impact of LUMC on CES. Political ecology utilizes a common approach to relate local problems to global systems. In combination with land-use science, it discloses power dynamics within the coupled human-environmental systems (Turner and Robbins, 2008). By environmental justice we refer to distributional and procedural issues (Schlosberg, 2013) associated to CES. This approach was used to identify the fairness in the distribution of environmental wellbeing (Ernstson, 2013).

246 Figure 1. The conceptual framework used to develop the research.



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249 *5.1 Literature Search and Selection*

250 We employed a systematic literature review with the aim of identifying, evaluating and
251 interpreting the globally available research relevant to our research questions. Data
252 mining of suitable references started from employing the search terms: "ecosystem
253 service*" AND "agric*" AND "cultur*" AND "land use change" in the Scopus
254 literature database (on 15/12/2016. The results obtained were 273 peer-reviewed articles
255 spanning 1994–2016. Additionally, the literature on environmental conflicts related to
256 CES in agro-ecosystems was scrutinised adding the search terms "cultural ecosystem
257 service", AND "agric*" AND "conflict*". The results contained only 19 peer-reviewed
258 articles, spanning 2010–2016. Furthermore, 4 relevant articles were published in the
259 meantime, and included in the analysis. Only peer-reviewed papers, written in English,
260 Spanish and Portuguese were included in this review. Selection and exclusion criteria
261 included:

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263 a) Papers that contained information about CES, agriculture and possible conflicts
264 between different stakeholders driven by land use changes. Studies deemed eligible for

inclusion were papers and book chapters which reported primary empirical data on cultural ecosystem services, agriculture, and related direct or indirect conflicts.

b) Articles and book chapters dealing only with coastal management and forestry were excluded. Agro-forestry and wetlands were included only when they were closely related to traditional crop production of the communities and related conflict, such as in traditional rice cultivation.

Finally, 155 studies spanning 2003–2016 fulfilled the above eligibility criteria, and were selected for the analysis (Appendix A).

5.2 Data Organisation and Analysis

Information from the included papers was extracted and organised in an Excel file within the following categories: authors, title, journal, document type, place, year of publication, CES in agro-ecosystems, description of conflicts either directly stated or latent, type of land use and land management changes, stakeholders' group involved in the process, stakeholders impacted by the LUMC and the methodology used in each one of the selected papers.

The data thus organised was imported into the qualitative analysis software *NVivo (QSR, version 11.0)*, which was used to assist in coding and analysing each category of interest. Following (Siccama and Penna, 2008) the coding for each category was structured hierarchically. The general categories that were at the top included "conflict", "land use changes", "cultural ecosystem service", and "stakeholders" (Table 1). From then, specific categories, or child nodes, emerged below. Methods of descriptive statistics was used to analyse the frequencies and co-occurrence of the different types of codes. The complete outline of the methodology is presented in Figure 2.

Figure 2. Methodological stages of the research process

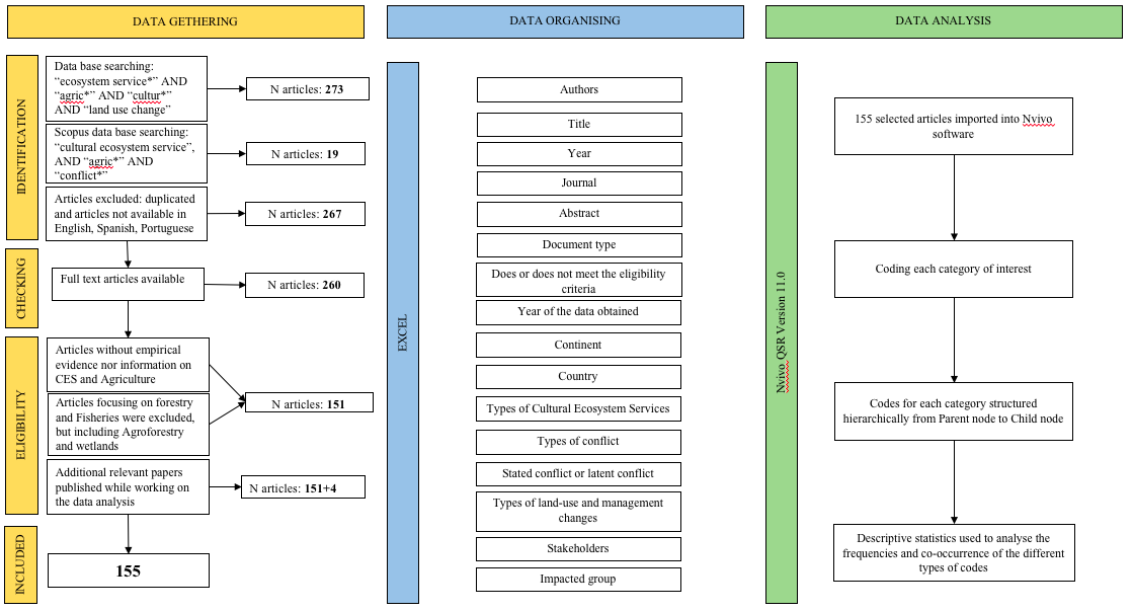


Table 1. Structure of codes

General category (Parent node)	***Specific categories (Child node)***	***Number of codes in the selected papers***
Place	Country Continent	174 271
Land use change	Types of land use change	348
Conflict	Causes of conflict Outcome of conflict Response	384 579 127
Stakeholders	Involved stakeholders Impacted groups	523 162
Cultural Ecosystem Service	Cultural agro-ecosystem services Service generating structures	1064 224

6. Results

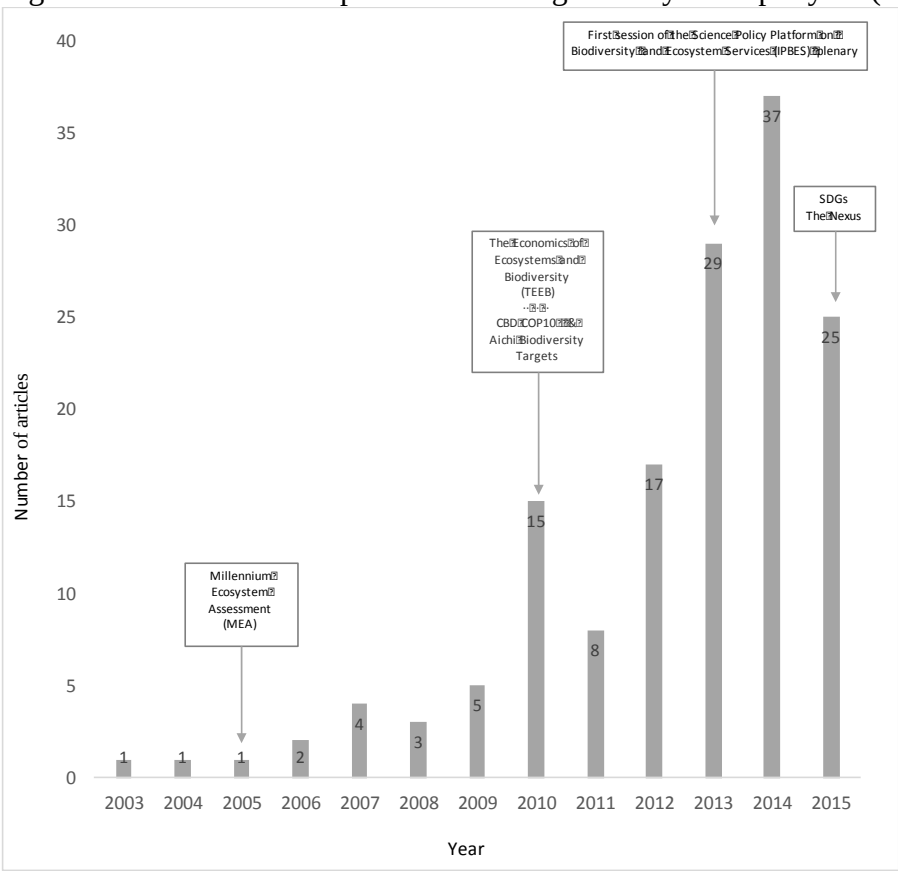
6.1 Mapping the Existing Literature

A consistent increase in the number of publications is apparent since 2007 (Figure 3), with a small peak in 2010, probably due to the influence of the Economics of Ecosystems and Biodiversity (TEEB) initiative. Alongside this, the Aichi Biodiversity Targets established in the tenth meeting of the Conference of the Parties of the Convention on Biological Diversity (CBD COP10) explicitly mentioned the role of agriculture in conservation, the relevance of culturally valuable species, and the respect

to customary use of biological resources (The Convention on Biological Diversity, 2016).

The number of publications continued to increase from 2012, until peaking in 2014, when the work program of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) started. In 2015, when Sustainable Development Goals (SDGs) and the Nexus were adapted, there is a decrease in the number of CES publications. Nowadays, CES that agro-ecosystems provide are mentioned in a significant number of publications (Nieto-Romero et al., 2014).

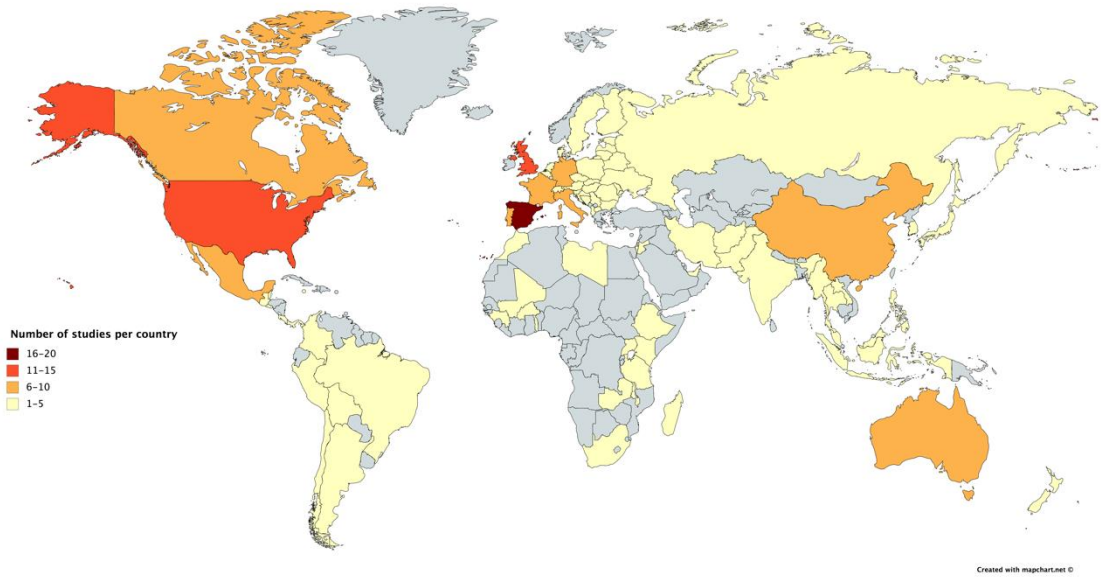
Figure 3. Number of CES publications in agro-ecosystems per year (2003-2015)



The geographic span of the literature is global, but unevenly distributed (Figure 4). CES in agriculture have been studied mostly in Western European countries, particularly in Spain, and North America, especially in the United States. China and Australia follow in number of publications. It is noteworthy that the regions that were given less attention within the literature include countries where the proportion of rural population

is still high, and so is people's dependence on agro-ecosystems as a primary source of their livelihood. This encompasses large areas of Africa and Central Asia, and some parts of Central and South America, where we can presume that CES are of great importance. There are then differences in the state of publications between the Global North and the Global South (Milcu et al., 2013).

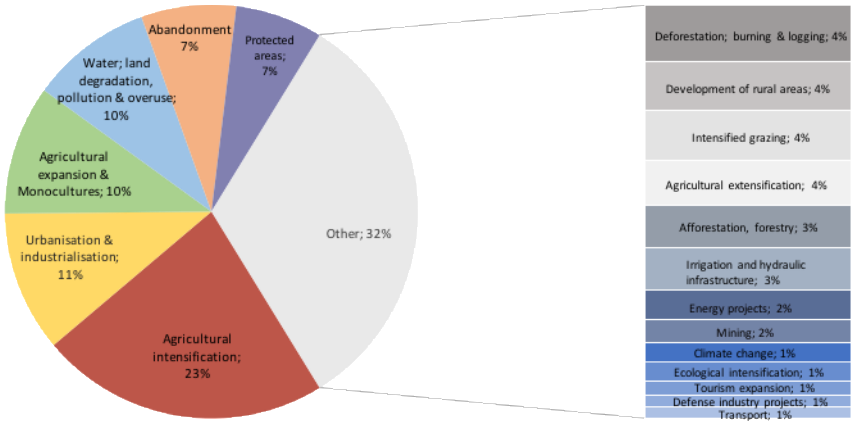
Figure 4. Number of studies on CES per country



6.2 Land Use Changes in Agro-ecosystems

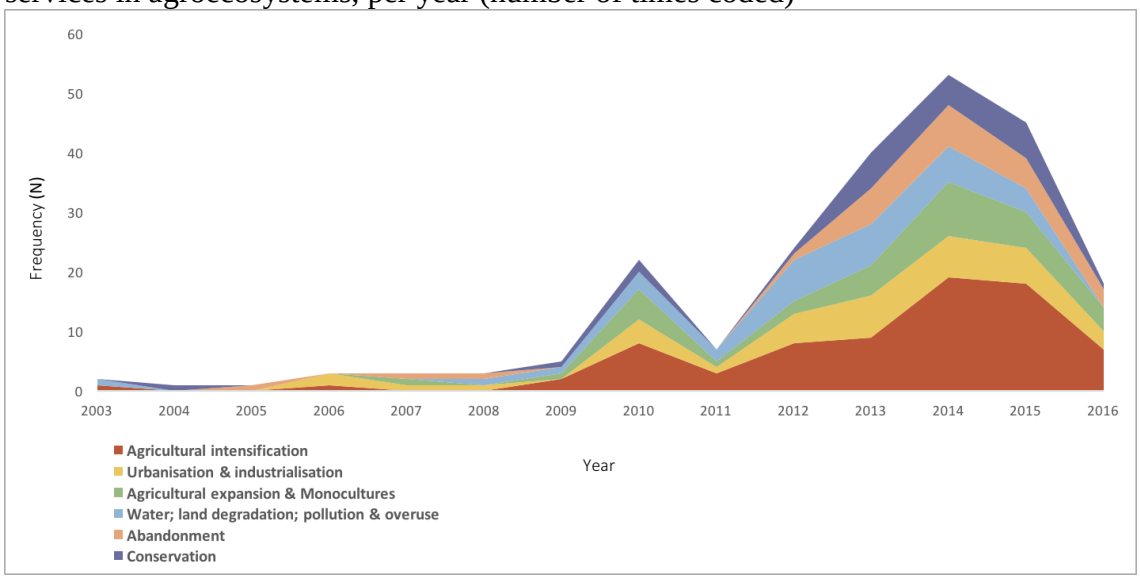
Some scholars argue that agro-ecosystems' capacity to deliver ES depends on the intensity of land use (e.g. Calvet-Mir et al., 2012). Against this, the main land use change reported in the reviewed literature is agricultural intensification, with 23% of all the coded changes in land use and land management. Also of importance are urbanisation and agricultural expansion, promotion of monocultures, and land degradation and overuse, with 10%-11% of registered LUMC. Land abandonment and conservation initiatives have similar percentages of 7%. The remaining 32% refer to diverse LUMC types reported in the literature, namely: deforestation, burning and logging; development of rural areas; intensified grazing; agricultural extensification; expansion of irrigation and hydraulic infrastructures or establishment of both renewable and conventional energy projects; mining; ecological intensification; tourism expansion; defence projects, transport; and climate change effects (Figure 5).

Figure 5. Land Use and Management Changes affecting cultural ecosystem services in agroecosystems, as reported in the literature (Percentage of times coded)



Focusing on the most frequent LUMC, it is noted that urbanisation and industrialisation, agricultural intensification, water and land pollution and related overuse and degradation have tended to increase significantly since the year 2011 (Figure 6). Meanwhile, the increase of agricultural expansion and monocultures has drawn more attention from researchers since 2012, when the global land rush was denounced by activists and recognised by scientists (Cristina et al., 2012). Land abandonment and, to a lesser degree, conservation, have also increased markedly since 2012.

Figure 6. Major Land Use and Management Changes affecting cultural ecosystem services in agroecosystems, per year (number of times coded)



6.3 Cultural Ecosystem Services and Their Service-generating Structure

A first outcome of the review is a thorough scrutiny of the **types of CES provided by agro-ecosystems** mentioned so far in the literature (Table 2). Since this is a bottom up identification of CES, the main categories (first column of the table) do not fully correspond with the standard classifications of CES (e.g. CICES, 2016). This allowed a flexible consideration of subcategories (second column) that gives an idea of the rich variety of CES involved in agro-ecosystems.

Table 2. The main cultural ecosystem services (CES) categories and their subcategories provided by agroecosystems appearing in the reviewed literature.

Categories	*Subcategories*		
Aesthetics/Beauty	Beautiful scenery	Seasonal phenology	
Artistic creation	Audio-visual/ Film making Carving Clothes and accessories making	Folklore Instruments playing and making	Photography Weaving Writing poetry
Traditional local varieties and breeds (Biocultural diversity)	Cultural diversity Erosion control techniques Fire use Food culture Food production methods	Food quality Food security Food sovereignty Hydrological function Natural capital conservation	Non-commodity food Poverty alleviation Natural hazards protection Soil fertility techniques Sustainable rural development
Celebrations	Family	Traditional ceremonies	Traditional markets
Co-creation of ecological values (Health of the people, the soil and the environment)	Adaptability to the environment	Nature value	Sustainability awareness Water management
Connectedness to nature	Connection to land	Human-environment relation	Nature-culture relation
Sense of Place	Agricultural identity Body ornamentations Cultural and symbolic practices Cultural value	Local culture Moral value Norms-codes Pride	Rural identity Socio-cultural identity Traditional clothes making Traditional headdresses
Cultural transmission	Customary law Family farming	Traditions Way of life	Wisdom
Education	Scientific knowledge	Cognitive development	
Heritage	Design and making of physical artefacts Agricultural landscape Centuries old trees Churches Furniture Gardens Historic rural architecture Irrigation canals	Paddy cultivation Paleo-environmental elements Stone walls and muds Terraces Villages and local houses Vine production Vineyards walls	Intangible patrimony Attachment to ancestor worship Ceremonies related to cultivation Family heritage Language creation Thousands of years of agricultural practices
History and historical memory	History of nature History of the place	Human history	Personal history
Inspiration	Intellectual	Spiritual	
Outdoor recreation & Cultural hunting	Animal watching Enjoyment of the countryside	Fishing Hunting	Target practices Work on the farm as recreation
Physical, intellectual, emotional sustenance	Emotions Enjoyment Expression Freedom Harmony maintaining	Health and well-being Housing Memory Mental sustenance Personal satisfaction	Physical sustenance Serenity Therapeutic areas Work

Place shaping and attachment	Attachment to the landscape Landscape experience	Local environment shaping Place attachment	Place identity Sense of place
Social Environment	Belonging Cohesion within community Community spirit Peasant's membership to the community	Secret meeting sites Seed exchange Shared land Shared water source	Shared water source Social construction Social practices Social relation
Spiritual enrichment	Beliefs Myths Religious beliefs	Rituals Sacred areas Spiritual connection with land	Spiritual sustenance Symbolic systems
Tourism	Agro-tourism Coastal tourism	Ecotourism Game farming	Rural tourism
Traditional rural lifestyle and agricultural practices	Agrobiodiversity Cultural plants and animals Fruit and vegetable diversity Genetic diversity	Land cover diversity Low-input practices Pastoral nomadic culture Species diversity	Traditional pasture Traditional rural lifestyle Typical agricultural products Uniqueness of the land
Traditional knowledge	Forms of knowledge Ecosystem/Environmental knowledge Knowledge sharing Land ethics Skills Sustainable land management	Object of knowledge Crop varieties Food cultivation Fuel collection Land health	Local animal breeds Medicine Scents Species occurrence

Besides offering a comprehensive – yet probably incomplete – list of CES, Table 2 also suggests their connection. Only the most frequent interconnections with 20 or more links identified in the literature are represented in Figure 7. The size of the circle indicates the frequency of appearance, and the width of the tie indicates the frequency of connection. Proximity between nodes indicates more frequent associations. The colour of the node corresponds to the CES classes in CICES (2016) and their hybrid.

The network clearly demonstrates how CES in agriculture are interrelated. Together they form a rich agricultural heritage. Two forms of agricultural heritage are recognised in the literature. The first one is the design and making of physical artefacts, such as the agricultural landscape itself, surrounded by historic rural architecture, including churches, and local houses. The second one is intangible forms of patrimony accrued during thousands of years of agricultural practices, attachment to ancestor worship, ceremonies related to cultivation, and languages. We observe that traditional agricultural practices relate closely to cultural identity, and both strongly relate to heritage. It is also directly connected to traditional knowledge. Those are later transmitted across generations.

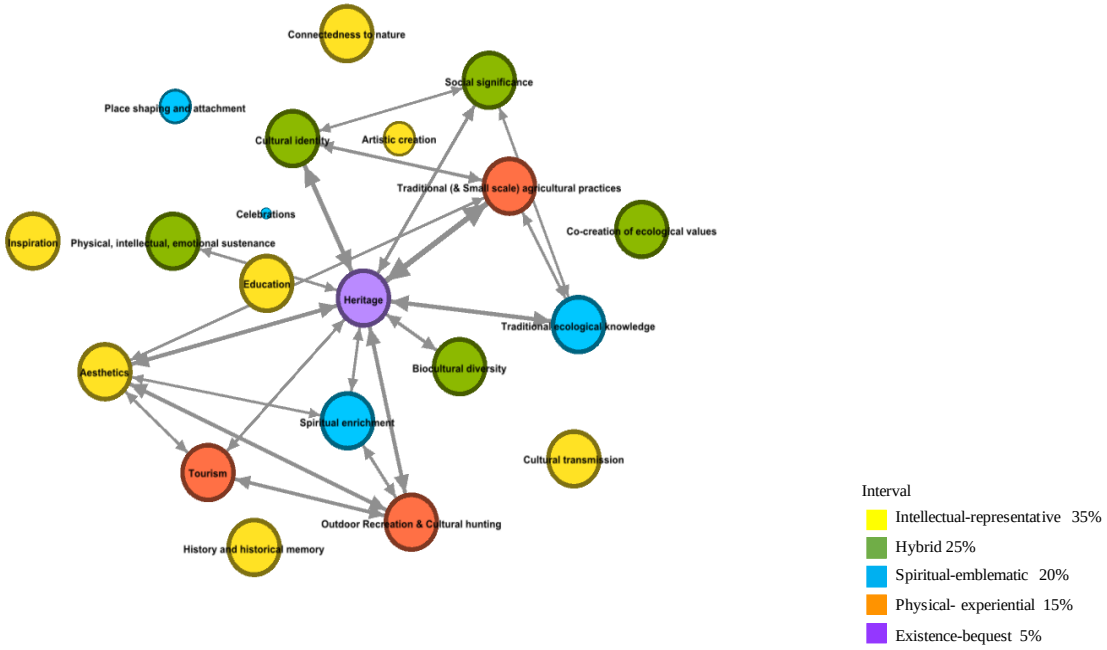
Through co-creation of ecological values and connectedness to nature, people not only adapt to their surrounding environments, but also play an important role in conservation

(of genetic resources, species-richness, and resources like water), which creates an awareness of nature value and again the traditional ecological knowledge.

People have left traces all over agricultural lands. Knowledge furthermore was shaped and maintained through traditional practices (e.g. Gómez-Baggethun et al., 2010). The social significance of traditional knowledge can be seen in the practices of sharing (e.g. land and water sources) and exchanging (e.g. food and seeds) (Calvet-Mir et al., 2012a), and importantly in sense of attachment and belonging to a place. It is also highly related to community spirit and cohesion. Also, in the case of biocultural diversity, the way food is produced has a direct impact on food quality and security, as well as on cultural diversity. Further, food production plays an important role in celebrations, and agricultural and rural identity, manifested in traditional clothes and symbolic practices.

Besides providing a work and housing place, agro-ecosystems play an important role in people's physical, intellectual, and emotional sustenance (Milcu et al., 2013). Spiritual connection with land also creates sacred areas and religious beliefs. Those are closely connected to education, whereas agro-ecosystems also provide a base for scientific research and cognitive development of a given community. Still, the proximity of inspiration also indicates its importance in people's physical, intellectual, and emotional sustenance.

Figure 7. Network of interconnections between Cultural Ecosystem Services in agroecosystems

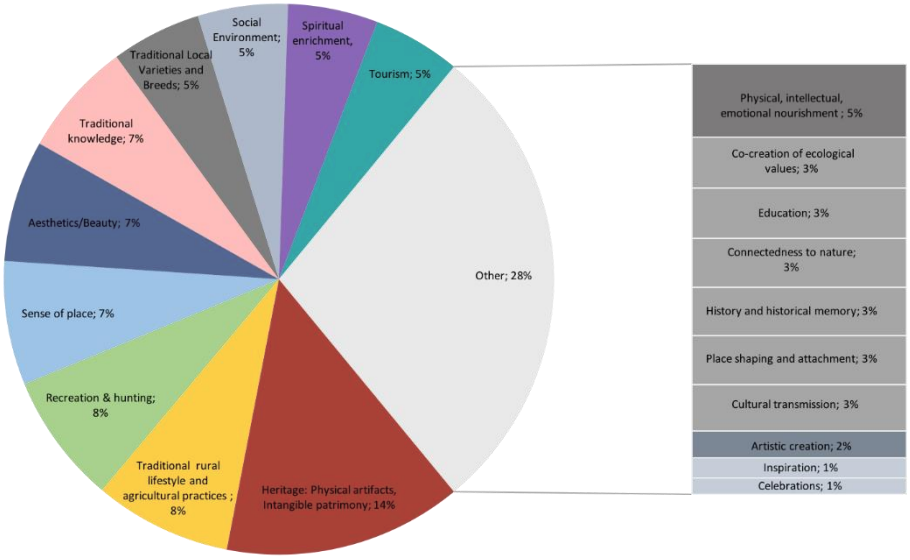


Agricultural landscapes are appreciated for their recreational qualities and tourism attraction (Plieninger et al., 2014). In our results, outdoor recreation, hunting, tourism and aesthetics had a significant correlation to each other. They are CES in agroecosystems that often generate market benefits, and therefore play a significant role of economic sustenance. In their diverse forms (e.g., agro-tourism, ecotourism and game farming) they are directly connected to the management, either sustainable or not, of a specific area. However, they strongly correlate to nonmaterial spiritual enrichment benefits. The less frequent, but still with a significant association to other CES are peoples' attachment to their places, celebration and artistic creation. All of them are relatively associated to cultural identity.

Figure 8 shows the relative **frequency of the diverse CES types** in the literature. The most recurrent ones were agricultural heritage, recreation, hunting and traditional knowledge. With similar percentage, traditional local varieties and breeds or biocultural diversity, the importance of social interactions between local people, their spiritual enrichment, and tourism follow. Less frequent were intangible CES, such as physical, intellectual and emotional nourishment, co-creation of ecological values or how agro-

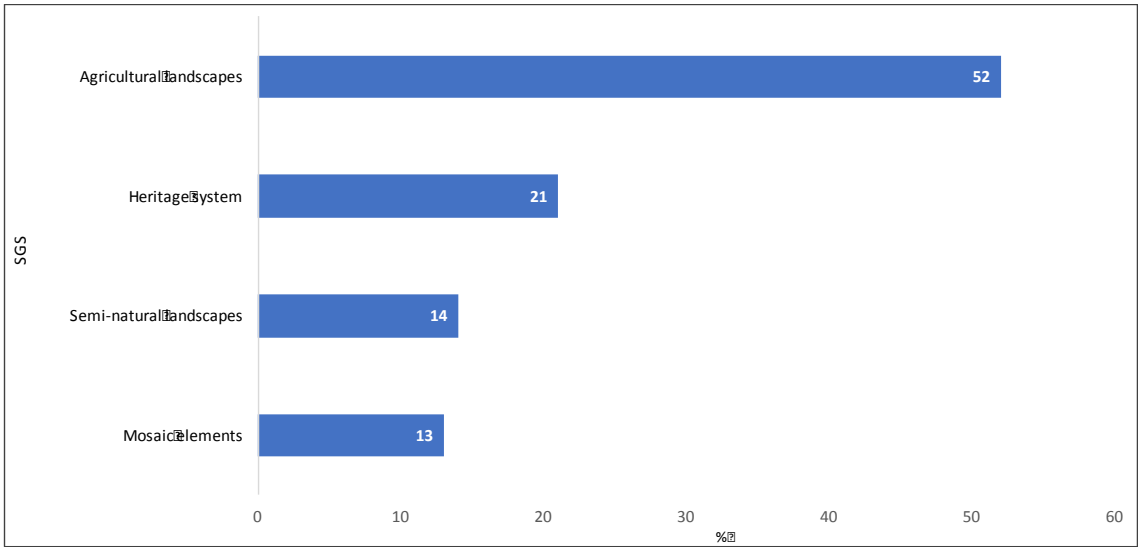
ecosystems help to care the health of the soil, the environment, and the people; then education, connectedness to nature, history and historical memory of a given place and their transmission between generations (e.g. Pretty, 2011). Celebrations, artistic creation, and inspiration had the lowest frequency. However, the literature addresses their importance, such as the role of poppy seeds cultivation in local celebrations, oral history and transmission, found in the study of Evered (2011).

Figure 8. Cultural Ecosystem Services in agroecosystems in the reviewed literature



Here the notion of **service-generating structures** (Fischer and Eastwood, 2016) deserves some attention. With this we refer to the physical elements that, through human intervention and often involving the transformation of ecosystems, promote ES co-production. In agro-ecosystems, CES depend on humans, and in that way, are sustained and maintained. Figure 9 shows the types of structures used for that purpose and their relative importance in the revised literature. Rural landscapes have always been shaped by agriculture-based societies creating a build and nature-based heritage, as well as (agri)cultural and semi-natural landscapes. In turn, these become a means for CES generation and often for the provision of other types of ES. The protection and maintenance of these structures is therefore crucial for the multi-functionality of agro-ecosystems.

Figure 9. Services generating structures (SGS) appearance within the reviewed literature



6.4 CES-related Conflicts in Agro-ecosystems

Tensions related to land use changes in agro-ecosystems and associated CES are manifold. Therefore, proposing a single typology of conflicts is challenging. In order to offer a complete understanding of the matter, this section traces three different stages that, together, configure each conflict: the *causes* of the conflicts, their effects or *outcomes* and the ensuing *responses*.

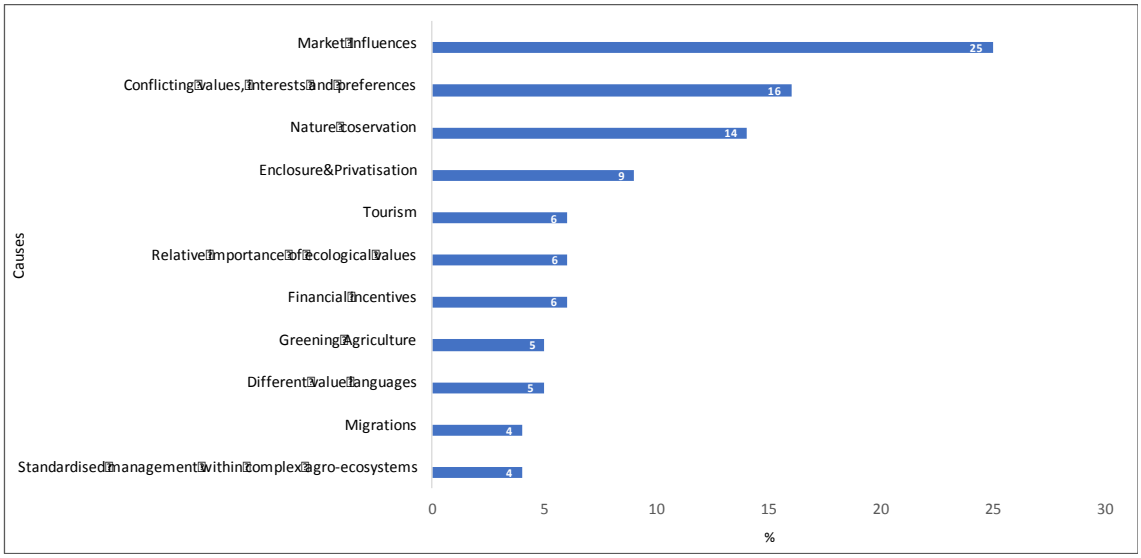
Figure 10 summarises the list and relative frequency of **causes**, or processes generating conflicts according to the reviewed literature. Each one, or a combination of them, accompanies a land use change that eventually entails negative effects for some actors. The most frequent process refers to market influences, sometimes related to tourism expansion. Tourism has a positive side in economic sustenance of the areas, but access to benefits is not for everyone, and it often causes a large rise in land and housing prices. Further to this, conflicts can arise if financial provisions are involved, such as micro finance schemes, payments for ecosystem services or subsidies, where the dominance of metric-based valuations, in which non-commodity values remain invisible when land use change decisions are made. For instance, (Kosoy and Corbera, 2010) argue how putting a price on ecosystem services through payments, makes human-nature relation invisible and only one language of ES value, in this case the monetary

value, dominates. Because community may value a particular ecosystem for its historical socio-ecological relations. Also, Jose and Padmanabhan, (2016) in their study in India, showed how market-oriented development policies implementation do not consider social-historical part of traditional paddy rice cultivation. This led to cultural practices abandonment in the rice cultivation, which historically has always served to prevent the exploitation of natural resources. Corbera et al. (2007) furthermore found that land-use change from maize cultivation to planting trees for carbon fixation, in Mexico, led to conflict between stakeholders who participated in the plantation and those who did not want to take part in the market for ecosystem services program.

Thus, socio-cultural or ecological conflicting values, interests and preferences, can often be a cause of a conflict, or different value languages, such as in case of differences between scientific and local language. Further restrictions may emerge if nature conservation decisions are made. Agricultural greening policies or the promotion of renewable energy production are often a case for such decisions (e.g. Kirchner et al., 2015).

Water, land and forest privatisation, or traditional territories enclosure –including fee payment systems such as case in Madagascar study (Brimont and Desbureaux, 2014) – prevent people from using resources they had been employing before. Sometimes the land use is allowed, but conditioned to market share or productivity increase (Merlín-Uribe Yair et al., 2012). Generalisation of standardised agro-environmental measures causes conflicts, since measures might work in one place, but may not work in another (van Zanten et al., 2016).

Figure 10. Causes of CES-related environmental conflicts in agroecosystems

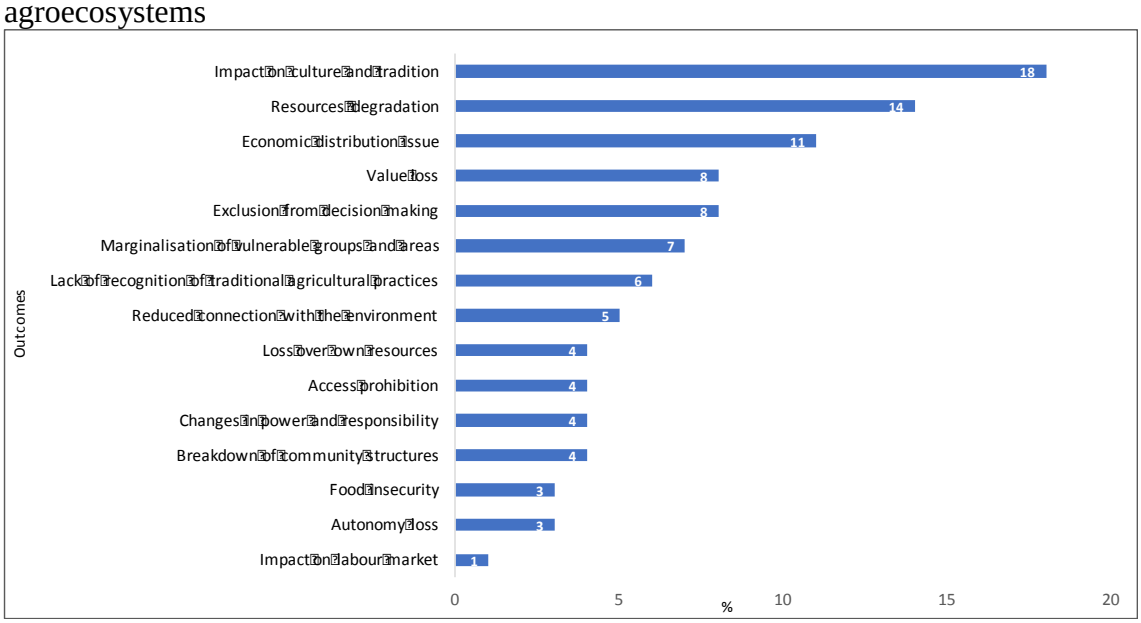


Because of the land use changes induced by these causes several types of **outcomes** are reported in the literature (Figure 11). The three most frequently addressed are impact on culture and nature-related traditions, resources degradation of previously existing forms of natural resources use (land, water, forests), and economic distribution issue, such as poverty or gentrification of rural areas. Follows value loss, either economic for rural sector, or environmental and social for rural communities. Different forms of exclusion are related to either vulnerable groups from decision making, environmental management, policy making or participation in scientific research. This is followed by marginalisation of rural communities.

In general, these outcomes point towards the lack of appreciation for farmers' work and recognition of the cultural value of farming. The literature also reports prejudices against artisanal and small-scale economies (e.g. Barthel et al., 2013), hand in hand with economic transformation of rural environments. The latter one includes agricultural development projects, agri-business and commodity crops, that concur with environmental pressures.

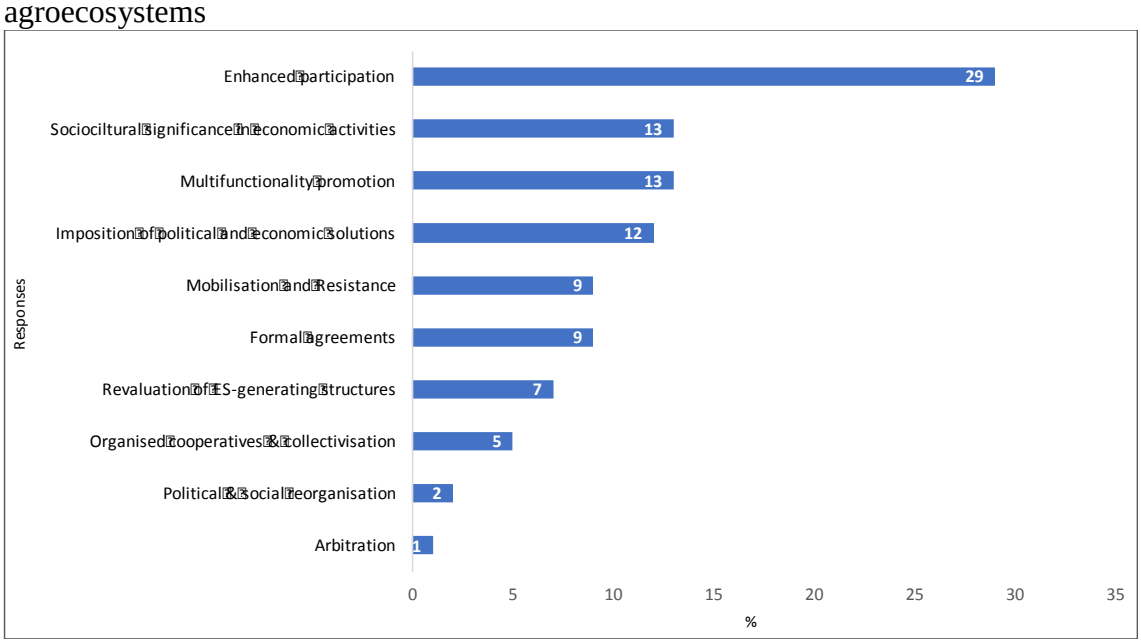
Access prohibition to traditional lands appears less frequently in the literature. For example, Brimont and Desbureaux, (2014) in their study in Madagascar found how protected areas initiatives exclude local communities in using traditional territories, and

549 how fee payments were implemented to access these lands. It is however, the direct
550 result of the abovementioned land enclosure and ensuing privatisation (Heynen and
551 Robbins, 2005). Even less attention has been given to changes in power and
552 responsibilities and breakdown of community structures. Smaller amount of papers
553 reviewed addressed issues regarding autonomy loss, related to control of areas for
554 example, and the impact on the labour market.
555
556 Figure 11. Outcomes of CES-related environmental conflicts due to land use changes in
557 agroecosystems



558
559
560 When these types of negative outcomes appear, people do not remain passive and the
561 literature reports this as well (Figure 12). The **responses** in the conflicts not only mean
562 mobilisation and resistance, although this is indeed one of the reactions. Enhanced
563 participation, in fact, is the most common situation mainly through recognition of
564 traditional ecological knowledge. When there is resistance, in some cases tradition itself
565 is mobilised through the defence of traditional cultivation, cultural and symbolic
566 practices, or collective resource ownership. Agreements between the resisting actors
567 and public authorities and private sector also occur, especially when revaluation of ES-
568 generating structure is recognised (e.g. Aspe et al., 2016) . However, sometimes a
569 political or economic 'solution' is simply imposed.
570

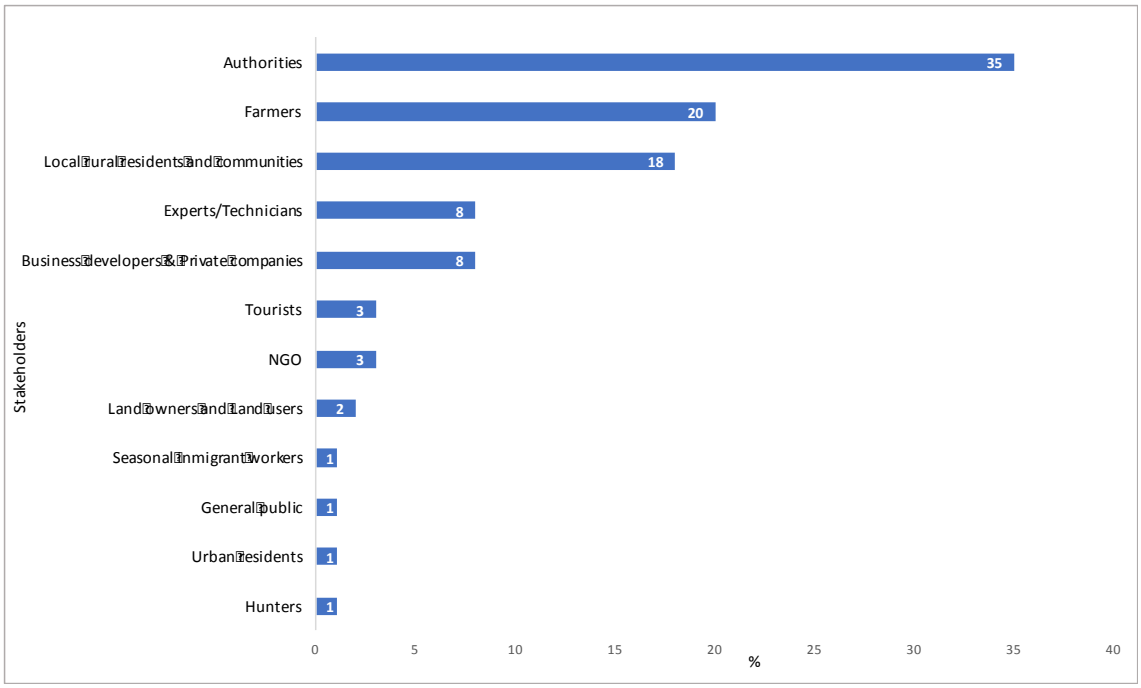
Figure 12. Responses in CES-related environmental conflicts due to land use changes in agroecosystems



6.5 Stakeholders

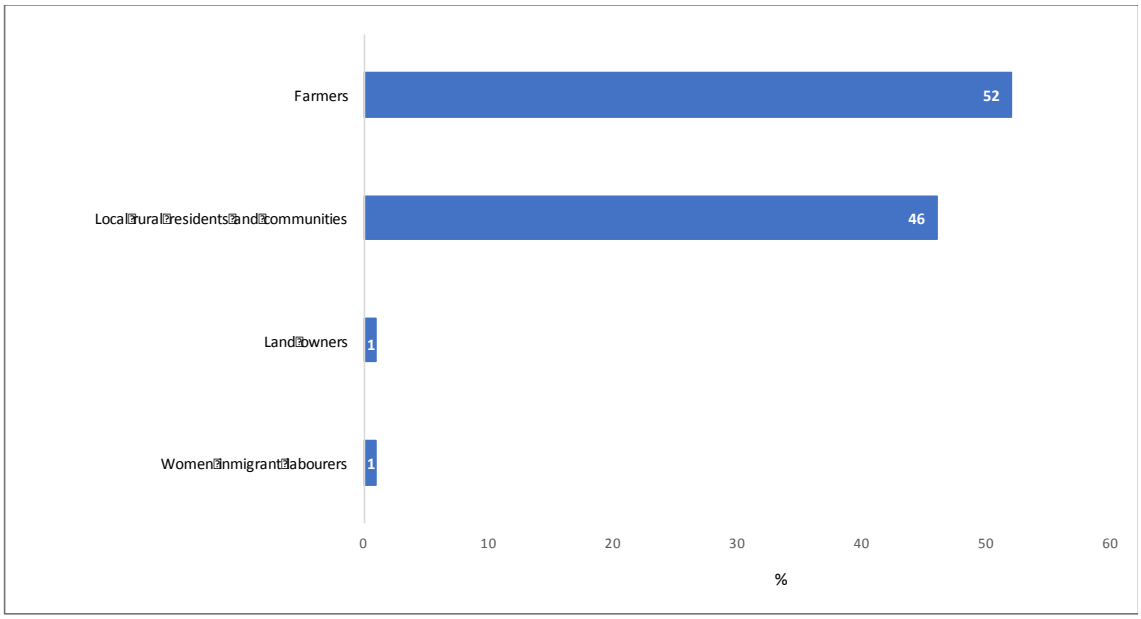
Looking at the relative frequency of stakeholders (Figure 13), the results indicate that different groups are involved in agro-ecosystem management and use, with authorities and farmers being the most common. The most impacted groups impacted by the LUMC in agro-ecosystems seem to be the least powerful and with limited presence in environmental resources management decisions, such as farmers, rural residents, and women in-migrant labourers (Figure 14). Authorities, experts and private companies, presumably more powerful, were not identified as being affected by LUMC at any point.

593 Figure 13. Stakeholder groups in CES-related environmental conflicts in
594 agroecosystems



595

596 Figure 14. Impacted stakeholders groups in CES-related environmental conflicts in
597 agroecosystems



598

599

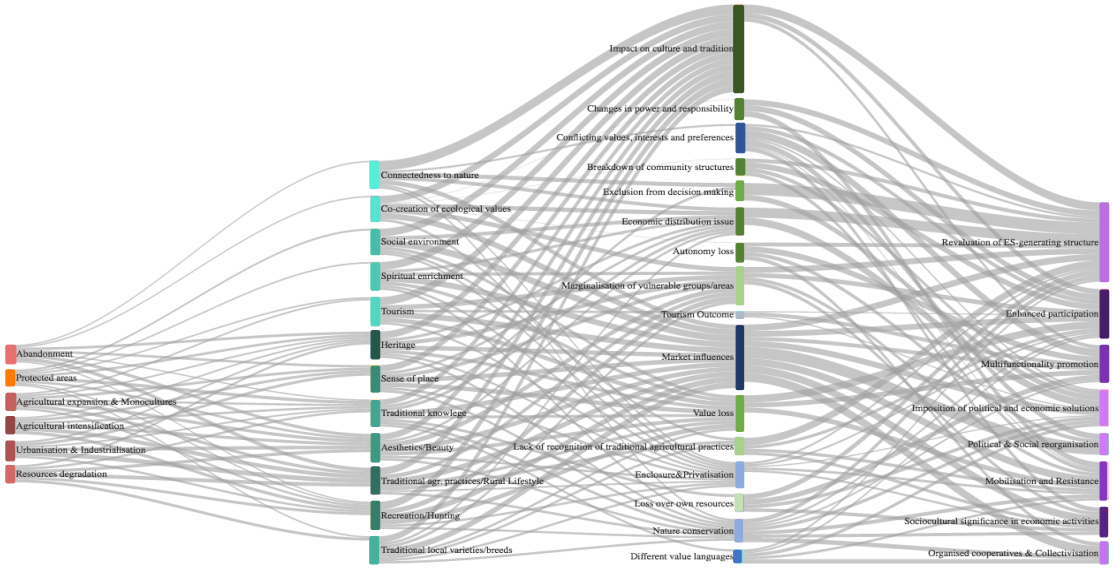
600 *6.6 Interrelation Between LUMC, CES and Environmental Conflicts*

601

602 Figure 15 shows the complex interrelation between LUMC, CES, causes and outcomes
603 of, and responses to environmental conflicts. The first left column of codes in the figure

represents LUMC marked in the salmon colour shades. The second column of codes represents CES categories provided by agroecosystems in turquoise shades. The third column represents the conflict causes -marked in the blue shades and conflict outcomes -marked in the green shades. In the fourth column conflict responses are presented in the violet shades. This figure only includes those variables and interactions that were mentioned most frequently and consistently within the literature - the first fifty percent of the most frequently coded relationship in each category. The thicker the connecting line, the stronger the relation between variables. The darker the node colour, the higher the frequency of appearance of the variable within the literature. The longer the vertical node, the higher the overall number of connections. Details on these relationships are presented in Figures 16A, 16B, 16C and 16D.

Figure 15. Interrelation between LUMC in agroecosystems, CES, and environmental conflicts



Land abandonment is the driver of agro-ecosystem change with the major impact on CES, followed by agricultural expansion and monocultures. Intensive agriculture and urbanisation were equally addressed in the reviewed literature, and with a lower impact on CES. The most common impact of each of these LUMC was on traditional agricultural practices, rural lifestyle, aesthetics and, to a lesser extent, on heritage and traditional knowledge. It is notable, how the impact of LUMC on tangible CES seems to be more frequently reported than on the intangible CES, such as in the case of spiritual enrichment, sense of place, and connectedness to nature (Figure 16A).

In Figure 16B, market influences are the most frequent and the most significant conflict cause, in each one of the CES impacted by LUMC. Enclosure and privatisation, as well as nature conservation initiatives, are related to all impacted CES, except traditional knowledge. Notwithstanding, impacts on traditional knowledge seem to be caused by different value languages. Meanwhile connectedness is rather originated from conflicting values, interests and preferences among different stakeholders. Nevertheless, we found tourism and protected areas to be both a LUMC and a conflict cause.

Figure 16C, on outcome or consequences of environmental conflicts related to LUMC, unveils the impacts on culture and nature-related traditions as the most commonly affected. This is followed by agroecosystems' value loss (i.e. economic, environmental and social) except in case of traditional local varieties and breed, connectedness to nature, and co-creation of ecological values. Instead, the more significant conflict outcome in this case were marginalisation of vulnerable groups, their poverty, and breakdown of community structures. Further, traditional knowledge and connectedness to nature occurs along with exclusion from agro-environment decision making and loss of access to natural resources. Social environment that people build around agroecosystems relate to lack of recognition of traditional practices.

Responses are the final component of environmental conflicts. Frequent responses were mainly efforts to revaluate ES-generating structures, i.e. the recognition of the importance people have in shaping thriving ecosystems. This response relates to exclusion from decision making, poverty, and especially to threats on culture and tradition. Communities' enhanced participation in agricultural management and decision making was the second biggest response. This was related to breakdown of community structures, marginalisation. A commonly reported response was also the increasing awareness and promotion of the multifunctional character agroecosystems, i.e. nutrient and water cycling, climate regulation, food provisioning, and remarkable cultural values. It often appears when conflicting interests, values and preferences concur. Mobilisation and resistance, common events in environmental conflicts in general, appear relatively less frequently than other responses in our data. They seem to emerge from market influences, marginalisation of vulnerable groups and rural areas, as well as enclosure and privatisation of natural resources (Figure 16D).

Figure 16A, 16B, 16C, 16D. Detailed illustration of interactions between LUMC in agroecosystems, CES, and environmental conflicts

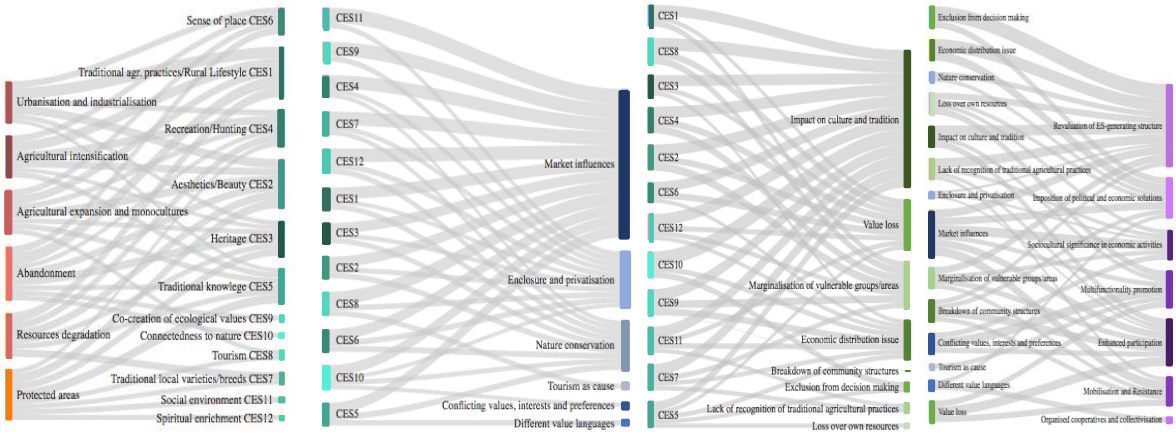


Fig. 16A Fig. 16B Fig. 16C Fig. 16D

7. Discussion

This review confirmed the important role agroecosystems play in providing rich and varied CES to societies, as argued in the work of Calvet-Mir et al., 2012; Lovell et al., 2010; Nieto-Romero et al., 2014. Our approach endorses and expands the recognition of CES categories and highlights their subcategories, based on the data at the global level.

Our results also emphasize the interrelation of CES, and their tight connection with land management, a point already reported by Tilliger et al., (2015) and Van Berkel and Verburg, (2014). Agroecosystems thus, provide CES with different characteristics that are interdependent. In combination, they form tangible and intangible heritage in agricultural settings. That is especially visible in CES categories like biocultural diversity, co-creation of ecological values, traditional knowledge, and connectedness to nature. Our results additionally show that culturally and environmentally, traditional agricultural landscapes not only include croplands, vineyards, or flower-rich landscapes, but also traditional irrigation canals, water wells, and stone walls that surround them. Therefore, elaborating on Fischer and Eastwood, (2016), we argue that human activity and their cultural practices, are needed to sustain agroecosystems and the ecological processes therein.

In general, conflicts are very well studied in agriculture (e.g. Kumar Paul and Røskaft, 2013; Rótolo et al., 2014; Seghezzo et al., 2011), but how they relate to CES remained a gap within the literature. Plieninger et al., (2015) highlighted how CES play an important role in peoples' everyday lives, in maintaining further healthy agricultural management, and are appreciated by local communities. A key finding of this study is that when those relationships are broken or even lost, environmental conflicts emerge. Conflict is a process occurring through various stages, rather than only as the last stage manifestation of a discontent.

Our analysis elaborates the notion of environmental conflicts in agroecosystems, by identifying the link between LUMC types and specific CES categories. Throughout our review, and according to a study of Ruoso et al., (2015), we show that consequences or outcomes LUMC have on CES in agriculture lead to significant impacts on culture and tradition in general, mainly at the expense of local rural communities and farmers.

Since CES connect to one another, LUMC indirectly can have multiple and chained impacts on various CES. For instance, through agricultural intensification, landscape aesthetics changes, but also do change recreational activities and opportunities. Spiritual enrichment, closely tight to both aesthetics and recreation, is in turn influenced by agricultural intensification as well.

In fact, our analysis showed the crucial role agricultural intensification, expansion, monocultures, and urbanisation play in impact on CES related to agriculture. However, by analysing in depth the interaction between LULMC and impacts on CES we observe that the relatively less researched issues of 'land abandonment' and 'protected areas incentives' have comparable if not higher impact on CES. Land abandonment has a significant impact on co-creation of ecological values – which is also less studied– and may result in the breakdown of community of structures.

By stressing the relevance of service generating structures, such as stonewalls, terraces, secular trees, or other material heritage elements, our data challenges the 'intangibility' of these CES class. In order to be functional, these structures need to be properly

718 nurtured. We even found that the most tangible CES, e.g. knowledge on traditional crop
719 varieties, still dominate the cultural agroecosystem research. Admittedly, less tangible
720 aspects, such as spiritual enrichment, connectedness to nature, and social interactions,
721 remain untapped, as corroborated in the work of Bostrom et al., (2012), Nahuelhual et
722 al., (2014), and Tengberg et al., (2012). Not only they deserve further attention, but we
723 also found that most conflict rising from the impact of LUMC in agroecosystems is on
724 these intangible elements. Hence, it is important to approach studies on LUMC and
725 CES as whole, considering both tangible and intangible elements in their interaction.
726
727 A main point of this paper has been to develop and populate a framework that
728 emphasizes the dynamic nature of environmental conflict by distinguishing the stages of
729 causes, outcomes/consequences and responses. It endorses an idea of latent problems in
730 agriculture as actual conflicts (Jose and Padmanabhan, 2016), and understands the
731 conflict as a process rather than a mobilisation event. The conflicts analysed in the
732 review are mainly driven by increased market influences, enclosure and privatisation of
733 natural resources. An example of the latter are narrow conservation incentives, which
734 may exclude local community participation, and involve conflicting value languages
735 between scientists, managers and local people, as Mastrangelo et al., (2015) and
736 Martinez-Alier (2014) argue.
737
738 Existing power asymmetries among different stakeholders in agricultural management
739 and decision making increase tensions or lead to latent conflicts (Jorda-Capdevila and
740 Rodríguez-Labajos, 2014; Jose and Padmanabhan, 2016; Mastrangelo et al., 2015; M.
741 Reed et al., 2009). According to this, when LUMC modify CES, they tend to affect
742 most vulnerable people living on and from agricultural lands, like farmers and local
743 communities. Conflicts around CES, either manifest or latent, should be part of an open
744 discussion on issues of recognition, and eventually on a link of CES analysis with
745 environmental justice (Schlosberg, 2013).
746
747 In this discussion, LUMC threatening agricultural heritage have particular relevance.
748 Our study underlines heritage as a key connector of different and interrelated CES.
749 Together, they ensure people's involvement with their natural and cultural

environments, and the articulation of responses in face of unwanted developments. Responses to those conflicts are not restricted to mobilisation and resistance. In fact, revaluation of ES-generating structure, communities' enhanced participation are the most common responses to these conflicts, or as well as active promotion of multi-functionality (e.g. Allan et al., 2015; Biasi et al., 2015; Fibrank et al., 2013).

8. Conclusion

This study undertook a comprehensive literature review to analyse how conflicts due to LUMC are related to CES at the global level. We have firstly identified and analysed different categories of CES, developing and articulating its taxonomy. This has been the base for an analysis of the interrelation between LUMC, CES and environmental conflicts, the main aim of this paper.

Agroecosystems provide multiple CES that are closely interrelated with one another. Therefore, LUMC can directly or indirectly impact CES in agriculture. Changing markets influences, enclosure and privatisation of natural resources, and conservation incentives, that still exclude community participation, appear as drivers of CES change. LUMC have a significant impact on culture and tradition in general, mainly at the expense of the most vulnerable living on and from agricultural lands, such as farmers and local communities.

As a consequence of these complex economic, social and environmental processes, environmental conflicts arise. Our review classified these conflicts, according to the types of causes, consequences and responses around them. Responses to conflicts occur with mobilisation and resistance being one among many reactions. In fact, revaluation of ES-generating structure, as well as communities' enhanced participation, are the most common responses reported in the literature.

The literature on CES explicitly addressing conflicts is still quite narrow, and offers ample possibilities for further research, both in geographic scope and thematically. This is certainly a limitation of the paper, as it has been restricted to knowledge already

available in the scientific literature. In this respect, this review does not cover the whole spectrum of possible environmental conflicts related to CES in agroecosystems.

Still, we believe that insights here offered entail a contribution of ES research and a base for further investigations and findings on the practical level. First, it offers a global perspective on a topic that so far has been addressed mostly through case-studies. By providing a comprehensive map of what the literature achieved in relation to the effects of LUMC in agriculture on CES and related conflicts, we also understand what it has failed to address so far- the complex relationship between LUMC, CES and different stages of environmental conflicts.

In that way, we highlight the relevance of including conflicts into further ES research, and the need for better understanding existing power asymmetries among stakeholders. Such asymmetries generate conflict and stoke latent conflicts regarding CES and this issue should be further recognised in agricultural planning and management.

This is further important for understanding the complex social, ecological, and economic processes in agroecosystems behind LUMC as drivers, with direct or indirect impact on CES, and environmental conflicts that might escalate between different stakeholders as consequences of these changes and inequities.

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