Open access • Journal Article • DOI:10.1007/S13593-013-0183-4

European agricultural landscapes, common agricultural policy and ecosystem services: a review — Source link

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Published on: 01 Apr 2014 - Agronomy for Sustainable Development (Springer Paris)

Topics: Ecosystem services, Ecosystem valuation, Common Agricultural Policy, Landscape assessment and Landscape planning

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Agron. Sustain. Dev. (2014) 34:309–325
DOI 10.1007/s13593-013-0183-4

REVIEW ARTICLE

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Accepted: 18 September 2013 / Published online: 25 October 2013

Abstract Since the 1950s, intensification and scale enlargement of agriculture have changed agricultural landscapes across Europe. The intensification and scale enlargement of farming was initially driven by the large-scale application of synthetic fertilizers, mechanization and subsidies of the European Common Agricultural Policy (CAP). Then, after the 1990s, a further intensification and scale enlargement, and land abandonment in less favored areas was caused by globalization of commodity markets and CAP reforms. The landscape changes during the past six decades have changed the flows and values of ecosystem services. Here, we have reviewed the literature on agricultural policies and management, landscape structure and composition, and the contribution of ecosystem services to regional competitiveness. The objective was to define an analytical framework to determine and assess ecosystem services at the landscape scale. In contrast to natural ecosystems, ecosystem service flows and values in agricultural landscapes are often a result of interactions between agricultural management and ecological structures. We describe how land management by farmers and other land managers relates to landscape structure and composition. We also examine the influence of commodity markets and policies on the behavior of land managers. Additionally, we studied the influence of consumer demand on flows and values of the ecosystem services that originate from the agricultural landscape.

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Keywords Ecosystem services · Landscape services · Agricultural landscapes · Landscape management tradeoffs · Landscape planning · Assessment · Valuation

Contents

1 Introduction

Through the last six decades, agricultural landscapes in Europe changed dramatically (Stoate 2001; Jongman 2002; Klijn 2004; Tscharntke et al. 2005). After World War II, the large-scale application of synthetic fertilizers and mechanization allowed the intensive cultivation of poor and unstable soils and in several European countries land consolidation policies were adopted to further increase production, with large consequences for landscape structure and composition (Klijn 2004). During the same period, production support by the European Common Agricultural Policy (CAP) aimed at self-sufficiency of agricultural production became the major incentive for intensification of agriculture. In the UK, for instance, results of agricultural intensification were a sharp increase in crop yields (by threefold in the case of wheat production). At the same time, it was estimated that 97 % of the enclosed grasslands were lost between 1930 and 1984 as a results of land consolidation or through conversion to arable land (UK National Ecosystem Assessment 2011). Since the 1990s, the CAP is transforming from a production support subsidy system towards an income support subsidy system (Lowe et al. 2002). The changes in the CAP, in combination with an increased globalization of agricultural commodity markets, have stimulated farmers to increase production efficiency in order to be competitive on the world market. The need for increased cost-efficiency of agriculture has again led to changes in agricultural management, directly or indirectly altering the characteristics of European landscapes (Lefebvre et al. 2012). Consequences of this increase in production efficiency are further intensification of agricultural management, scale enlargement of farms and fields and the abandonment of marginal agricultural areas. All three processes lead, under most circumstances, to a homogenization of landscape, either by creating larger scale agricultural areas with sparse landscape elements, or by the re-growth of more continuous forest areas in more marginal, mosaic-type, landscapes (Jongman 2002; Klijn 2004). However, large spatial diversity in these processes occurs throughout Europe (Verburg et al. 2009) as there are large spatial differences in the environmental and social–cultural context, land use history and institutional setting. In a number of former socialist countries, post-socialist land transformation led to fragmentation of large-scale farming, while in Western Europe farm and parcel sizes are continuously increasing. At the same time, decreasing profitability of farming resulted in both Western and Eastern Europe in abandonment of farmland (e.g., Kuemmerle et al. 2008; Verburg et al. 2009; Renwick et al. 2013).

Society benefits from agricultural landscapes in many ways (Tscharntke et al. 2005; Zhang et al. 2007). These benefits are referred to as ecosystem services or landscape services. Willemen et al. (2008) and Termorshuizen et al. (2009) advocate the use of the concept of landscape services instead of ecosystem services in socio-ecological systems, such as agricultural landscapes. They argue that ecosystem services are often narrowly defined and restricted to natural ecosystems. In addition, in agricultural landscapes it is often the landscape pattern and the spatial structure of ecosystem patches that is important for the provisioning of services (Termorshuizen et al. 2009). However, in recent years, the scope of the ecosystem services concept has broadened; several studies also refer to ecosystem services in agricultural landscapes and relate these services to landscape structure and composition (e.g., van Berkel and Verburg 2013; van Oudenhoven et al. 2012). In this study—where we have reviewed papers that address ecosystems services as well as those that address landscape services—we use the term ecosystem services to refer to the goods and services supplied by agricultural landscapes.

The primary goal of the agricultural sector is to produce provisioning services: agricultural products and raw materials. However, it is widely recognized that agricultural landscapes also deliver cultural and recreational, regulating, habitat, and supporting services (Gobster et al. 2007; Power 2010; de Groot et al. 2010). Some services are an unintended effect of farming activities, i.e., agricultural management is mostly not aimed at sustaining the production of non-provisioning services. Many of these unintended services support the commodity provisioning service, e.g., through regulating the nutrient cycle or providing a habitat for pollinators essential for achieving high agricultural production levels. Cultural services do not sustain agricultural production, but deliver benefits derived from the aesthetic function of landscapes, including tourism, sense of place, spiritual experiences and recreation, offering possibilities for additional regional income through, e.g., the recreation and tourism sector (Millennium Ecosystem Assessment 2005; TEEB 2010a). All components that are part of the agricultural landscape, as well as the spatial structure of the landscape, are important determinants of the portfolio of services provided by these landscapes.

Although, there is an increasing recognition of the importance of the wider variety of ecosystem services, especially in peri-urban areas (Zasada 2011), in landscapes with intensively managed agriculture, focused on the optimization of commodity provisioning services, often a loss of non-provisioning services is observed. Agricultural policy and regional development incentives have, therefore, shifted towards supporting agricultural management aimed at the maintenance of a broader range of ecosystem services (Prager et al. 2012; Rey Benayas and Bullock 2012). To support the effective design of policies and planning that affect agricultural landscapes and agricultural management practices, knowledge on the values of the services provided by agricultural landscapes is required. While the attention for ecosystem services has increased strongly over the past years, most focus is on (semi-) natural ecosystems (e.g., Costanza et al. 1997; de Groot 2002), whereas agricultural landscapes are often neglected. A broad knowledge base on ecosystem service valorization and the role of the current policies in the provisioning of these services is required to support effective policy design in the direction of improved landscape management. Such knowledge should particularly provide insights into the ability of the landscape to contribute to the production of added value for society and the possible tradeoffs and indirect effects of such landscape management.

The objective of this paper is to present an analytical framework that addresses the value of ecosystem services in agricultural landscapes and to provide a structured review of the scientific literature and assessment of methods to implement this framework. The framework was designed based on a review of existing frameworks for ecosystem service assessment and socio-ecological systems analysis (e.g., Millennium Ecosystem Assessment 2005; TEEB 2010b; Daily et al. 2009; Ostrom 2009; Liu et al. 2007), while accounting for the specific conditions in agricultural landscapes, including the role of agricultural and landscape policies (the CAP in the European Union context). The available knowledge and methodologies for applying the framework were reviewed and organized in three thematic areas. First, the knowledge base on the potential supply and flow of ecosystem services was studied by focusing on the relation between agricultural management, landscape structure and composition, and ecosystem/landscape functions. Second, the relation between the benefits from the ecosystem services, their (economic) values and regional competitiveness was analyzed. The third area concerns the relations between actors and policies that aim at either valorization of ecosystem services or alter the supply and demand for ecosystem services.

Throughout the paper, a case study area—Winterswijk national landscape in the Netherlands (Fig. 1)—will serve as an example to illustrate the application of the concepts and connections in the framework. Winterswijk national landscape, located in the eastern part of the Netherlands, is a region dominated by agricultural activities: around 60 % of the land is used for dairy farming practices. Large parts of the landscape have been preserved from land consolidation practices, and can be characterized as a small-scale bocage landscape with relatively small plots enclosed by hedgerows.

2 Analytical framework

Figure 2 presents the analytical framework for assessment of ecosystem services in agricultural landscapes. The structure and graphic design of the framework is based on the commonly used and widely accepted framework for the analysis of ecosystem services adopted by The Economics of Ecosystems and Biodiversity (TEEB 2010b) and designed by Haines-Young and Potschin (2010). We have modified the framework to include elements that are specific to the analysis of valorization of the landscape within agricultural areas, including a clear distinction between the demand and supply of services as determinants of their value and a specification of the different actors and pathways of mechanisms that affect the contribution of agricultural landscapes to the regional economy and human well-being.

The alterations to the initial TEEB ecosystem services cascade (Haines-Young and Potschin 2010) are based on a literature review and were discussed and validated in a number of stakeholder workshops. First, the draft framework was discussed in a plenary stakeholder laboratory, which was composed of 25 members that represented EU-wide—mostly public—institutions that address the agricultural sector, the CAP, and the interface between CAP and landscapes. Second, the draft framework was discussed in local stakeholder laboratories in nine case study areas of the research project CLAIM (http://claimproject.eu/case_studies.aspx). The local stakeholder sessions were composed of members that represent local institutions involved in land management, valorization of ecosystem services and rural development.

In the landscape box of the analytical framework, agricultural landscapes are characterized by their spatial structure and composition. Landscape structure includes the diversity and complexity of the spatial (and temporal) structure of the landscape; whereas landscape composition refers to the relative prevalence of land use/land cover types (e.g., crop types) and landscape elements (e.g., solitary trees). Both are important determinants of landscape functions: the abundance and spatial organization of fields, tree lines, hedgerows, and agroforestry determine the aesthetic values of the landscape and its regulating functions, including carbon sequestration, regulating the hydrology and providing a habitat for pollinators (Jose 2009; Burel 1995; van Oudenhoven et al. 2012; Tscharntke et al. 2005).

The functions of the landscape describe the capacity of the landscape to provide ecosystem services. The aesthetic function of, for instance, hedgerows and tree lines potentially delivers cultural and recreational services (de Groot 2006, 2010). The flow (or supply) of services—that connects the landscape box to the benefits and regional competitiveness box—and the demand for ecosystem services by society determine the benefits and value of these services. Although some services are provided even in absence of a demand for

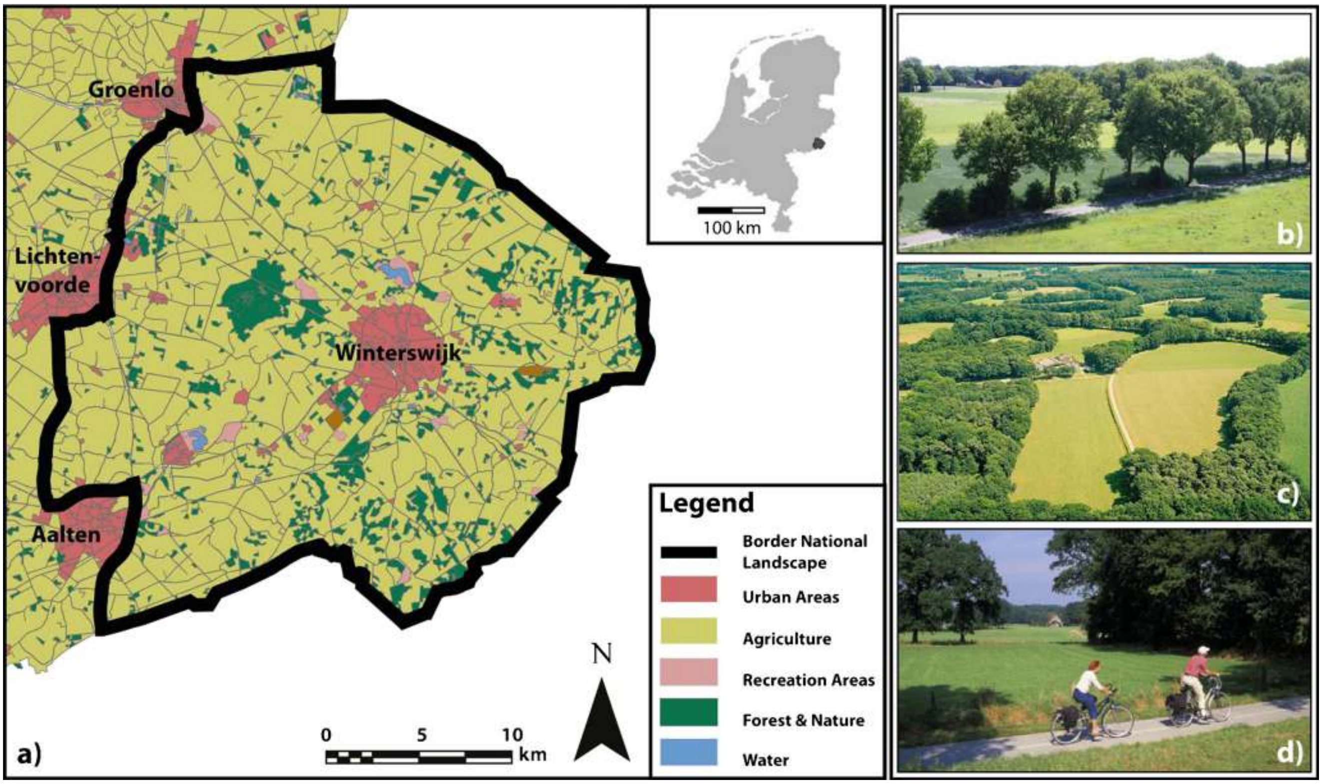

Fig. 1 This figure shows a land use map of Winterswijk national landscape (**a**) and three typical pictures of the national landscape (**b**, **c**, and **d**). Picture **b** (landscape view) and **c** (bird's eye perspective) show a typical landscape with relatively small plots enclosed by hedgerows and tree lines. Picture **d** shows recreational cyclists in the landscape; cycling is the main recreational activity in the area

these services (e.g., regulation of water run-off will happen irrespective of the demand for such regulation), it is only when there is a demand for those services that they obtain a value from society. The value of benefits delivered by ecosystem services in agricultural landscapes (i.e., landscape values) can be assessed by means of a monetary or social valuation (TEEB 2010b). Most monetary valuation studies have focused on the value of natural ecosystems (e.g., Costanza et al. 1997), but a number of studies have also attempted to provide an economic value to services provided by agricultural landscapes (e.g., Willemen et al. 2010; García-Llorente et al. 2012). In addition, a number of studies that address cultural values assigned to landscapes have been elaborated through social valuation techniques indicating the (relative) preferences of stakeholders for landscapes (Daniel et al. 2012).

Moving further in the analytical framework, the value of ecosystem services is related to the contribution of these values to the regional economy and how ecosystem services may enhance the social welfare and competitiveness of the region. In this study, regional competitiveness is understood as an indicator that combines regional economic performance and regional social welfare. When ecosystem services are valorized and externalities are fully internalized by regional economic and institutional actors, the market and regional policy will ensure optimal land management. The resulting landscape will be tailored towards provision of the range of services demanded by society. In reality these conditions are rarely met. Many ecosystem services are not integrated in markets, only have long-term or off-site benefits and local providers of agricultural management are often not the beneficiaries the services (Syrbe and Walz 2012). In addition, cultural resistance towards alternative ways of agricultural management and risk perception often inhibit the adoption of the necessary measures (Burton et al. 2008). When ecosystem services are not integrated and/or the beneficiaries of the services are not located in the region or resistant to modification of agricultural management, additional policies may be required to assist in the valorization of the ecosystem services provided. Moreover, different agricultural management strategies may provide similar sets of services, by either integrating the different functions in the same landscape units or segregating them by concentrating provisioning services in specific parts of the landscape.

In the analytical framework, the relations between landscape structure and composition towards the contributions of landscape to regional competitiveness are shown as a cascade: not all parts of the landscape equally contribute to landscape function. Not all landscape functions produce ecosystem services and ecosystem services only obtain a value when demanded by society. Such values only contribute to regional

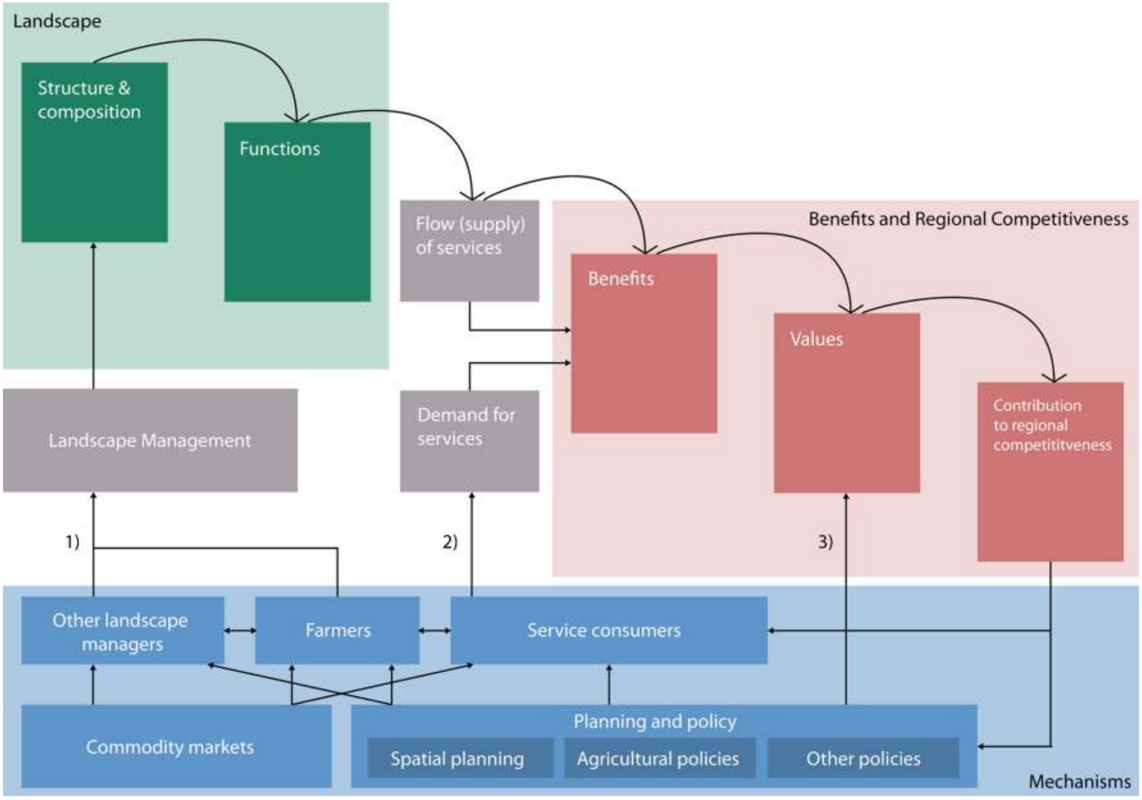

Fig. 2 Analytical framework addressing the relationship between agricultural landscape structure and composition, the supply and demand of ecosystem services and the contribution of these services to regional competitiveness. The cascade in the framework is based on Haines-Young and Potschin (2010) and TEEB (2010a). The mechanisms box describes the actors and policies that impact on agricultural landscapes and the ecosystem services they provide. Farmers and other land managers affect landscape structure and composition through landscape management (*1*); consumers of different ecosystem services generate a demand for services and, therefore, create benefits (*2*) and ecosystem service benefits are influenced by policy and planning through, e.g., payments for ecosystem services (*3*)

competitiveness when the values are integrated into the regional economy. Understanding the transfers between the different components of this cascade is essential to identify where policy instruments can help to enhance the contributions of agricultural landscape to the regional competitiveness.

Different policy instruments and spatial planning measures (Fig. 2) impact agricultural landscapes. Directly and indirectly these policies affect supply, demand and market value of ecosystem services. Such policies are designed and implemented at different levels, from local permits and spatial planning to European agricultural policies. These policy instruments influence the ecosystem services cascade in three different ways (Fig. 2).

1. Farmers and other landscape managers are influenced in their agricultural and landscape management through a.o. agri-environmental regulations, such as European directives or other natural resource management standards (arrow 1 in Fig. 2). Compliance to landscape management regulations by landscape managers has an effect on landscape structure and composition. Subsequently, landscape structure and composition determine its functions and the supply of ecosystem services.
2. Policies promoting the demand for ecosystem services, such as those promoting rural tourism or certification of regional products, alter the demand of landscape consumers for provisioning and cultural service flows. Therefore, these policies are likely to increase the value of regional ecosystem services (arrow 2 in Fig. 2). Increased values can positively affect regional competitiveness. In turn, the increased demand and value may affect the ways in which the landscape is managed to balance demand and supply for such services.
3. A third mechanism that influences the ecosystem services cascade, are payments for ecosystem services (arrow 3 in Fig. 2). Payments include traditional production support, i.e., subsidies per quantity agricultural commodity produced, or payments for cultural, regulating or habitat ecosystem services that generate extra-regional benefits. Regional payments for ecosystem services increase regional competitiveness and, therefore, change landscape management tradeoffs for landscape managers. Through landscape structure and composition, landscape functions and landscape service flow, landscape benefits and values are affected by payments for ecosystem services.

3 Implementation of the analytical framework

This section describes the three thematic areas of the analytical framework that were introduced in the previous section in more detail based on a literature review. In addition, the scientific methods available to reveal, quantify and value the different relations in the analytical framework are described and illustrated for the Winterswijk case study area.

3.1 From landscape structure and composition to functions and service flows

3.1.1 Literature review

The structure and composition of agricultural landscapes is determined by the interplay between landscape management and the biophysical characteristics of the environment. Often, a landscape is the result of a co-production of human and natural processes, where humans adapt their management to the spatial and temporal variation in the environment and the environment is modified by human intervention. Here, research supports policy and practice by improved understanding of the ways in which management practices affect landscape structure and composition, and, subsequently, how the landscape structure and composition affect the functioning of the landscape.

Several studies have described the influence of landscape change in agricultural landscapes on its functions. For agricultural scale enlargement and intensification (e.g., Tscharntke et al. 2005; Jongman 2002; Wade et al. 2008; Bauer et al. 2009) as well as for land abandonment (e.g., Agnoletti 2007; Reger et al. 2009) studies have investigated the impacts of such landscape changes on farmland biodiversity. Although the link between biodiversity and ecosystem services is highly debated (Mace et al. 2012), biodiversity in agricultural landscapes can contribute to several functions. These include supporting the agricultural system (pollination, genetic biodiversity), cultural functions and habitat functions (habitat for wildlife) (Zhang et al. 2007; Moonen and Barberi 2008).

In the context of cultural services related to visual landscape characteristics, many studies report on the relation between the composition, spatial structure and management aspects of landscapes and their aesthetic values. These case studies often have not been conducted from an ecosystem services perspective (e.g., Hanley et al. 1998; Moran et al. 2007; Rambonilaza and Dachary-Bernard 2007; Huber et al. 2011; Hasund et al. 2011; Sayadi et al. 2009; Campbell 2007; Fry and Sarlöv-Herlin 1997; Junge et al. 2011). Some of these studies were conducted before the popularity of the ecosystem services concept, while others originate from another disciplinary focus (psychological focus, i.e., Strumse 1994; van den Berg and Koole 2006; Hunziker et al. 2007).

For regulating and habitat functions, much less studies were found that relate these functions to the structure and composition of landscapes. The relation between ecosystem services flow and landscape characteristics is often established at the level of case studies based on measurement or observation. However, for a number of regulating ecosystem functions generalization of these relations and extrapolation to other areas is possible based on simulation models that describe the underlying processes, an example being the calculation of carbon sequestration or soil protection (Dendoncker et al. 2004; Freibauer et al. 2004; Leip et al. 2008).

Agricultural management practices cause a recurrent disturbance in landscapes. Therefore, the impacts of agricultural management that are negatively affecting functions are sometimes referred to as dis-services. Dis-services are here regarded as processes that inhibit the provisioning of goods and services in the landscape (Zhang et al. 2007; TEEB 2010b). Where pollination, for example, supports the provisioning function of agriculture, the use of agricultural chemicals can provide a dis-service on the insect population responsible for pollination.

Table 1 provides a classification of important characteristics of landscape structure and composition that determine its function based on a range of studies. The services provided by landscape functioning are here classified according to MEA (2005).

3.1.2 Methods to estimate functions and service flows

Ecological or landscape indicators estimate the relation between functions and land use/land cover-based metrics. These indicators are frequently used to enable the spatial extrapolation of the potential supply of ecosystem services in a landscape (Kienast et al. 2009). Burkhard et al. (2010) designed a matrix for the assessment of the functions of different land cover types. In this approach, the functions of a specific land cover type (originating from European land cover data) are established by expert judgment and case study analysis (Burkhard et al. 2010). However, this approach does not distinguish the structure, composition and management of agricultural landscapes that largely affects the functions of these landscapes. Other studies have developed an indicator based on the spatial structure of land cover types (e.g., van Berkel and Verburg 2013). Whereas some regulating functions, such as carbon sequestration or the provisioning of agricultural goods (Schulp et al. 2008), can be elaborated using a land cover composition-based metric, the assessment of cultural and pollination services requires the analysis of landscape structure-based metrics (Willemen et al. 2008; Schulp and Alkemade 2011; Schulp et al. 2014). For these services, it is important to account for landscape structure as, for instance, the aesthetic function is determined by landscape structure characteristics such as landscape patchiness or

Table 1 This table shows relations between landscape structure and composition and the supply of ecosystem services. The column on the left side of the table describes the landscape characteristic, the middle column describes the type of ecosystem service that is related to this particular landscape characteristic, and the right column contains references to studies that have investigated these relations

Landscape structure and composition characteristic	Ecosystem service	References
Crop/livestock type	Provisioning, regulating, cultural	(Cooper and Baldock 2009; Zhang et al. 2007; Power 2010)
Field margins	Regulating, cultural, habitat and supporting	(Marshall and Moonen 2002; Huber et al. 2011; Hynes and Campbell 2011; Grammatikopoulou et al. 2012; Junge et al. 2009; Soini et al. 2012)
Green linear elements	Regulating, cultural, habitat and supporting	(Burel 1995; Le Cœur et al. 2002; Johns 2008; Laterra et al. 2011; van Berkel and Verburg 2013)
Grey linear elements	Cultural	(Campbell 2007; Moran et al. 2007; Hanley et al. 1998; Hasund et al. 2011)
Historic buildings	Cultural	(Tempesta 2010; Dramstad et al. 2006; Hasund et al. 2011; Arnberger and Eder 2011)
Landscape diversity	Regulating, cultural, habitat and supporting	(Laterra et al. 2011; Willemen et al. 2008; van Berkel and Verburg 2012; Barroso et al. 2012; Jongman 2002; Tscharntke et al. 2005; Hunziker and Kienast 1999; Wade et al. 2008)
Landscape fragmentation	Provisioning, cultural, habitat and supporting	(Tscharntke et al. 2005; Kremen et al. 2007; Brander 2011)

openness as a result of the abundance of linear elements (van der Zanden et al. 2013).

Landscape indicators are established at various geographical scales and with various grain sizes; ranging from European (Haines-Young et al. 2012) to local scale (Plieninger et al. 2013; van Berkel and Verburg 2013). At a European scale, Paracchini et al. (2011, 2012) proposed a rural–agrarian landscape indicator to estimate the societal appreciation of landscapes based on three indices: agriculture in protected areas, rural tourism, and certified regional products. This indicator was established at NUTS 2 regional level. At the local level, van Berkel and Verburg (2013) present a landscape indicator to assess the cultural function of landscape elements based on plot scale data. This indicator was used to extrapolate the observed relations between the aesthetic appreciation of the landscape by visitors and the presence of landscape elements throughout the case study area.

3.1.3 Case study example

In the Winterswijk case study area, the most important ecosystem services delivered by the agricultural landscape are cultural and agricultural provisioning services. While the agricultural provisioning function can be quantified based on agricultural statistics, the quantification of the aesthetic landscape function which determines the capacity of the landscape to deliver cultural services is more difficult. van Berkel and Verburg (2013) tested two landscape indicators based on landscape structure characteristics. The first landscape indicator estimates the aesthetic function based on the stated preferences for individual landscape elements (such as hedgerows) by tourists. The stated preference scores for the individual landscape elements enable the quantification of the aesthetic function based on a map of the presence of the different landscape elements. The second indicator is based on stated preferences of tourists for different land cover structures in the case study area as displayed in aerial photographs. The resemblance of different parts of the landscape in terms of composition and structure is used to extrapolate the stated preferences across the case study area van Berkel and Verburg (2013). Figure 3 indicates that the use of these different landscape indicators leads to different patterns of the estimated aesthetic function across the region. Although both indicators indicate high levels of service provision in the south-east of the study region, it is especially the edges of the larger nature areas that are estimated to provide services based on the land composition/structure indicator while the indicator based on individual landscape elements is not able to distinguish the edge and inner core of the natural areas.

3.2 From functions to benefits, values, and contribution to regional competitiveness

3.2.1 Literature review

The rural society and the regional economy benefit from agricultural landscapes when the service flows from the landscape fulfill a demand. These benefits can be quantified by their social or economic value. However, this does not always mean that the benefits of the ecosystem services are attributed to the regional population or to managers of the landscape that produces the services, e.g., farmers. Many services, e.g., water and climate regulation, benefit regions far from the actual landscape providing these services (Martín-López et al. 2009;

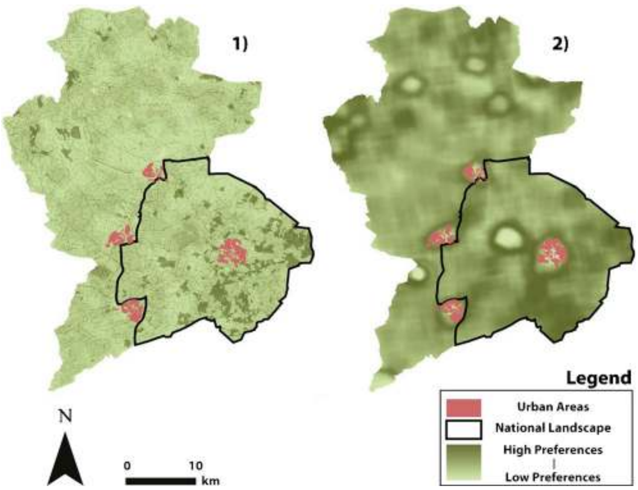

Fig. 3 Maps displaying the spatial distribution of the aesthetic landscape function for the Winterswijk case study area based on a preference survey. These maps display the spatial variation of the aesthetic function using two different methodologies. *Map 1* is based on stated preferences of visitors of the landscape based on pictures of individual landscape elements, such as forests, hedgerows, and cultural buildings. *Map 2* is based on stated preferences of visitors for aerial photos of landscapes with different structure and composition of land cover types and landscape elements. This figure is modified after van Berkel and Verburg (2013)

Syrbe and Walz 2012). Although in this case the services certainly have value, they do not make a direct contribution to regional competitiveness.

The value of the ecosystem services depends on both the capacity of the landscape to deliver services and the socio-economic context (Burkhard et al. 2012; Termorshuizen et al. 2009). The value of ecosystem services depends on the needs and preferences of stakeholders that are affected by these services (Hein et al. 2006). Hence, to assess the value of an ecosystem or landscape, it is required to specify and map the stakeholders that manage the landscape and those that benefit (i.e., beneficiaries) from its services.

The agricultural sector is often both a producer and beneficiary of the provisioning services and those regulating and supporting services enabling agricultural production through nutrient cycling and pollination (Zhang et al. 2007). In case of cultural ecosystem services it is mainly the local community and tourism industry that benefits, rather than the landscape managers themselves. However, indirect benefits and interaction between the benefits from cultural services and the demand for other services may lead to benefits for the landscape managers. In Tuscany, the appreciation of the landscape by tourists has increased the demand for regional farm products supporting the agricultural sector (Daniel et al. 2012). Furthermore, the increased economic activity in regions with rural tourism may benefit the regional society as a whole through investments and facilities (which may be referred to as second-order effects). An example of the benefits of agricultural landscapes for the regional economy is found in peri-urban areas. Recreation-oriented diversification by farmers (Zasada 2011) and investment in agricultural areas by hobby farmers from urban origin foster the regional economy in those areas.

Several studies have estimated the socio-economic values that stakeholders attach to non-marketed ecosystem services in agricultural landscapes. To gain understanding on tradeoffs between agricultural provisioning services and non-marketed ecosystem services, numerous studies have attempted to value cultural ecosystem services, regulating services and biodiversity related services. Values that emerge from cultural services are often estimated using stated preferences (e.g., van Berkel and Verburg 2013; Plieninger et al. 2013). Regulating services often represent a so-called indirect use value. This means that beneficiaries benefit from the ecosystem service unconsciously, for instance through pollination of crops or by flood regulation (Schulp et al. 2012; Nedkov and Burkhard 2012). Furthermore, many studies have stressed the tradeoffs and relations between agricultural provisioning services and farmland biodiversity (Tscharntke et al. 2005; Mace et al. 2012).

To estimate the importance of flows and values of ecosystem services for the regional society and economy, the contribution of landscape benefits and values to regional competitiveness is adopted in the analytical framework (Fig. 2). The box contribution to regional competitiveness describes the relative importance of ecosystem services and values as compared to other sources of well-being in the region.

The meaningfulness of the concept of competitiveness in a territorial sense is intensively discussed (e.g., Porter 1985; Krugman 1994). For companies, competitiveness as a measure of economic viability is broadly accepted. In a competitive market, competitiveness refers to meeting the demands of clients in a better way than the competition (Thomson and Ward 2005). For regions, the concept competitiveness is defined by the European Commission as “the ability to produce goods and services which meet the test of international markets, while at the same time maintaining high and sustainable levels of income or, more generally, the ability of (regions) to generate, while being exposed to external competition, relatively high income and employment levels” (European Commission 1999). Another concept of regional competitiveness is proposed by Krugman (1994) and Porter and Ketals (2003), who argue that competitiveness, could have the simple meaning of the productivity of the economy, which determines an area’s standard of living. Krugman (1994) also introduces a positive change of productivity as an indicator for competitiveness. Also here he draws the connection between living standard, productivity and competitiveness in pointing out that the growth rate of productivity essentially determines the growth in national living standards (Krugman 1994).

When the concept of regional competitiveness is applied in a strict economic sense it has limited use for assessing the contributions of agricultural landscapes. For example, an area that produces agricultural raw materials very cheaply can be described as competitive, regardless of its social and environmental conditions. Given the limitations of existing definitions of regional competitiveness, the analytical framework describes regional competitiveness by a number of indicators that measure the socio-economic welfare in a region. Subsequently, the contribution of landscapes to regional competitiveness is estimated by the social and economic values of ecosystem services and related second-order effects. In line with the definition of human well-being by the MEA (2005), regional competitiveness indicators include regional economic performance, mainly expressed by productivity data, as well as social welfare (e.g., health, security, social capital) data. For example, the relative value added of sectors that depend on ecosystem services (or related second-order effects) or the employment rates in sectors that are dependent on ecosystem services assist to estimate the contribution of ecosystem services to regional competitiveness.

3.2.2 Methods to estimate benefits and values

Ecosystem service values in agricultural landscapes can be assessed by means of economic and social valuation (Millennium Ecosystem Assessment 2005; Liu et al. 2007; Ostrom 2009; TEEB 2010a; 2010b; Daniel et al. 2012). Based on individual consumer and producer surpluses, economic valuation addresses the use (direct use, indirect use and option) and non-use values by a total economic value (Pearce and Turner 1990; Hein 2010). Social valuation assesses the value of perception-based cultural ecosystem services, including sense of place, sense of community and mental and physical health, in a non-monetary qualitative way (Chan et al. 2012; Daniel et al. 2012).

For the economic valuation of ecosystem services, producer surpluses (i.e., the net benefits for the producer) need to be considered when the production of the service involves production costs. In agricultural landscapes, the agricultural management performed by farmers to maintain the level of non-provisioning service production may require investments, labor, or deviate from optimal management practices from the perspective of agricultural commodity production. Therefore, these management costs should be considered a negative producer surplus.

According to neo-classical economic theory, the value of a good or service under perfect market conditions is reflected by the market price as a function of supply and demand. The marginal economic value of private or traded ecosystem services can, therefore, be established by market prices (Hein 2010). This method is known as direct market valuation (de Groot 2002). In agricultural landscapes, marketed food and fiber provisioning services are often valued by market prices (Power 2010).

Economic valuation studies of non-marketed ecosystem goods and services can be conducted by either stated or revealed preference methods. The most commonly used stated preference methods for environmental economic valuation are contingent valuation and choice modeling (Hanley et al. 1998). Single attribute contingent valuation measures consumer surpluses (willingness to pay) for management options for a landscape or ecosystem as a whole and the services it delivers (e.g., Willis and Garrod 1993; Drake 1999; Hanley et al. 1998). Choice experiments estimate the utility of a landscape as a function of a set of landscape attributes (Campbell 2007; Dachary-Bernard and Rambonilaza 2012; Garrod et al. 2012; Swanwick and Hanley 2007) and enable the valuation of separate attributes in a landscape (for example hedgerows in Dachary-Bernard and Rambonilaza 2012). Revealed preference methods estimate the value of non-marketed environmental goods, not by intentions or declarations as in stated preference methods, but by actual revealed behavior. Examples of methodologies are hedonic pricing (e.g., Waltert and Schläpfer 2010; Vanslembrouck and van Huylenbroeck 2005) and the travel cost method (Martín-López et al. 2009; van Berkel and Verburg 2013).

Opposed to scientists who seek to express all ecosystem service values in economic terms, there is an emerging field of scholars in ecosystem services science who argue that some services should be measured using qualitative social valuation methods (Chan et al. 2012; Daniel et al. 2012). Alongside economic considerations, individuals and groups in society attach spiritual, aesthetic, cultural, moral, and other values to their environment (Millennium Ecosystem Assessment 2005). All these values can affect people's preferences and actions in an agricultural landscape, and they reflect affective, symbolic, and emotional views connected to the landscape (Lothian 1999; Soliva et al. 2010).

Social valuation techniques are applied mainly to value cultural ecosystem services, such as sense of place and sense of community, physical and mental health, educational values and social cohesion (Chan et al. 2012). A number of case studies have applied social valuation methodology for the assessment of ecosystem services in an agricultural landscape context (e.g., Petrosillo et al. 2013; Plieninger et al. 2013; Bryan et al. 2010). These studies use a number of methods, including participatory mapping, questionnaires and in-depth interviews, to relate specific social and cultural services to landscape characteristics and enable the identification of hot and cold spots of cultural ecosystem services perceived in the case study area (Plieninger et al. 2013). The methods express cultural ecosystem services values using qualitative measurements and ratings. In general, adopting the more intangible cultural services in the analytical framework is challenging, since landscape perception is often related to cognitive attributes of landscapes, such as naturalness or disturbance (Kaplan and Kaplan 1989; Sevenant and Antrop 2009). Although some attempts have been made (e.g., Soini et al. 2012), it is difficult to relate intangible cultural services (e.g., sense of place) to landscape structure and composition.

3.2.3 Case study example

The most prevalent non-marketed ecosystem services in the Winterswijk case are cultural services that are related to the aesthetic function of the agricultural landscape. The small-scale bocage landscape in the area attracts many walkers and cyclists, which is indicated by the abundance of biking and walking paths and facilities for overnight stay (bed and breakfasts, holiday parks, campsites). To assess the relative importance of the different cultural ecosystem services, van Berkel and Verburg (2013) asked visitors to rate the services on a 1–5 Likert scale. Aesthetic beauty (mean value of 4.7) and recreation (mean value of 4.16) were perceived as the most important cultural services, whereas cultural heritage (3.7), inspiration (3.27) and spirituality (2.38) were considered less important. In order to estimate the monetary value of these cultural ecosystem services, van Berkel and Verburg (2013) applied a stated preference method. The stated preference method measured tourists' Willingness-To-Pay (WTP) for landscape maintenance using photo-realistic montages of possible landscape changes. Preferences for the current landscape were compared with preferences for landscapes that are the result of three processes of landscape change in the area: agricultural scale enlargement and intensification, residential infill, agricultural abandonment followed by re-wilding. For each process of change the willingness to pay for measures to avoid such changes in landscape was estimated. The WTP for landscape maintenance per visitor was estimated at 86 Euros per year on average.

In terms of contribution to the regional competitiveness, the combined relative value added of the tourism, recreation and retail sectors (including transport) to the regional economy (NUTS 3 region the Achterhoek) is 21 %. In contrast, the relative value added by the agricultural sector in the Achterhoek region is less than 4 % (Eurostat 2006). In addition, in Winterswijk municipality about 3 % of the working population is directly employed at cultural and recreation facilities; whereas 25 % of the working population is employed in hotel, catering and retail sectors, which also heavily depend on tourism and recreation activities (CBS 2011).

While a lot of the tourism benefits contribute to the regional tourism industry (e.g., large campsites, hotels), farmers also benefit from tourism. In Winterswijk municipality, there are 17 small scale on-farm campsites with 247 places (Polman and Slangen 2008). Furthermore, 133 out of 331 (40 %) of the farms in the municipality are classified as "hobby-farm" (CBS 2012). These farms are often owned by people that have moved to the region from other parts of the country, contributing to the maintenance of the facilities and services in the region.

3.3 Mechanisms that influence the ecosystem service cascade

3.3.1 Literature review

The flow from landscape structure and composition to contributions of ecosystem service values to regional competitiveness is influenced by different mechanisms that depend on the interplay of policy, actors and framework conditions in the case study area (Fig. 2). van Oudenhoven et al. (2012) have elaborated the TEEB cascade model by including a description of the mechanisms that lead to changed management strategies. Their model indicates a simple chain leading from social perceptions of values to policy to land management. In our analytical framework, we have further elaborated this by distinguishing different actor types and distinguishing the different mechanisms that influence the ecosystem service cascade. Figure 4 shows an overview of different types of policy instruments that could affect the ecosystem services cascade in agricultural landscapes.

Three types of policy instruments important to the valorization of ecosystem services are distinguished (Fig. 4): regulatory instruments, economic instruments and information instruments (Vedung 1998). Regulatory instruments or so-called "sticks" apply penalties or sanctions in case of non-compliance to prescribed behavior. An example of an EU level regulation affecting the landscape is the Water Framework Directive where compliance with the set of norms for water quality is legally binding. In addition, further regulations exist on member state and even local level, particularly through spatial planning or nature conservation policies. Aiming at market intervention, economic instruments (carrots) encompass taxes, payments and subsidies as well as trading schemes and ownership rights. They are setting either positive or negative incentives to market participants to follow an intended behavior. Agri-environmental payments represent important examples in the context of agricultural landscapes. Payments for carbon sequestration, for instance as implemented in REDD (Reducing Emissions from Deforestation in Developing Countries), are another example of market-based payments for ecosystem services (Jenkins 2004), however less relevant to agricultural landscapes. In addition, subsidies remunerating positive behavior also include compensation payments for not performing measures connected with an environmental risk. In practice, often mixed forms exist that connect subsidies with tax instruments (tax reductions for desired products).

Information instruments are classified into voluntary agreements, born from intrinsic motivation, and suasory instruments. The latter aim at moral suasion of objective information and subjective value patterns of single economic decisions by individual decision makers, for example, by informing about social

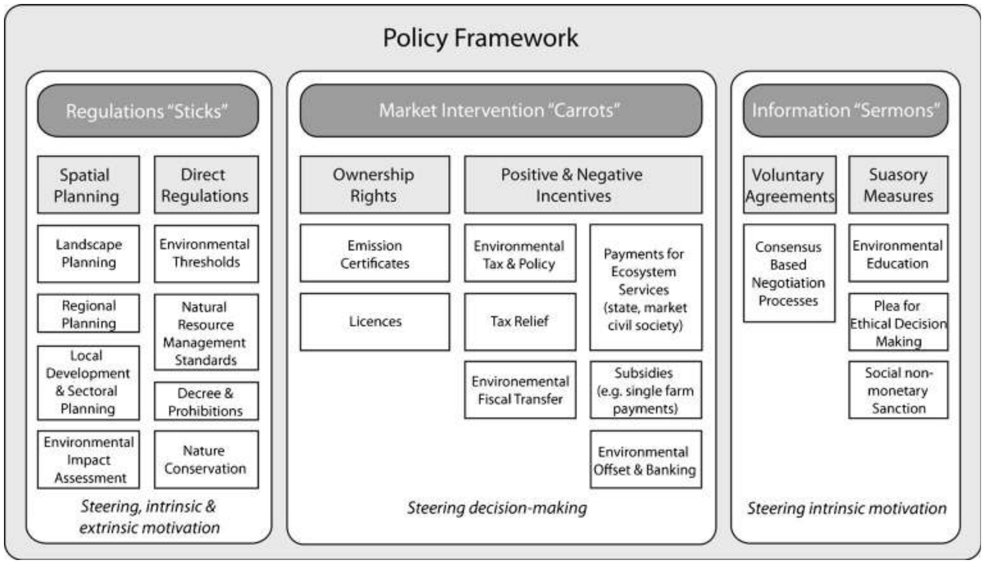

Fig. 4 Policy instruments that assist the valorization of ecosystem services in agricultural landscapes. Based on Vedung (1998) and Ring and Schröter-schlaack (2011)

costs of behavior, pleas for ethical behavior, non-monetary social sanctions.

In the European Union context, agri-environment schemes, which are part of pillar II of the CAP (2007–2013), are the most commonly used instrument for landscape policy. According to the classification in the previous paragraph, agri-environment schemes can be described as voluntary economic instruments (Burton et al. 2008). They are based on contractual arrangements between the land managers and a public authority and provide farmers with payments for, among others, extensively managed field margins and hedgerows. However, the effectiveness of the current agri-environment schemes is debated, since they generally operate at farm level and do not encourage landscape level coordination (Prager et al. 2012). Because most payments are organized on farm level, a spatial mismatch occurs between management levels and targeted ecological processes. Evidence suggests that it is economically more efficient to organize payments at landscape level than the current farm level approach (Prager et al. 2012; van Berkel and Verburg 2011; Wünscher et al. 2008).

The main actors involved in landscape management are farmers, environmental interest groups, regional water and soil associations, public authorities, economic development agencies (tourism, chambers of commerce, rural development agencies), trusts and foundations, and local communities. Farmers are the main implementing actors of landscape policy in agricultural areas. Therefore, the success of voluntary agri-environment schemes heavily depends on farmers' environmental attitudes (Prager and Freese 2009). Several studies have been conducted to investigate the motivations of farmers to participate in agri-environment schemes. In 2000, it was found that throughout Europe financial incentives and environmental attitudes are equally important to farmer participation in agri-environment schemes (Wilson and Hart 2000). Moreover, Jongeneel et al. (2008) found that for Dutch farmers trust in government is an important factor in participating in nature conservation and the development of rural tourism.

In addition to European and national level policy, regional framework conditions—that describe the influence of contextual institutional and socio-economic conditions—also influence landscape management. In the UK and Belgium, for instance, it was found that framework conditions on a national level foster the potential for implementation of multifunctional farming (Clark 2006; Vandermeulen et al. 2006). The socio-economic and institutional context refers to factors that determine the demand for ecosystem services from agricultural landscapes in the region of interest, such as regional economic performance, institutional and non-institutional environmental attitudes, population density, and urban proximity (Zasada et al. 2011).

3.3.2 Methods to evaluate the impact of societal mechanisms and policies

Simulation models are among the most important methods to examine the interactions between farmer characteristics and landscape management. Such models are used to make explorations of the influences of socio-economic developments, often captured in scenarios, on agricultural management and land use. Regional and European scale multi-model approaches (e.g., FSSIM, GTAP, CAPRI, CLUE) have been used to simulate how land use/land cover and the agricultural economy are affected by future socio-economic development and policies (Piorr et al. 2009; Renwick et al. 2013; Schouten et al. 2013). The output of many models is focused on land cover changes alone and only information on the composition of the landscape is derived, which makes it difficult to estimate the supply of non-provisioning services (Louhichi et al. 2010; Verburg et al. 2013).

In assessments of the response of agents to policies or changes in the framework conditions it is important to distinguish different decision making strategies across regions and across different actors. Many large-scale models assume uniform decision making, implemented through a uniform rule set across spatial simulation units (pixels) or by assuming economic rational behavior. Other studies have specifically addressed these differences in behavior. In the Netherlands, significant differences are witnessed for participation rates in agri-environment schemes between farm types; especially between land-tied farming types (dairy and arable farming, high rates) and intensive agro-industrial models (e.g., intensive livestock, low rates) (Jongeneel et al. 2008). Therefore, typologies and agent-based models have been developed to estimate future responses of farmers to internal (views and intentions, farm characteristics) and external (socio-economic networks, policies and markets) conditions and its influence on landscape structure and composition on a regional scale (Valbuena et al. 2008; Valbuena et al. 2010; van Berkel and Verburg 2012).

Typologies are useful to capture the diversity in farm types and environmental attitudes (Schmitzberger et al. 2005). Agent-based models are capable of accounting for different types of decision strategies and interactions between different actors, grasping the dynamics of decision processes. These approaches are specifically suitable for the assessment of voluntary mechanisms that are likely to have uptake rates that differ depending on environmental attitudes of different agent types. Other methods important to understanding the roles of different agents in landscape management and landscape policies include social network analysis and the mapping of actor networks (Reed et al. 2009; Ortolani et al. 2010).

3.3.3 Case study example

In Winterswijk national landscape, AES play an important role in landscape management. Many dairy farmers participate in compensation schemes for the maintenance of valuable landscape elements (Schouten et al. 2013). Moreover, since 2011, the Winterswijk landscape is a pilot project to test future CAP agri-environmental policy: agri-environment schemes are organized by farmers in the landscape collectively to ensure better spatial coordination of measures, which could benefit the flows and values of ecosystem services in the landscape (Prager et al. 2012). However, agri-environment schemes are still voluntary measures, and thus, the effectiveness of these policies depends on the participation rate of farmers. Jongeneel et al. (2008) found that in the Netherlands farmers' trust in the government and the drive for expansion of the farm are important explanatory variables for both their participation in agri-environment schemes as well as their efforts for diversification (i.e., additional sources of income). To gain a more dynamic understanding of the effectiveness of agri-environmental policy in the Winterswijk landscape, two different agent-based models have been developed and applied in the region.

Schouten et al. (2013) designed an agent-based model to measure the resilience of agri-environment schemes contracts in the context of milk price fluctuations for dairy farmers under two different governance structures. A baseline scenario of geographically fixed compensation payments was compared to flexible payments in a spatially differentiated scenario. The authors found a higher uptake of agri-environment schemes under the spatially differentiated scenario. In their agent-based model, the behavior of farmers is determined by both the economic and the ecologic characteristics of the socio-ecological system; it assumes economically rational behavior and includes spatially explicit biophysical characteristics.

In contrast to Schouten et al. (2013), the agent-based model of van Berkel and Verburg (2012) uses an agent typology to comprehend farmers' strategies of expansion and/or diversification, designed by Valbuena et al. (2008, 2010). In their typology, five classes of actors are distinguished, based on farm characteristics and environmental attitudes including hobby farmers, non-expansionist conventional, non-expansionist diversifier, expansionist conventional and expansionist diversifier (Valbuena et al. 2008). Based on this agent typology, farmer behavior—for instance the adoption of agri-environment schemes—was predicted in a dynamic multi-agent model. With these predictions, future landscape scenarios were developed focused on the removal/restoration of linear landscape elements and agricultural abandonment allowing an assessment of changes in the agricultural landscape of the region. van Berkel and Verburg (2012) discussed the model results in an interactive workshop with stakeholders to support discussion about landscape policies and planning.

4 Discussion

The analytical framework presented in this paper provides guidance for a structured assessment of the contributions of agricultural landscapes to regional competitiveness through the provision of multiple ecosystem services. The framework provides a comprehensive model to account for the full range of processes that relate agricultural management to landscape characteristics and the contribution of the agricultural landscape to regional competitiveness. The application of such an integrative perspective of the interactions within the framework encourages better informed landscape policy (de Groot et al. 2010).

The framework is based on the widely adopted ecosystem services cascade (Haines-Young and Potschin 2010) to assess relations between landscape structure and composition and human well-being in agricultural landscapes. In contrast to more naturally managed ecosystems, the flows and values of ecosystem services in agricultural landscapes are largely determined by agricultural land management as well as by societal demand for marketed agricultural provisioning services and non-marketed services (Termorshuizen et al. 2009). This is particularly relevant in an increasing urbanized world with reinforced urban–rural linkages and ongoing societal changes with a strong focus on quality of life issues (Seto et al. 2012). Therefore, these human–nature feedbacks are critical in the framework and essential for a meaningful analysis of ecosystem services in agricultural landscapes. Human–nature feedbacks are also central to the recently developed concept of landscape agronomy that explicitly addresses the ways in which agricultural management practices influence landscape structure and composition (Benoît et al. 2012). By combining the ecosystem services concept and the landscape agronomy concept, a complete picture of the human–environment interactions relevant to agricultural landscapes is provided. Both research communities offer methodologies that help operationalizing the framework.

Human–nature feedbacks occur at several spatial scales and are driven by different societal mechanisms. Landscape managers and beneficiaries of ecosystem services affect the cascade through adaptation to a different context (including global commodity market influences, climate change and environmental cognitions). In addition, their behavior is driven by spatial planning and other policies that directly or indirectly affect landscape management, as well as the demand for ecosystem services and the values of those services (Wilson 2008; Zasada 2011; Prager et al. 2012). Often, these feedbacks do not work one-directionally: changes in the system will have indirect impacts and second-order effects. Such re-bounds are described by Maestre Andrés et al. (2012) and occur both inside or outside the landscape under consideration. While having a negative connotation, some re-bounds cause positive feed-forward mechanisms that operate through a reinforcement of started trends, e.g., through consolidation of the regional economy and increased availability of investment opportunities for land management to provide a wide range of ecosystem services (Wilson 2008).

In several scientific disciplines, methodologies have been developed that enable the analysis of specific components of the analytical framework. Applied ecologists study the anthropogenic functions of ecological structures, environmental economists determine economic value of ecosystems, and policy analysts evaluate the impact of agricultural policies on landscape composition. Disciplinary focus has often restricted analyses to components of the full framework rather than analyzing the interconnections between the components (Seppelt et al. 2012). The risk of focusing on parts of the framework is that important feedbacks through changes in mechanisms and adaptive behavior of consumers and land managers are ignored. A methodological focus on ecosystem functions or biodiversity (Burkhard et al. 2010; Maes et al. 2012) may disregard the possibilities for valorization given the lack of knowledge about the societal demand for the delivered services in the region. A focus on economic valuation alone may target the stimulus to the provisioning services in regions where the production of the services is non-optimal as result of the functioning of the local agro-ecosystem or where societal constraints limit the adoption of measures. Research should, therefore, focus on the integrated assessment of the full framework, requiring the increased collaboration and integration across the different disciplines. However, our literature review indicated that knowledge gaps exist and only few methods are available for studying the connections between the different components of the system. These are a priority for advancing an integrated view on the role of agricultural landscape (management) in the regional economy.

Different starting points can be used within the analytical framework depending on the research questions. Analysis might start by focusing on a specific policy instrument by analyzing the impacts of that policy on landscape characteristics and the corresponding consequences for the value of landscape within the regional economy. The framework could, for instance, be applied in ex-ante or ex-post evaluations of proposed agricultural or landscape policies. It is also possible to start from observed or projected changes in the landscape and analyze how these lead to tradeoffs and synergies between different ecosystem services and their impacts on society. Additionally, scenario analysis can be applied to assess the need for new types of policy instruments to provide insight in the impacts of these policies.

The analytical framework places individual research efforts and methods into context. It brings the ecosystem services concept explicitly to the agricultural domain to support and sustain the socio-economic values contained in European agricultural landscapes.

Acknowledgments We acknowledge funding from the European Commission, 7th Framework Programme through the project CLAIM (Supporting the role of the Common agricultural policy in Landscape valorisation: Improving the knowledge base of the contribution of landscape Management to the rural economy, www.claimproject.eu). This work does not necessarily reflect the view of the European Union and in no way anticipates the Commission's future policy in this area. Furthermore, the authors like to thank the case study leaders in the CLAIM-project, Manuel Arriaza, Edward Majewski, Handan Giray, Dimitre Nikolov, and Jean Christophe Paoli, for their contributions to the paper during project meetings.

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