# Exploring the provision of ecosystem services through rural landscape management: a development of conceptual framework

Rovai M. [1] Bartolini F.[1], Brunori G. [1] Fastelli L.[1]

[1] University of Pisa, Department of Agriculture, Food and Environment, Pisa, Italy

fabio.bartolini@unipi.it

Paper prepared for presentation at the 3rd AIEAA Conference
"Feeding the Planet and Greening Agriculture: Challenges and opportunities for the bio-economy"

25-27 June, 2014
Alghero, Italy

## Summary

*Millennium Ecosystem Assessment (MA) provides bases for comprehensive understanding of Services provided by ecosystems, linking ecosystems and human well-being. As rural landscape is considered provider of multifunction services and is affected by a wide range of land uses several ecosystems are involved in developing an operative definition of landscape. Thus a common and comprehensive definition of landscape function, services provides, benefits and value are not enough developed. In fact, the concept of landscape function or services has been used as synonymous to ecosystem services Literature has highlighted that alternative land uses/rural area managements affect the ecosystem services provision, due to the trade-off, synergies and disservices in the provision of these services.*
*The paper aims at exploring the linkages between ecosystem services and regarding rural landscape. To support this comprehensive assessment of the linkages between ecosystem services and landscape an empirical analysis to understand trade-off and synergises in ecosystem services provision by landscape are applied in Tuscany region.*
*Results will contribute to provide empirical evidences and knowledge about the implementation of mechanism aimed to align provision of ecosystem services by rural landscape towards current and future needs.*

Keywords: Landscape, Ecosystem services, Tuscany; Multicriteria Analysis; Fuzzy

JEL: Q18 – Agricultural Policy; Food Policy; Q10 General

# Exploring the provision of ecosystem services through rural landscape management: a development of conceptual framework

Rovai M. [1] Bartolini F.[1], Brunori G. [1] Fastelli L.[1]

[1] University of Pisa, Department of Agriculture, Food and Environment, Pisa, Italy

## 1. INTRODUCTION

Ecosystems Services provided by landscape represent a central issue into the mitigation of climate changes strategies and biodiversity mitigation (Frank et al., 2012) and at the same time provides notable recreation and cultural services benefits (Moran, 2005).

Millennium Ecosystem Assessment (MA, 2005) provides basis for comprehensive understanding of Services provided by ecosystems, linking ecosystems and human well-being. Despite large interest in the literature there are different approaches to classify ecosystem services, based on the goods, process and function (Hermann et al., 2011).

As rural landscape is considered provider of multifunction services and is affected by a wide range of land uses several ecosystems are involved in developing an operative definition of landscape. Thus a common and comprehensive definition of landscape function, services provides, benefits and value are not enough developed (Hermann et al., 2011).

Literature has highlighted that alternative land uses/rural area managements affect the ecosystem services provision, due to the trade-off, synergies and disservices in the provision of these services (Zhang et al., 2007). Foley et al., (2005) by comparing three alternatives land-uses (natural ecosystems; intensive cropland and) found a synergies and trade-off in the quantity of ecosystems services provided.

The concept of landscape and the ecosystem services are used as synonymous words, due to the multifunctional of function of alternatives in land uses that quality landscape concept (Hermann et al., 2011). As a consequence, even if a growing literature deals with the linkages between ecosystem services and landscape, there is a overlooking of common understanding of the mechanism that describes rural landscape functions, services, benefit and value (Van Zanten et al., 2014). In particular the paper investigating the supply and the demands of landscape will explore the trends on its provisions.

The paper aims at exploring the linkages between ecosystem services and regarding rural landscape. To support this comprehensive assessment of the linkages between ecosystem services and landscape an empirical analysis to understand trade-off and synergises in ecosystem services provision by landscape are applied in Tuscany region.

Results will contribute to provide empirical evidences and knowledge about the implementation of mechanism aimed to align provision of ecosystem services by rural landscape towards current and future needs.

## 2. DEFINING LANDSCAPE: THE TUSCANY LANDSCAPE PLAN

Landscape is defined in different ways and the several available definitions are affected by the lens on which landscape is analysed (see for example Moran, 2005; Hermann et al., 2011). Thus a plethora of definition can be found in the literature. However, there is larger consensus about the description of the elements that constitutes and qualifies the landscape. Thus generally landscape can be defined as assemblage of physical attributes that is viewed by people for which society can identify-on it. Where these attribute are altimetry, geology, land use (crops or forest, forest type), water, colour, adjacent scenery and cultural modification (Moran, 2005). Then distinct landscapes are composed by different combinations of these attributes (Moran 2005).

The wide varieties of forms assumed by the rural landscape are frequently characterized by a dense grade of various anthropic artificial processing; it is therefore very difficult to classify the rural landscape in a country. The distinctive features of the Tuscan countryside were determined over the centuries by various variables, both physical and socio-economic, for this it was necessary to search for a key to interpreting able to comprehensively assess the interaction between these levels of information.

Furthermore the increasing in demand for a sustainable planning and preservation of rural landscape has been a driver of develop of specific instrument to classify and indentify features and peculiarity of rural areas (see Gisotti 2013). With this aim has been identified an analytical tool, able to be used as the main descriptive paradigm for recognizing and identification of specifics landscape structures in several contexts. The rural morphotype is the territorial structure, resulting from the interaction between morphological features, agricultural aspects and attributes of the settlement system. The weight exerted by each of the factors (morphological, cultural, settlement) which characterizes each morphotype is variable, and from it depends the mutability with which the same type of landscape shows itself in the region.

The morphotypes were ordered within in a taxonomy of regional rural landscapes, from more 'simple ' ( by grade and type of human settlement in the territory and of present crops ) to the more complex ( in terms of culture, rural infrastructure and relationships that exist between the various factors characterizing). The Region of Tuscany has so incorporated into the new landscape plan an abacus consisting of 23 rural morphotypes identified and mapped (Regione Toscana, 2013).

## 3. METHODOLOGY

Object of the paper is to assess the contribution of Tuscany rural landscape on the ecosystem services benefit. Due to its characteristics of market failure, price of private goods cannot internalise the landscape value. Thus several methods have been developed to estimate the landscape value. The widest method applied is the monetary quantification of the benefit provided by landscape by applying the concept of total economic value. Total economic value measures direct and indirect market value of goods and services provided by willingness to pay for the functions associate. Thus the several benefit provided by the landscape are then aggregated using monetary quantity (See Targetti et al., 2012 to a review of those methods applied to the landscape context). With other approach such as non monetary approach, it is possible to estimate the contribution of landscape at ecosystem services by measuring and working with physical indicators. Multicriteria analysis represents the widely applied and allows measuring the benefit generated by landscape using decision makers' utility function. Several methods, developed in the operation

research field, allow to aggregate performance on different environmental factors (see Guitouni and Martel, 1998 for a review of aggregation methods).

Applications of Multicriteria analysis in the context of policy impact or alternative land uses are quite common in agricultural economics and in ecological economics fields (see for example Finn et al., 2009). In this paper we adopt a fuzzy weighted sum to quantify the contribution of relevant Tuscany landscape on the ecosystems services. The methodology is based on the following four steps: a) identification of relevant Tuscany landscapes; b) identification and selection of ecosystem services; c) assessment of benefit for each ecosystem services–landscape pair d) aggregation of benefit provided by each Tuscany landscapes.

The first step is based on identification of relevant landscape of Tuscany landscapes. Relevant landscapes are identified using the concept of morfotypes described in the previous paragraph. Due to exploratory objectives of the paper, we have decided to select only the most relevant landscape and those easily identifiable by non-experts (beneficiaries). Thus six different landscapes were selected (see next paragraph for the description of selected landscape).

The second step aims to identify and select a list of ecosystem services against which measure benefit provided by the rural landscapes. For this purpose the classification proposed by De Groot et al. (2010) were used. The classification is based on hierarchical structure of ecosystem services. De Groot et al. (2010) identify four general sets ecosystems service: provisioning services; regulation services; habitat or supporting services and cultural and amenity services. Within these sets a list of more specific services are identified. With respect classification proposed by De Groot et al., (2010) we withdrawal those ecosystem service for which appraisal requires high level of expertise (e.g supporting services, provision of water; provision of biochemical and medical resources) or those that cannot be assessed without the use of physical data (e.g. waste treatment).

Within the third step, for each landscape and ecosystem service pair the benefits provided by the landscapes are estimated. Estimation is realised asking at beneficiaries to express a judge about the relative contribution of each landscape to a specific ecosystem service. The data are collected using a survey addressing at agricultural and agri-ecosystem management faculty students. Prior to the questionnaire, the students were informed about the role of landscape in rural areas and the expected impact on ecosystem services. No information about the features of different landscape was provided before the questionnaire submission. For each pair of landscape- ecosystem service the respondents estimated the benefit using a Likert scale from zero value (no effect) to nine (main contribution). During the survey, we submitted to respondent the picture that was used by Tuscany region to identify the morphotypes for landscape planning purpose (see Regione Toscana, 2013). The visual cards showed during the interviews are presented in the annex 1. The methodological choice to use cards containing photography instead of description or physical indicators is quite common in the assessment of willingness to pay for different landscape option and it is coherent with the definition of landscape provided in the previous paragraph. (Dachary-Bernard and Rambonilaza, 2012)

The fourth step (aggregation and ranking among Tuscany landscapes) is conducted applying Multicriteria analysis. Firstly, during the questionnaire the weights of each ecosystem service in the entire Tuscany region are assessed. The weights reflected the expected relative importance of the ecosystem services in the Tuscany region. Therefore the weights are used to aggregate contribution of different landscape on the provision of ecosystem services following the hierarchical structure presented in the annex 2. The aggregation method adopted is a fuzzy weighted sum, which is widely used in assessing environmental policy due to inclusion into the assessment the degree of uncertainty expressed into concept of the membership function (Bartolini et al., 2010).

Formally for each pair of landscape ( $i$ ) and ecosystem service ( $j$ ) the contribution is expressed as $E_{ij}$ . Using the data collected from survey $E_{ij}^{c}$ represent the average value obtained by all survey (central value). To copy with uncertainty applied in the appraisal process, we have used fuzzy logic to include subjectivity judgment. Thus and adding and subtracting standard deviation the central value ( $E_{ij}$ ), a lower and upper value was calculated that reflects variation among the individual experts in the scores. The lower value $E_{ij}^{l}$ is given by $E_{ij}^{l} = E - \sigma^2$ while upper value $E_{ij}^{u}$ is given by $E_{ij}^{u} = E + \sigma^2$ .

Following Dubois and Prade (1980) and Bartolini et al., (2010) the membership function $\mu_m(x): X = [0,1]$ for the set of triangular number $\left(E_{ij}^{l}, E_{ij}^{c}, E_{ij}^{u}\right)$ is equal to:

$$\mu_m(x) = \begin{bmatrix} \dfrac{1}{E_{ij}^{c} - E_{ij}^{l}} e - \dfrac{E_{ij}^{l}}{E_{ij}^{c} - E_{ij}^{l}}, \text{ if } e \in \left[E_{ij}^{l}, E_{ij}^{c}\right] \\ \dfrac{1}{E_{ij}^{c} - E_{ij}^{u}} e - \dfrac{E_{ij}^{u}}{E_{ij}^{c} - E_{ij}^{u}}, \text{ if } e \in \left[E_{ij}^{c}, E_{ij}^{u}\right] \\ 0, \text{ if } e \le E_{ij}^{l} \text{ or } e \ge E_{ij}^{u} \end{bmatrix}$$

Membership function ( $\mu_m(x)$ ) allow to associate with the triangular number a distribution of probability around the central value and between the lower and the upper values, The triangular numbers for the low level of ecosystem services are aggregated at upper level using the relative weights previously elicited. Giving an arbitrary level of membership function ( $\alpha - cut$ ), for two generic landscape alternatives ( $l_1$ ) and ( $l_2$ ), the alternative $l_1$ dominates alternative $l_2$ for a generic ecosystem service ( $j$ ) when $E_{1j}^{l} > E_{2j}^{u}$ .

## 4. IDENTIFICATION OF REPRESENTATIVE LANDSCAPE

As aforementioned in the previous paragraph six landscapes/morphotype which are enable to describe the relevant Tuscany landscapes are identified. These landscapes allow describing the heterogeneities in ecological infrastructure endowment of the region and picture of the landscape are presented in the annex 1. A description of the main landscape features for all landscape (morphotype) follows.

The first morphotype (Plant Nursery) describes a landscape strongly artificially that, although composed of open spaces, it lost most of the agricultural and rural character. It is composed, in fact, by extensive areas devoted to nurseries crops and in terms of perception can be likened to a vast garden pleasant for aspects of regularity and richness of vegetation. However, its environmental quality is strongly affected by the waterproofing of most soils (both potted plants and in open field), by the low level of ecological infrastructure and by the alteration of drainage system. The settlement is often the result of growth processes that have occurred over the past sixty years, it is widespread and heavily branched and has altered the historical territorial structure, today recognizable in the urban sprawl.

The second morphotype (association between arable crops and monocultures tree) is widespread mainly in flat areas and in some valley floor crossed by waterways. It is characterized by the association of poplar groves (and other systems of arboriculture) and extended arable fields, usually sign of simplification landscape. The geometry of the fields has a size variable: sometimes remains relatively high, with plants growing of small size and the fabric of arable land which preserves the traditional footprint; while in other cases shows itself wide. This landscape is perceived as a very particular landscape, where the open skyline of arable simple alternate to with dense weave of tall trees characterized by the density and verticality.

The third morphotype (hilly mosaic to vineyard and olive grove prevalent) is typical of hilly areas and is characterized by the alternation of olive groves and arable land both simple and dotted with scattered trees. Sometimes there are vineyards of variable size between the main crops, other times there are fields of small size and boundaries rather soft. The forest, whether in the form of stains that of linear formations, diversifies crops. The degree of ecological infrastructure is high, thanks to the role of hedges and of forests that diversify the crops and define most of the boundaries of the fields. The olive groves can be both traditional and newly developed regarding the density. On steeper slopes can be observed the presence of hydraulic and drainage systems. The typical settlement that is associated with this morphotype is the historic village of small-medium sized slightly altered by the dynamics of recent expansion and surrounded by the cultured tissue.

The fourth morfotypes (arable crops of land reclamation) are typical landscape usually associated with lowland soils consisting of alluvial deposits. The landscape is organized by the great works of hydraulic launched in various parts of the region in the second half of the eighteenth century and completed around the year fifty of the twentieth century. Indentify aspects of this morphotype are: the geometrical form of the fields; the regular scan of soils by the presence of houses and farms; the presence of an articulated system of water drainage and runoff of surface waters. The settlement density can be very low with minimal alteration of its historical structure or higher and connected to widespread urbanization. The degree of ecological infrastructure depends on the variable presence of hedges and rows of trees placed in field.

The fifth morphotype (periurban enclosed agricultural areas) describes the landscapes in which the distinctive character is the interplay between built-up areas and open spaces, cultivated and not. It is are not built and without waterproofed, but entirely bounded by urban fabric, almost always by buildings (both residential and productive character), but also by major infrastructure projects. The main crops are arable land and permanent grassland resulting from agricultural simplification processes that have led to alteration of the drainage system and change of the traditional territorial structure. The degree of ecological infrastructure of the individual fields is generally very low. These spaces play a crucial role as discontinuity in the morphology of sprawling urban tissue, and it can be able to build a network of areas of significant ecological value, functional, social.

The sixth morphotype (arable crops simple of traditional structure) is associated with sweet morphologies and is found mostly in hilly areas and is rarely present in mountain environments. This landscape is characterized by the predominance of arable land and of simple grassland; the fields geometry is not traceable to phenomena of landscape simplification but dependent on the structural features of the landscape. The level of ecological infrastructure is variable, however, prevail contexts with few vegetation elements. In some zones of the region, this type of landscape is characterized by a great aesthetic-perceptive value given through sweet morphologies, horizons of arable, chromatic properties of the soils, etc; also currently it is the image most promoted and disseminated by as typically Tuscany.

Hereafter we will refer at landscape indicating the corresponding morphotype.

## 5. RESULTS

In this paragraph firstly the contribution of each landscape against a low level of ecosystem services (table 1), and then landscape benefit using upper aggregations levels are presented (see figure 1; figure 2; and figure 3).

**Table 1.** Contribution of selected landscapes at different ecosystem services (N=18).

| Ecosystem services | L1 | | L2 | | L3 | | L4 | | L5 | | L6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| prov_food | 0.31 | | 0.12 | ** | 0.93 | *** | 0.88 | *** | 0.36 | * | 0.73 | *** |
| prof_fib&oth | 0.24 | | 0.90 | *** | 0.65 | *** | 0.61 | ** | 0.37 | * | 0.58 | *** |
| prov_orna | 0.97 | *** | 0.38 | ** | 0.51 | *** | 0.56 | *** | 0.31 | | 0.48 | *** |
| prov_gen | 0.86 | *** | 0.50 | | 0.73 | ** | 0.70 | * | 0.23 | *** | 0.55 | * |
| reg_air | 0.49 | ** | 0.77 | * | 0.86 | *** | 0.66 | | 0.32 | *** | 0.83 | *** |
| reg_wat | 0.50 | | 0.58 | | 0.65 | | 0.67 | * | 0.30 | *** | 0.75 | *** |
| reg_eron | 0.30 | *** | 0.64 | | 0.81 | *** | 0.56 | | 0.23 | *** | 0.75 | |
| reg_polli | 0.67 | | 0.55 | | 0.86 | *** | 0.70 | | 0.36 | *** | 0.65 | |
| reg_haz | 0.44 | * | 0.59 | | 0.81 | *** | 0.57 | | 0.38 | ** | 0.60 | |
| reg_clim | 0.54 | | 0.57 | | 0.75 | ** | 0.60 | | 0.28 | *** | 0.80 | *** |
| reg_biol | 0.46 | * | 0.60 | | 0.77 | *** | 0.58 | | 0.35 | *** | 0.81 | |
| cul_tur | 0.27 | ** | 0.25 | *** | 0.58 | | 0.62 | * | 0.40 | | 0.80 | *** |
| cul_her | 0.31 | ** | 0.33 | ** | 0.79 | *** | 0.59 | | 0.41 | | 0.81 | *** |
| cul_aest | 0.57 | | 0.50 | | 0.79 | *** | 0.64 | | 0.35 | *** | 0.88 | |
| cul_art | 0.41 | * | 0.43 | | 0.72 | ** | 0.54 | | 0.31 | *** | 0.84 | *** |
| cul_hist | 0.12 | *** | 0.30 | | 0.42 | | 0.26 | | 0.14 | *** | 0.56 | *** |
| cul_edu | 0.69 | | 0.54 | | 0.65 | | 0.59 | | 0.36 | ** | 0.69 | |

*** significance at 1%; ** significance at 5%; * significance at 10%

Table 1 shows the average contribution of each landscape to the low level of ecosystem services. These values are normalised between zero and one. Thus, value closes to one highlights high benefit provided by landscape at the ecosystem service, while, at the opposite, vale close to zero shows no contribution. The Student t-test was conducted in order to verify which of the average across landscape differ significantly from the overall average. Moreover those significant landscape-ecosystem services pair, allows to identify the landscapes which differ (positively or negatively) by the average.

Table 1 highlights very high heterogeneity of benefit provided by the main regional landscape. Results show that provisioning services (food; feed & other etc.) have higher heterogeneity among regional landscapes. Furthermore results highlight trade-off in the provisioning services. This is particular relevant for the first four landscapes that have respectively higher value for provision of ornamental species, provision of fibber &other and for provision of food. While, at the opposite these landscape show low contribution to the other provisioning services.

The landscape composed by hilly mosaic to vineyard and olive grove prevalent (L3), periurban enclosed agricultural areas landscape (L5) and landscape composed by arable crops simple of traditional structure (L6), are these that differ significantly from the average value concerning the regulation services. Results show quite high contribution of landscape 3 for the following regulation services (mainly for soil erosion, pollination, natural hazard mitigation). The landscape 5 (enclosed agricultural areas) shows low contribution for the regulation services. Finally, the landscape 6 (arable crops simple of traditional structure) shows the higher contribution for air quality and water quality regulating services.

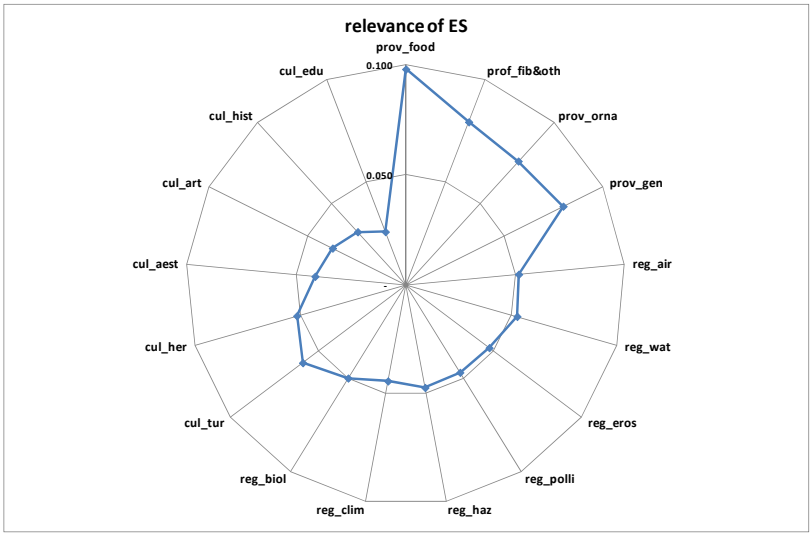
The benefit provided by the landscape concerning the cultural and amenity services is highly diversified: all landscapes differ from the average for at least one of these ecosystem services. Very low

contribution is observed by landscape 1 (plant nursery), landscape 2 (association between arable crops and monocultures tree) and landscape 3 (hilly mosaic to vineyard and olive grove prevalent), while other landscapes show provision of cultural (mainly in cultural heritage and aesthetic and historical services).

Altogether results shows that landscape 2 (association between arable crops and monocultures tree) and landscape 5 (periurban enclosed agricultural areas) have higher heterogeneity across ecosystem services due to peculiarity of ecological infrastructure which characterised the landscape. Even if the other landscapes show overall similarity in provision of ecosystem services, the different endowment in ecological infrastructure reveal difference in provision of ecosystem services within the set of provision services (e.g. provision of food or provision of cultural heritage).

In the following figures aggregation of ecosystem services benefit is undertaken. The aggregation is undertaken using the weights estimated during the surveys. Figure 1 contains the appraisal of the relative importance (weights) in the Tuscany region.

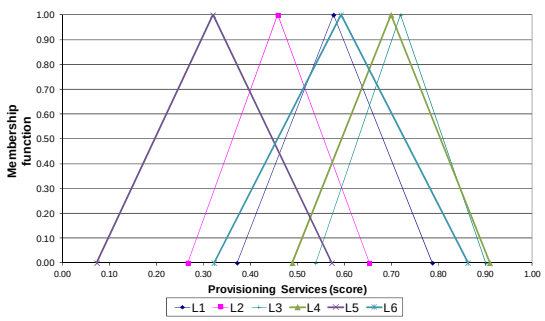
**Figure 1:** Relevance of Ecosystem services in Tuscany region.



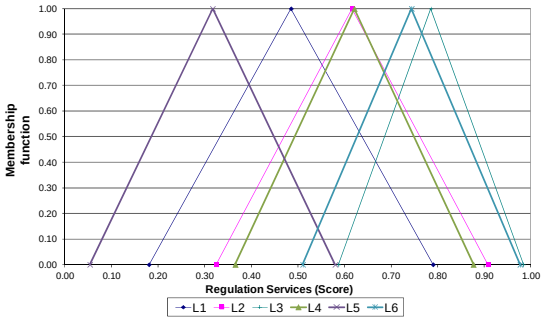

The figure contains the relative relevance of each ecosystem services (weights). The score is compute taking into account the hierarchical structure of ecosystems services (see annex 2). The Higher score is observed for provision of food (0.1) while the other ecosystem services, within the same group show lower and similar relevance (0.08). Ecosystems services belonging at the regulating services show similar relevance value between score (0.03 and 0.05). The respondents have stated higher relevance for regulation of water quality and air quality. Within the cultural and amenities ecosystems services those ecosystem services with higher importance are the recreation and tourism services followed by cultural and heritage identity.

The following two figures show different aggregations of the beenift provided by the Tuscany landscape: using aggregation at upper level of service (provisioning, regulation; cultural and amenity) and aggregating benefit for all ecosystem services.

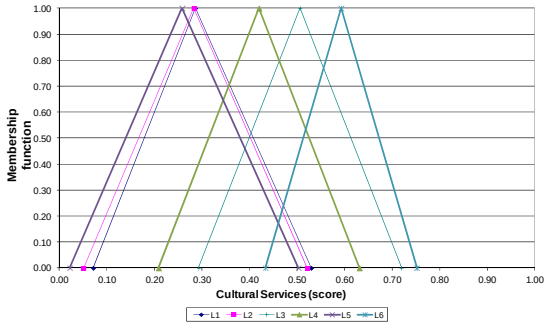
**Figure 2.** Landscapes contribution on ecosystem services dimensions (provisioning, regulation; cultural and amenity).




A




B




C

The Figure 2 is composed by three parts, which measure contribution of each landscape at the provisioning services (a); at regulation services (b) and at cultural and amenities services (c).

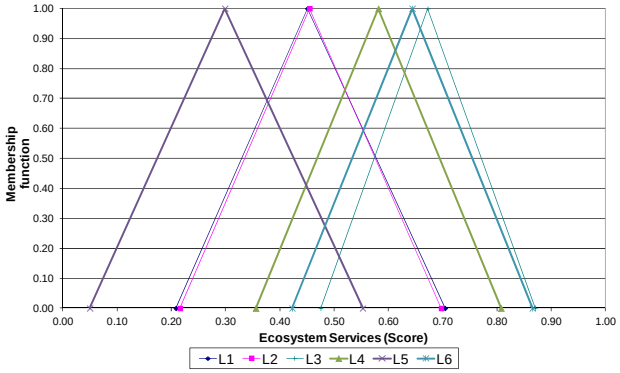
Using $\alpha - cut$ higher that 0.8, the figure "a" allows to detect a set of dominant landscapes composed by hilly mosaic to vineyard and olive grove prevalent landscape ((L3) and arable crops of land reclamation (L4). With higher uncertainty ($\alpha - cut \geq 0.7$) also Landscape 6 (arable crops simple of traditional structure) and landscape 1 (plant nursery) have similar benefit for the provision services. While, opposite contribution can be observed for landscape 2 (association between arable crops and monocultures tree) and landscape 5 (periurban enclosed agricultural areas). Thus even with quite high value of uncertainty enclosed agricultural areas landscape remain dominated by all other landscape.

The figure "b" allows identifying dominant landscape typology concerning the regulation services. Comparing with the previous one figure, the landscapes performance show similar pattern but, it returns different ranking. Then it results highlights a dominance of landscape 3 (association between arable crops and monocultures tree) and landscape 6 (arable crops simple of traditional structure) with $\alpha - cut > 0.75$. The landscape 5 (periurban enclosed agricultural areas) and landscape 1 (plant nursery) return low score due to absence of ecological infrastructure and intensive agricultural practices that may returns low regulation potential (i.e. low land covering over the years and low agro-biodiversity).

Concerning provision of cultural and amenity service (figure "c"), the results highlight a more homogenous assessment of different landscapes due to less uncertainly in the judgment. In fact, three landscapes show high score compared with the others: landscape composed by hilly mosaic to vineyard and olive grove prevalent (L3); landscape composed by arable crops simple of traditional structure (L6) and landscape composed by arable crops of land reclamation (L4). These three landscapes show uniformity in the judgment.

The figure 3 contains the contribution of selected Tuscany landscape at the ecosystem services provision.

**Figure 3.** Landscapes contribution at ecosystem services benefit




The figure shows that benefit generate by the selected landscapes can be order in three groups. The group with higher benefit are composed by arable crops simple of traditional structure landscape (L6); arable crops of land reclamation landscape (L4) and hilly mosaic to vineyard and olive grove prevalent landscape (L3). These landscapes provide similar benefit using $\alpha - cut \geq 0.8$. Results show that the landscape composed by association between arable crops and monocultures (L2) and plant nursery landscape (L1) have very close ecosystem services benefit and very similar uncertainty. While, even with quite low of value of $\alpha - cut$ the periurban enclosed agricultural areas landscape (L5) show very low performance and are completely dominated by other landscapes

## 6. CONCLUSIONS

The aim of this paper is to explore the relations between ecosystem services and landscape. Despite the relevance of both concept and the plethora of evaluation, there is still a gap of comprehensive analysis.

The paper working on the gap, trying empirically to assess the contribution of rural landscape on ecosystem services in the Tuscany region. The assessment of benefit provided by rural areas provides relevant information and it represents a growing topic into the policy debate. The enchaining and maintaining the ecosystem services provided by agriculture through the management of rural areas represent one of policy priority for the new programming period. Thus, the assessing of ecosystem services and the linkages with agricultural systems and ecological infrastructure endowments that qualify landscape represents a growing issue also for policy evaluation purposes. Moreover, our result pointed out that different landscape strongly affects the perception of the benefit by the society and thus (when are not internalized by market) can constitute a basis for policy interventions.

The preliminary results confirm previous literature findings about the extent of trade-off and synergies in the provision of ecosystem service by different agro-ecosystem (Foley et al., 2005). Furthermore, our results, highlight a substation equivalence importance of the category of ecosystem which claim for a balanced management of the territory with an equilibrate furniture of ecosystem services.

Paper applies a MCA which is a quite common method to assess policy impact and is widely applied to alternative land use management valuation. Despite it, the method suffers of some shortcomings, due to the subjectivity of the judgment that may reflects overcomes or under-estimation. This seems the case for

example of regulation services, where technical expertise may be required to assess the landscape contribution to ecosystem services, and difficulties in the appraisal can expected. Furthermore the sample selection and the use of student instead of expert reflect the explorative approach of the methods and should allows some rooms to explore combination with expert judgment and enlarging the sample.

## REFERENCES

Bartolini, F., Bourke, D., Finn, J., Viaggi, D. (2011). Ex-Post Analyses of Agri-Environment Schemes: A Comparative Analysis Using Expert Judgement and Multicriteria Analysis. *Agricultural and Environmental Informatics, Governance and Management: Emerging Research Applications*: 23-38.

Dachary-Bernard, J. and Rambonilaza, T. (2012). Choice experiment, multiple programmes contingent valuation and landscape preferences: How can we support the land use decision making process? *Land Use Policy* 29: 846-854.

de Groot, R. S., Alkemade, R., Braat, L., Hein, L., Willemen, L. (2010). Challenges in integrating the concept of ecosystem services and values in landscape planning, management and decision making. *Ecological Complexity* 7: 260-272.

Dubois, D., and Prade, H. (1980). *Fuzzy Sets and Systems, Theory and Applications* (Vol. 144). New York: Academic Press.

Finn, J. A., Bartolini, F., Bourke, D., Kurz, I., Viaggi, D. (2009). Ex post environmental evaluation of agri-environment schemes using experts' judgements and multicriteria analysis. *Journal of Environmental Planning and Management* 52: 717-737.

Foley, J. A., DeFries, R., Asner, G. P., Barford, C., Bonan, G., Carpenter, S. R., Chapin, F. S., Coe, M. T., Daily, G. C., Gibbs, H. K., Helkowski, J. H., Holloway, T., Howard, E. A., Kucharik, C. J., Monfreda, C., Patz, J. A., Prentice, I. C., Ramankutty, N., Snyder, P. K. (2005). Global Consequences of Land Use. *Science* 309: 570-574.

Frank, S., Fürst, C., Koschke, L., Makeschin, F. (2012). A contribution towards a transfer of the ecosystem service concept to landscape planning using landscape metrics. *Ecological Indicators* 21: 30-38.

Gisotti M.R. (2013). Rural territories in the Landscape Plan of Tuscany: structures, problems and transformation rules. *Scienze del Territorio* 1: 399-406

Guitouni, A. and Martel, J.-M. (1998). Tentative guidelines to help choosing an appropriate MCDA method. *European Journal of Operational Research* 109: 501-521.

Hermann, A., Schleifer, S., Wrbka, T. (2011). The concept of ecosystem services regarding landscape research: A review. *Living Reviews in Landscape Research* 5: 1-37.

Millenium Ecosystem (2005). Millennium ecosystem assessment Ecosystems and Human Well-Being, International Food Policy Research Institute (IFPRI). Washington DC: IFPRI.

Moran D. (2005). The economic valuation of rural landscapes Scottish Agricultural College - AA211 study for SEERAD

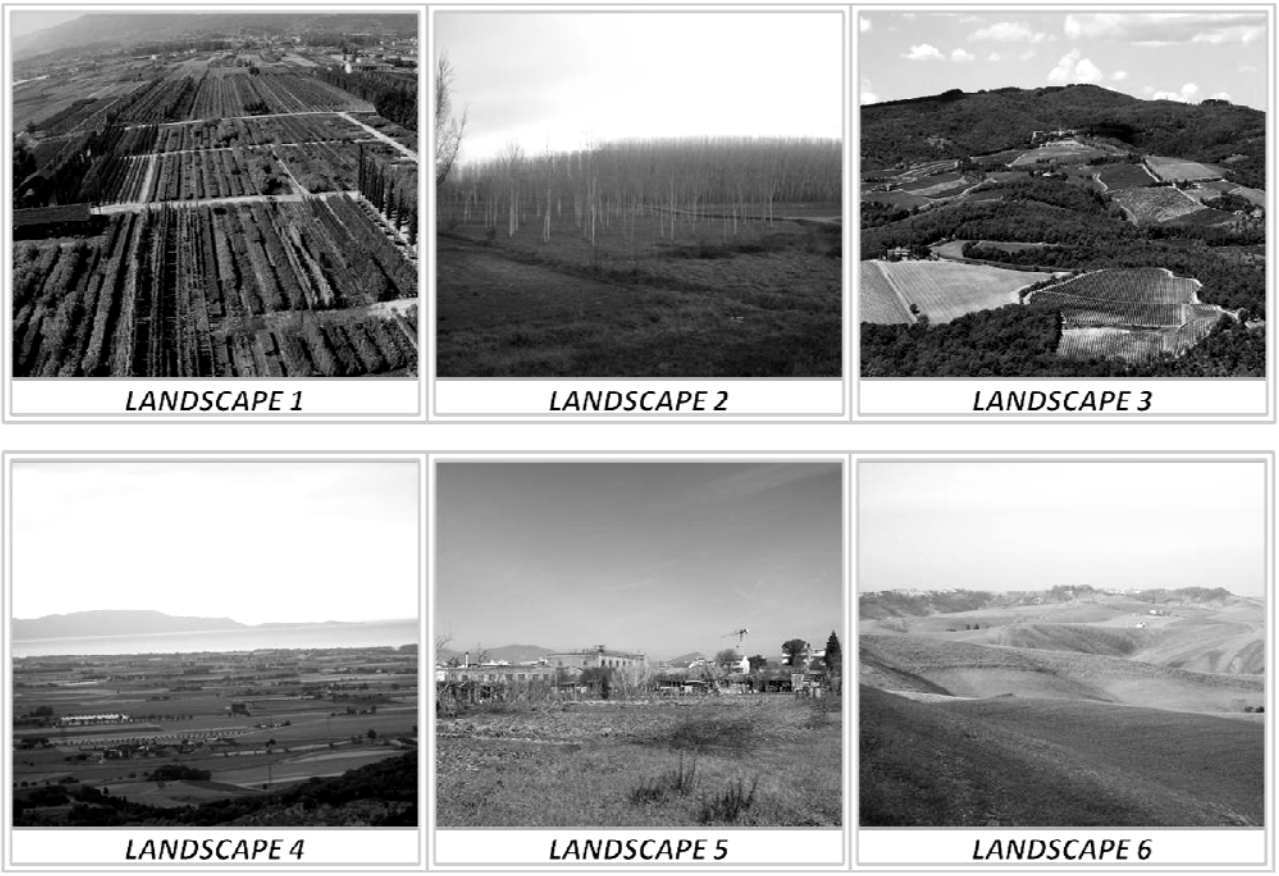
Regione Toscana (2013), Piano Paesaggistico, Sezione 3, Schede dei paesaggi e individuazione degli obiettivi di qualità-funzionamenti, dinamiche, obiettivi di qualità, azioni prioritarie, <http://www.regione.toscana.it/piano-paesaggistico/ambiti> (02/13).

Targetti S., Galimberti G. Manriques R. Raggi M. Viaggi D. (2012) Understanding the relationship between agricultural policy and landscape services: a review of methods. Paper prepared for presentation at the 1st AIEAA Conference 'Towards a Sustainable Bio-economy: Economic Issues and Policy Challenges' 4-5 June, 2012 Trento, Italy

van Zanten, B. T., Verburg, P. H., Espinosa, M., Gomez-y-Paloma, S., Galimberti, G., Kantelhardt, J., Kapfer, M., Lefebvre, M., Manrique, R., Piorr, A., Raggi, M., Schaller, L., Targetti, S., Zasada, I., Viaggi, D. (2014). European agricultural landscapes, common agricultural policy and ecosystem services: a review. *Agronomy for Sustainable Development* 34: 309-325.

Zhang, W., Ricketts, T. H., Kremen, C., Carney, K., Swinton, S. M. (2007). Ecosystem services and dis-services to agriculture. *Ecological Economics* 64: 253-260.

## ANNEX 1 RELEVANT LANDSCAPE SELECTED



## ANNEX 2- HIERARCHICAL STRUCTURE OF ECOSYSTEMS SERVICES

| **Upper level of Ecosystem services** | **Lower level of eco system services** | **Code** |
|---|---|---|
| Provisioning services | Food | prov_food |
| | Fibber, fuel, other row material | prof_fib&oth |
| | Ornamental species and/or resources | prov_orna |
| | Genetic material | prov_gen |
| Regulation services | Air quality | reg_air |
| | Water | reg_wat |
| | Erosion protection | reg_eron |
| | Pollination | reg_polli |
| | Natural hazard mitigation | reg_haz |
| | Climate regulation | reg_clim |
| | Biological regulation | reg_biol |
| Cultural and amenity services | Recreation and tourism | cul_tur |
| | Cultural heritage and identity | cul_her |
| | aesthetic | cul_aest |
| | Inspiration for culture, art and design | cul_art |
| | Spiritual and religion inspiration | cul_hist |
| | Education and science | cul_edu |