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EVALUATION OF ECOSYSTEM SERVICES PRODUCTION UNDER DIFFERENT AGRICULTURAL POLICY SCENARIOS

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Abstract

The objective of this study is to test a methodology for the classification of areas according to the provision of ecosystem services (ES) and for the evaluation of the effects of different agricultural policy scenarios on such classification. The framework was applied to the classification of the 26 municipalities of the province of Ferrara, Italy. The case study area can be considered a traditional cultural landscape, characterised by historical-cultural sites, agricultural areas and protected areas of natural importance. The evaluation focuses on the different categories of ES and applies a set of indicators available from secondary data sources assessing different aspects of ES. From the policy perspective, the context was represented by the pre-2014 CAP and represented the Baseline scenario. In the next stage, the model simulated a New CAP scenario, based on the measures of the RDP 2014-2020 that are addressed on restoring and enhancing ecosystems. The classification approach in each of the two scenarios was implemented under two weighting solutions. As a general remark, it is observed that the provision of ES varies greatly from one municipality to the next. All the municipalities offer a significant number of provisioning and cultural services, mainly connected to recreational opportunities. From the experience carried out in this study, we can conclude that the application of the PROMETHEE, in particular with the integration of the weights for the ES indicators, has shown the potential to support the characterisation of agricultural land in terms of the provision of multiple ES. The study presents MCDA as a suitable tool to illustrate the differences in the provision of ES in different case study areas. To some extent, in spite of the limitations of this work, this also applies to analyzing the consequences of different agricultural policy scenarios in the provision of these services.

1. Introduction and objectives

1.1 Background

The concept of ecosystem services (ES) has been used in research since the 1980s. The term was originally conceived to highlight humanity's dependence on nature, and the fact that the multitude of plant and animal species in the forests, oceans, lakes, wetlands, and other ecosystems provides humanity with a wide selection of goods. The concept of ES involved the framing of beneficial ecosystem functions as services in order to increase public interest in biodiversity conservation (de Groot, 1987). The next step during the 1990s, was the mainstreaming of ES in the literature (Costanza et al., 1997; Perrings et al., 1992). In 2001, the Millennium Ecosystem Assessment (MEA, 2000) emerged the ES on the global policy agenda (Gómez-Baggethun et al., 2010). The objective was to assess the consequences of ecosystem change for human well-being. The series of MEA publications described the condition and trends of the world's ecosystems and the services they provide, and the options available to restore, conserve or enhance their sustainable use. At present ES concept has become a central issue in conservation planning and environmental impact assessment (Burkhard et al., 2010).

Definitions of the ES concept through various publications, give attention to the ecological basis or the economic use, capturing environmental concerns in ecological and socio-economic terms (Diehl et al., 2016):

- Ecosystem Services are the benefits human populations derive, directly or indirectly, from ecosystem functions (Costanza et al., 1997).
- Ecosystem Services are the benefits people obtain from ecosystems (WRI, 2005).
- Ecosystem Services are components of nature, directly enjoyed, consumed, or used to yield human well-being (Boyd and Banzhaf, 2007).
- Ecosystem Services are the aspects of ecosystems utilized (actively or passively) to produce human well-being (Fisher et al., 2009).
- Ecosystem Services are the direct and indirect contributions of ecosystems to human well-being (TEEB, 2010a).

The ability of ecosystems to yield ES is largely connected to biodiversity; for this reason the ES and the biodiversity literature overlap to some extent. Biological diversity, or biodiversity, refers to the variety of life forms at all levels of organization. Biodiversity is generated and maintained in natural

ecosystems, where organisms encounter a wide variety of living conditions that shape their evolution in unique ways. Biodiversity is usually quantified in terms of numbers of species, and this perspective has greatly influenced conservation goals. It is important to remember, however, that the benefits that biodiversity supplies to humanity are delivered through populations of species residing in living communities within specific physical settings in other words, through complex ecological systems, or ecosystems (Luck et al., 2003). Natural ecosystems provide fundamental services which humanity needs. These include the production and maintenance of biodiversity; purification of air and water; decomposition of wastes and regulation of climate; services until recently have been less appreciated. The consequences of population loss for species conservation are well recognized, but have been little addressed from the point of the functioning of ecosystems and the provision of ES (Hughes et al., 1997). Because threats are increasing, there is a critical need for identification and monitoring of ES both locally and globally, and for the incorporation of their value into decision-making processes. There is a need for policies that achieve a balance between sustaining ES and pursuing the short-term goals of economic development.

Following the publication of the Millennium Ecosystem Assessment in 2005 (MEA, 2005), ES have been included for the first time into the international environmental policy agenda. This agenda included efforts to develop integrated systems of ecosystems (Weber, 2007). In current policies the ES concept is being integrated at global and European level (EC, 2009; Perrings et al., 2011). The global strategic plan for biodiversity for the period 2011 - 2020 (EC, 2011a) of the Convention of Biological Diversity complements previous conservation biodiversity targets with the addition of ES. The EU has adopted an ambitious strategy to halt the loss of biodiversity and ES in the EU by 2020 (EC, 2010a). There are 6 main targets, and 20 actions to help Europe reach its goal. Target 2 focuses on maintaining and enhancing ES and restoring degraded ecosystems by incorporating green infrastructure in spatial planning (Table 1). This will contribute to the EU's sustainable growth objectives and to mitigating and adapting to climate change, while promoting economic, territorial and social cohesion and safeguarding the EU's cultural heritage. It will also ensure better functional connectivity between ecosystems within and between Natura 2000 areas and in the wider countryside. According to the EU Biodiversity Strategy, by 2050, biodiversity and the ES, its natural capital, are protected, valued and appropriately restored for their essential contribution to human wellbeing and economic prosperity, and changes caused by the loss of biodiversity are avoided.

Biodiversity and agricultural production are connected and their capacity to be mutually supportive is increasingly recognized. On one hand, maintaining biodiversity makes agricultural production and

related practices more sustainable. On the other hand, it is recognized that changing agricultural land use is a major cause of the decline of biodiversity. As a result, the Common Agricultural Policy (CAP), the largest agricultural support system worldwide has been reformed in order to meet the Europe 2020 Strategy goals. The European Commission highlighted the importance of using the CAP to halt the decline of biodiversity, and various efforts have been made to merge biodiversity conservation into agricultural policy. At present, the CAP is divided in two main "pillars", pillar 1 includes market support measures and direct payments and pillar 2 includes rural development and agri-environmental policies. The reformed CAP has shifted from an agricultural production support system towards a broader focus including the inventory of public goods and ecosystems services provided by agriculture (EC, 2009a). Both CAP pillars contribute to biodiversity conservation, pillar 1 through direct payments and pillar 2, through agri-environmental measures. Importantly, also the EU Water, Regional and Cohesion Policy recognize the importance of investing in natural ecosystems, in particular urban green areas, floodplains and nature for recreation, as a source of economic development. However, it is further necessary to develop a policy framework that considers the most recent research on multidimensional ES and enhance the provision of ES in order to preserve social and cultural landscape values and maintain the multifunctionality of agricultural ecosystems. Both agriculture and regional development contribute to over 80% the annual EU budget, so the inclusion of ES in these policies is considered an important step towards a more sustainable economy.

Table 1 EU Biodiversity Strategy (Target 2)

By 2020, ecosystems and their services are maintained and enhanced by establishing green infrastructure and restoring at least 15 % of degraded ecosystems.
Action 5: Improve knowledge of ecosystems and their services in the EU
5) Member States, with the assistance of the Commission, will map and assess the state of ecosystems and their services in their national territory by 2014, assess the economic value of such services, and promote the integration of these values into accounting and reporting systems at EU and national level by 2020.
Action 6: Set priorities to restore and promote the use of green infrastructure
6a) By 2014, Member States, with the assistance of the Commission, will develop a strategic framework to set priorities for ecosystem restoration at sub-national, national and EU level. 6b) The Commission will develop a Green Infrastructure Strategy by 2012 to promote the deployment of green infrastructure in the EU in urban and rural areas, including through incentives to encourage up-front investments in green infrastructure projects and the maintenance of ecosystem services, for example through better targeted use of EU funding streams and Public Private Partnerships.
Action 7: Ensure no net loss of biodiversity and ecosystem services
7a) In collaboration with the Member States, the Commission will develop a methodology for assessing the impact of EU funded projects, plans and programmes on biodiversity by 2014. 7b) The Commission will carry out further work with a view to proposing by 2015 an initiative to ensure there is no net loss of ecosystems and their services (e.g. through compensation or offsetting schemes).

Source: (EC, 2011) and own elaboration

In the last decades, in the field of ES, there is a rise of concern for the valuation of ecosystem functions, goods and services. Early references refer to the concept of ecosystem functions, services and their economic value (Helliwell, 1969; Odum and Odum, 1972). More recently, there is a growth in publications on the benefits of natural ecosystems to human society (Daily, 1997; de Groot, 1992; Pearce, 1993; Wilson and Carpenter, 1999). Boyd and Banzhaf (2007) and Fisher and Kerry Turner (2008) focused on the quantification of ES and their value to stakeholders and suggested various classification schemes. Turner and Daily (2008) proposed that ecosystem service research should address the various stages in decision-making, from problem identification to policy evaluation and capacity building. The measurement, modelling and monitoring of ES requires also relating ecosystem functioning to ecosystem service indicators. Different approaches describe these relationships, which representation require data, maps, monitoring (Lautenbach et al., 2011), experiments (Sandhu et al., 2008), expert opinion or modelling (Carpenter et al., 2009). Mapping the provision of ES is in general constrained by data availability. Improved ways and methods for ES quantification and assessment are needed to investigate the number and quality of ES produced by the individual ecosystems and to increase the ability to feed such knowledge into policy design.
Despite the increase in publications on ecosystem goods and services, a comprehensive framework for integrated assessment and valuation of ES is still missing (Armsworth et al., 2007; van Zanten et al., 2014). As a result, the ES concept is currently used in a range of studies with widely differing aims. According to Ash et al. (2010) this variety presents a problem for policy makers as well as researchers because it makes it difficult to assess the credibility of assessment results and reduces the comparability of studies.

1.2 Research objective

The objective of this study is to test a methodology for the classification of areas (in our case municipalities) according to the provision of ecosystem services and for the evaluation of the effects of different agricultural policy scenarios on such classification. The focus is on sustainable land use, in terms of valuation of ecosystem services and natural resource management, linking socio-economic requirements with landscape potentials and applying multicriteria methods as the tool for analysis. The overall aim is to contribute to understanding the value of ecosystem services and improving methods for their evaluation, in an attempt to provide an instrument that contributes to closing the gap between the ecosystem service concept, regional planning and agricultural policies.

The analysis is based on the design of a framework suitable to be translated in a multicriteria evaluation process, followed by its empirical testing. In the present study, the PROMETHEE II multicriteria decision-making method is used. It is well adapted to problems where a finite number of alternatives are to be ranked considering several and sometimes-conflicting criteria. The framework was applied to the classification (outranking) of the 26 municipalities of the province of Ferrara, Italy. The case study area can be considered a traditional cultural landscape, characterised by historical-cultural sites, agricultural areas and protected areas of natural importance. The evaluation focuses on the different categories of ES and applies a set of indicators available from secondary data sources assessing different aspects of ES: the capacity of ecosystems to provide services, changes in the provision of ES, and benefits thus derived. In order to select a set of representative indicators, an extended literature review was carried out. The ES conceptual framework provided by the Millennium Ecosystem Assessment was used as it has proven effective for communicating how ecosystems underlie human well-being. The ES indicators were selected trying to achieve the best estimation of the benefits that people derive from an ecosystem, based on data already available for the area.

The method was tested considering two policy scenarios. In a first stage, the evaluation of the ES was based on the most recent data available. From the policy perspective, the context was represented by the pre-2014 CAP and, in particular, by the provisions of RDP 2007-2013. This represented the "Baseline scenario". In the next stage, the model simulated a "New CAP scenario", based on the measures of the RDP 2014-2020 of Emilia-Romagna Region and the specific operations of the Priority 4 that are addressed on restoring, preserving and enhancing ecosystems. All the key measures of Priority 4 support preserving, restore and enhance the ecosystems. However, only some of these measures have a direct influence on the values of the selected ES indicators in the present study. In order to understand which of the selected ES indicators are directly affected by the key measures addressed in the Priority 4, a detailed review of the different operations and output indicators of each measure has been performed. In the case of the New CAP scenario, the methodology was implemented according to the new values of the ES indicators.

The classification approach in each of the two scenarios was implemented under two weighting solutions. First the method was implemented without using weights, i.e. assuming that all indicators have equal weight. As a further step in the analysis, the framework was integrated with a weighting procedure in order to account for the different importance of the various ES indicators. The

approach adopted in the present study is based on individual judgment elicitation, using a questionnaire built on the same hierarchical structure the ES indicators are based on.

This study is an innovative work on ecosystem services evaluation. A considerable number of studies have contributed to improve the understanding of classification and valuation of ecosystem services. However, the values of different ES and the linkages between how CAP contributes and changes the provision of ES remain tested in spatial scales like regions or municipalities. Therefore, this study tries to fill this gap by discussing a particular evaluation on ecosystem services in municipality level, trying to measure the effects of different agricultural policy scenarios on the provision of ecosystem services.

The structure of the study is as follows. Chapter 2 describes the CAP evolution over the years and the post-2013 CAP reform. Chapter 3 presents the ecosystem services concept, a review of the relevant literature and a review of different methods for evaluation, mapping and assessment of the ecosystem services. Chapter 4 presents the theoretical framework of the proposed methodology. A description of the case study area and all the empirical information regarding the data collection are described in chapter 5. The results of the model are presented and interpreted in chapter 6. Chapter 7 presents a discussion of the results and chapter 8 illustrates the conclusions.

2. The Common Agricultural Policy

2.1 An overview of CAP history

The Common Agricultural Policy (CAP) has long been of symbolic importance to the European integration process and has been subject to calls for reform since the last 50 years. Proposed by the European Commission, it aimed to provide a framework to maintain adequate supplies, increase productivity and ensure that both consumers and producers received a fair deal in the market. The initial priority was to increase agricultural productivity in order to ensure farmers a satisfactory and equitable standard of living, and to stabilize agricultural markets and farmers' income (Tangermann, 2011). The priorities have shifted over time to environmental and animal concerns, as well as safety and health aspects. The need for a greater degree of integration of environmental issues in the agricultural policy gradually became evident in the 1980s. With the MacSharry 1992 reform, environmental protection became a concern of the CAP, in agreement with the general EU strategy of integrating environmental concerns in all policies. Under the agri-environmental regulation 2078/92, aid was made available to reduce agro-chemical inputs, to assist organic farming, to facilitate shifts to extensive forms of production or grassland management and to support production methods that protect the environment and maintain the countryside. The multi-functionality of agriculture was recognized by the Agenda 2000 reform: agriculture produces commodities, but also landscapes, balanced land use, and a quality environment. A new policy for rural development was developed, which became the second pillar of the CAP (Tangermann and von Cramon-Taubadel, 2013). In 2007 the policy introduced the EAFRD (European Agricultural Fund for Rural Development). The new CAP legal proposal on Rural Development (2011/0280 (COD) and 2011/0282 (COD)) established a Union sub priority on restoring and preserving the State of European Landscapes (Lefebvre et al., 2012). Regarding the new programming period, based in the document “The CAP towards 2020”, on October 2011 the Commission presented a set of legal proposals designed to make the CAP a more effective policy for more competitive and sustainable agriculture and vibrant rural areas (SEC(2011) 1154 final/2). As a consequence, the CAP has continued its gradual move from a production-based structure of subsidies to a market-oriented system, integrating support and standards for food safety, environment and biodiversity, animal welfare as well as rural development and innovation.

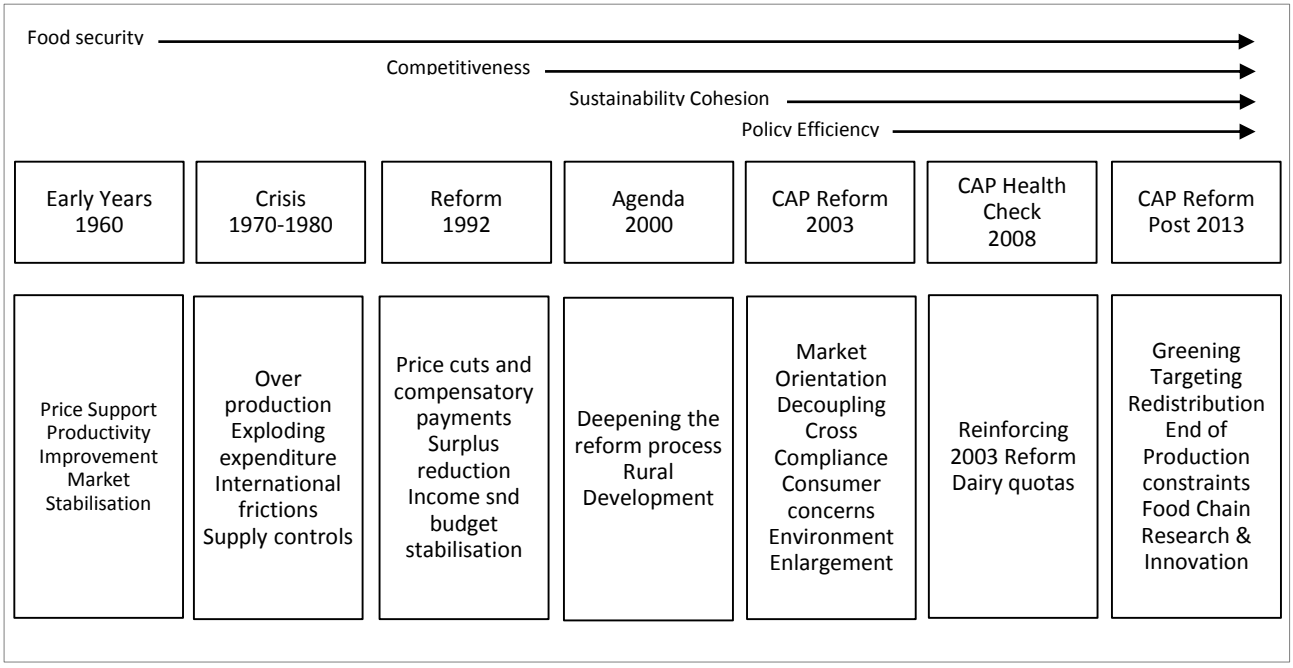
2.2 Development of the CAP

The CAP dates from 1957, and its foundations are entrenched in the Treaty of Rome. Article 39 of the Treaty specified a set of objectives for the CAP:

- to increase agricultural productivity by promoting technical progress and by ensuring the rational development of agricultural production and the optimum utilization of the factors of production, in particular labor;
- thus, to ensure a fair standard of living for the agricultural Community, in particular by increasing the individual earnings of persons engaged in agriculture,
- to stabilize markets;
- to secure availability of supplies;
- to ensure that suppliers reach consumers at reasonable prices.

Other important points are stated in Articles 40 and 43. According to the Article 40, the CAP should be implemented in stages during a five-year transition period starting in 1962. Article 43 placed the responsibility for designing the actual policy with the Commission, and the explicit deadline set was two years (Ritson and Harvey, 1997). The figure below (Figure 1) presents the different reforms and a selection of some main features, decisive in the development of the Common Agricultural Policy.

Figure 1 Historical Development of the CAP



Source: http://ec.europa.eu/agriculture/ and own elaboration

The key emphasis in the 1960s, when the CAP was brought into effect, was to increase agricultural productivity and food security. The means to achieve this were CAP subsidies and guaranteed prices to farmers, thus providing them with an incentive to produce. The framework established by the "common market organizations" set a minimum market price for the main commodities. In 1960 the Commission presented the proposal for the CAP (EC, 1960). The proposal included the following three principles for the Common Policy:

- free intra-community trade: no barriers to trade in agricultural products between the member states;
- community preference: suppliers from within the Community were to be given preference in the market over those from outside the Community;
- common financing: funding for the CAP would be through a European budget for all revenues and expenditures generated by the policy (Tracy, 1996).

A tariff union was created to ensure a common market based on free trade for agricultural products between the countries. All agricultural products were given their own market organizations with institutional prices. The market price on the internal market was to be stabilized through a system of intervention. In order to maintain the prices, the market organizations were combined with a system of variable import levies and export restitutions.

In 1968 a proposal for a structural policy reform of the CAP was presented COM (68) 1000 (EC, 1968). The aim of the reform was to implement measures that could ease structural adjustment in European agriculture, firstly by helping farmers to withdraw from agriculture through finding alternative occupations or taking early retirement, and secondly by reducing the farms, land and dairy cows in the agricultural sector in an effort to decrease overall production.

In the 1970s, attention was moved to problems with agricultural structures, agromonetary policies, signs of resurgence of strong national policies, and various reports and regulations of the early 1980s. Legislation was passed to modernize farms, to promote professional training, and to renew the agricultural work force by encouraging older farmers to take early retirement. In 1975, initiatives were taken to provide assistance to farmers working in difficult conditions, such as hill farmers and farmers in less favored areas (Vieri, 1994).

Since the early 1980s the CAP was connected to crises, trade wars, and has deadlocked GATT negotiations. According to Koster and Tangermann (1990) the following factors prompted CAP crises:

- a change in the EU's net trade position from being the world's largest importer of temperate-zone agricultural products to being the world's second largest exporter;
- exploding agricultural expenses leading the EU repeatedly into near-bankruptcy;
- failure to meet CAP objectives such as income parity between rural and urban workers and harmonization of rural living standards among regions;
- sensitivity of the price support scheme to exchange rate realignments;
- difficulties in policy formation;
- international pressure (GATT, agricultural exporters) to eliminate or change basic CAP mechanisms; and
- opposition from environmental groups.

As a result, by the 1980s, the EU had to struggle with almost permanent surpluses of most of the major farm commodities, which were either exported (with the help of subsidies), stored or disposed of within the EU (EC, 1985). Overall, the CAP distorted some world markets, did not always serve the best interests of farmers and resulted in some negative environmental impacts.

In May 1992 the EU adopted the most radical CAP reform package. With the MacSharry reform of 1992 several steps were taken by the EU to shift CAP subsidies away from price and market support towards direct support for farmers. This package reduced or eliminated support prices, and introduced direct compensation payments and mandatory set-aside for large farmers. It covered cereals, protein crops, oilseeds, beef, mutton and lamb, dairy, and tobacco, and was implemented between 1993 and 1996 (Martin, 1996). The main changes of the CAP during the decade 1985-1994, were international negotiations such as the GATT Uruguay Round, the European integration, the structural reform and the move towards diversification and Regional Rural Development policies (Ackrill, 2000).

By 1997 the cereal intervention and target prices fell by 33% and support prices in the oilseed sector were eliminated (Hathaway and Ingco, 1996). The EU compensated farmers for price reductions through payments per hectare, based on regional historical yields and actual farm size. Farmers received compensation payments for the set-aside at the rate for cereal price cuts. The EU eliminated co-responsibility levies and stabilizer penalties (Grant, 1997). On the contrary, changes in EU's dairy policies were negligible: they included a 2,5% cut in the target price for milk and a 5% cut in the intervention price for butter. EU policy makers removed co-responsibility levies but did not implement a planned 2% cut in the milk quota (Weyerbrock, 1998).

The Agenda 2000 reform, which basically continued along the same lines as the earlier MacSharry reform, was prompted by various factors (Moro and Sckokai, 1999). First, pressure for reform resulted from the proposed enlargement of the EU to include Central and Eastern European Countries (EC, 1998). Their relatively high share of agriculture in GDP would lead to unsustainable budget implications for the EU. Second, the anticipation of a new round of WTO trade negotiations generated a perceived need for further CAP adjustments. Third, and foremost, without reforms, the EU was thought to be unable to fulfill its earlier commitments made under the Uruguay round agreement (van Meijl and van Tongeren, 2002). Although Agenda 2000 in itself implied only minor changes, it continued to be the fundamental policy shift from market price support towards direct income support that began with the MacSharry reform.

From the perspective of transforming the CAP from a sectoral policy of farm commodity support into an integrated policy for Rural Development and environmental enhancement, the most significant feature of the Agenda 2000 reform was the Rural Development Regulation (1257/99), hailed by the European Commission as the new "second pillar" to the CAP (Lowe et al., 2002). With the Agenda 2000 reform different political aims became prominent, as signified by the shift in focus towards the maintenance and enhancement of the rural environment and the growing recognition of agriculture as a multifunctional activity (EC, 2000). However price support and income payments, together with milk quotas, remained the dominant support measures (Daugbjerg, 2003).

In June 2003 the European Council agreed on a compromise for the future of the CAP, the 2003 reform or Mid-Term Review (MTR) reform, which affected the impacts of the accession of the ten new member states. The reform included five main elements:

- continuation of the Agenda 2000 approach (revisions of the market policy, e.g. reductions in intervention prices for dairy);
- decoupling of direct support (a single farm income payment based on historical reference of payment);
- introduction of cross compliance (reduction of direct payments in case of non-respect of EU standards in the field of environment, food safety, animal health and welfare);
- strengthening of rural development by enhancing rural development instruments to meet new standards and by redistributing funds from 1st to 2nd pillar of the CAP;
- a mechanism for financial discipline to ensure that the CAP expenditures do not exceed the financial framework.

The main new feature of the Fischler Reform of the CAP is the Single Payment Scheme (SPS), i.e., the replacement of area and animal payments with single farm payments (SFP), which farmers received by activating their SFP entitlements (Gorton et al., 2008). The number of entitlements each farmer received at the starting point was equal to the average hectare between 2000 and 2002. Entitlements could be activated every year until at least 2013, but entitlement activation required the farming of a corresponding number of hectares of eligible land (Schmid et al., 2007). These payments were no longer linked to the quantity produced or the area planted, but they were still coupled to land (Swinbank and Daugbjerg, 2006). The 2003 CAP reform made further progress in the direction initiated by the Agenda 2000 reform, by aiming to make European agriculture more market oriented and giving a stronger focus to environmental protection.

In 2007 the EU launched a new, mini, reform of the CAP, which it called the "Health Check", and debate on the driving forces behind CAP reform re-emerged once again (EC, 2008). The key priorities for the Health Check and following on from the 2003 CAP reforms were the following (Henke et al., 2012):

- reducing the direct product related interventions with regard to cereals;
- reforming the set-aside rules regarding land use for cereals and other crops for food and fodder; the intention was to assist farmers to curb overproduction by paying compensation for not using land to grow such crops on some of their land;
- finding a way of helping farmers to cope with the ending in 2015 of the dairy quota – a limit on the amount of dairy products (e.g. milk) that can be produced;
- dealing with a range of new challenges including:
    - assisting farmers to further develop their risk management;
    - addressing issues arising from climate change such as changes in precipitation, extreme weather conditions, temperature levels, water availability and changed soil conditions;
    - water management;
    - biodiversity;
- strengthening the rural development aspects of the CAP; only 5% of direct aid under the CAP was directed into rural development and the proposal was be to increase to 13% by 2013.

Following the Health Check and with the Communication on "The CAP towards 2020: meeting the food, natural resources and territorial challenges of the future" COM (2011) 627 released in November 2010 (EC, 2010b), the process of post-2013 CAP reform began. After more than three

years of discussion and intensive negotiations, the reform process was concluded in December 2013 with the adoption of the four basic regulations of the reformed CAP by the Council of the European Union and, according to the Lisbon Treaty, for the first time by the European Parliament. These four consecutive regulations were covering the Rural Development (Reg.1305/2013), the financing, management and monitoring (1306/2013), Direct Payments for farmers (1307/2013) and, finally, market measures (1308/2013). To achieve the long-term goals for the CAP, the reform focuses on the competitiveness and sustainability of the agricultural sector by improving the targeting and efficiency of policy instruments (Keane and O'Connor, 2016).

The new CAP is aimed to be more efficient, targeted and coherent. It is based on a more holistic approach to policy support through the maintenance of the existing two pillar structure but in a more targeted, integrated and complementary way. Both pillars of the CAP are aimed at meeting the CAP objectives more effectively, with better targeted instruments of the first pillar complemented by regionally tailor-made and voluntary measures of the second pillar. A new payment scheme is introduced that will potentially induce changes at the individual farm level. The main objective of this new payment scheme is to redistribute the subsidies both between and within EU Member States and farmers in an equitable manner so as to move toward a more sustainable agricultural production. All EU Member States are therefore expected to implement in the short term the new payment scheme based on a uniform payment per hectare. That means they may take a national or regional approach enabling them to introduce a regional/national flat-rate payment by 2019, or ensure that those farms receiving less than 90% of the regional/national average rate see a gradual increase in payments, with the additional guarantee that every farmer receives a minimum payment equivalent to 60% of the national/regional average by 2019 (European Parliament and European Council, 2013). The previous single payment scheme is therefore replaced in this reform by a new basic payment scheme. Broadly similar to the single payment, the basic payment is a direct payment per hectare to active farmers based on their entitlements, which correspond to the eligible hectares. In addition to the basic payment scheme, the CAP reform introduces a "Payment for agricultural practices which are beneficial for the climate and the environment". This is commonly known as "greening payment" and represents an additional direct aid per hectare rewarding agricultural sustainable practices (Erjavec and Erjavec, 2015). The greening payment may potentially encourage farmers to meet certain environmental requirements in return for governmental support payments. This greening aid rewards farmers complying with three basic EU measures (or equivalent practices). These are: (1) crop diversification, (2)

maintenance of existing permanent grassland and (3) establishment of an ecological focus area on arable land (Hodge, 2013). Within the "green" elements that are now included in the programming period 2014-2020, the new CAP is expected to actively contribute to maintaining the rural landscape, to combating biodiversity loss and to mitigating/adapting to climate change (COM(2010) 672 final). Under Pillar II (Rural Development) of the revised CAP there are three long-term strategic objectives in the programming period 2014-2020: fostering the competitiveness of agriculture; ensuring the sustainable management of natural resources, and climate action; and achieving a balanced territorial development of rural economies and communities including the creation and maintenance of employment (EC, 2011b). More details are given in the next sections.

2.3 Rural Development Policy

The EU's Rural Development policy evolved as part of the development of the CAP, from a policy dealing with the structural problems of the farm sector to a policy addressing the multiple roles of farming in society and, in particular, challenges faced in a wider rural context. The strengthening of EU Rural Development Policy has become an overall EU priority. During recent years, European agricultural policy has given less emphasis to market mechanisms and, through targeted support measures, became more oriented towards satisfying the general public's growing demands regarding food safety, food quality, product differentiation, animal welfare, environmental quality and the conservation of nature and the countryside (EC, 2004).

Agenda 2000 established Rural Development Policy as the second pillar of the CAP, and brought Rural Development under a single regulation to be applied across the whole European Union. Following the fundamental reform of the first pillar of the CAP in 2003 and 2004 three major objectives for Rural Development Policy have been set for the period 2007-2013:

- increasing the competitiveness of the agricultural sector;
- enhancing the environment and countryside through support for land management;
- enhancing the quality of life in rural areas and promoting diversification of economic activities.

While the long-term strategic objectives of the Rural Development Policy post-2013 are left unchanged (competitiveness of agriculture, the sustainable management of natural resources and climate action and the balanced territorial development of rural areas), six EU-wide priorities have been defined to further specify these broad objectives: 1) innovation; 2) competitiveness and farm

viability; 3) food chain organization and risk management in agriculture; 4) restoring, preserving and enhancing ecosystems dependent on agriculture and forestry; 5) resource efficiency for a low-carbon and climate-resilient economy; 6) socio-economic development in rural areas.

2.3.1. Rural Development Policy in Italy

Rural Development in Italy is the overall responsibility of the Ministry of Agricultural, Food and Forestry policies (MIPAAF). Each of the 21 Italian administrative regions (19 regions and 2 autonomous provinces) has developed an individual Rural Development Program, which defines the policy strategy for the territory and indicates the measures chosen to address the specific needs of the rural areas. In the programming period 2000-2006, support of agriculture and rural development were fed by two different sources of finance. As regards the regions covered by Objective 1, all interventions are covered by the Rural Development Plans, co-financed by the EAGGF (European Agriculture Guidance and Guarantee Fund). All the other interventions are co-financed by the EAGGF and covered by specific Regional Operational Programs (ROP).

Regarding the programming period 2007-2013, each RDP consisted of 4 Axes, corresponding to the strategic priorities set in the National Strategy Plan (NSP). The total available resources amount to 16,687 billion euro, of which 8,292 billion were funded by the EU through the European Agricultural Fund for Rural Development. The NSP 2007-2013 focused on three main strategic objectives, chosen according to the Community Strategic Guidelines (CSG): 1- to improve the competitiveness of the farm/forestry sectors; 2-sustainable use of existing environmental and rural resources; 3- to improve the overall quality of life in rural areas, also by diversifying economic activities. Each strategic goal matches a given axis (1, 2, 3), with the 4th axis basically meant to serve as an integrated/bottom-up approach for reaching objectives n.2 and 3.

Looking at the key strategic objectives in more detail, the objective 1 was pursued mainly by:

- promoting farm innovation and filieres integration; developing quality of farm and forestry produce;
- strengthening the provision of physical and ICT infrastructures;
- improving the entrepreneurial capacity of farm and forestry workers.

For what concerns key objective 2, the indicated priority sub-objectives were:

- biodiversity conservation and safeguard of high-value agro-forestry systems;
- conservation of water resources; -reduction of greenhouse gases;

- countryside conservation.

The relatively minor attention to axis 3 in terms of funding were explained by the fact that, according to the NSP, its objectives could be better fulfilled if/when the previous two axis are properly supported and implemented.

Regarding the programming period 2014-2020, the RD Regulation addresses six economic, environmental and social priorities, and programs contain clear targets setting out what is to be achieved. It put also emphasis on networking activities at EU and national level:

1. fostering knowledge transfer and innovation in agriculture, forestry and rural areas;
2. enhancing the viability / competitiveness of all types of agriculture, and promoting innovative farm technologies and sustainable forest management;
3. promoting food chain organization, animal welfare and risk management in agriculture;
4. restoring, preserving and enhancing ecosystems related to agriculture and forestry;
5. promoting resource efficiency and supporting the shift toward a low-carbon and climate-resilient economy in the agriculture, food and forestry sectors; and
6. promoting social inclusion, poverty reduction and economic development in rural areas.

For the period 2014-2020, Italy has been allocated around EUR 10.4 billion for measures benefiting its rural areas. This will be spent in accordance with well-defined priorities set out in the 21 RDPs. Italy will focus in particular on strengthening research, fostering knowledge transfer and innovation as a cross-cutting priority, together with a specific attention to the Digital agenda, for facilitating the access to information and communication technologies for rural areas. Moreover, efforts will be made on enhancing the competitiveness of production systems and particularly of agricultural enterprises; supporting sustainable energy and quality of life; promoting climate change adaptation, risk prevention and management and protecting the environment and promoting resource efficiency.

2.3.2. Rural Development Policy in Emilia-Romagna

The overall objective of the Rural Development Plan 2007-2013 Reg (CE) n. 1698/2005 (E-R, 2014) of the Region of Emilia-Romagna was to support environmentally sustainable economic development that guaranteed improved competitiveness and social cohesion. There were three strategic objectives for Emilia-Romagna which corresponded to those of the Italian NSP: to improve competitiveness in the agricultural and forestry sectors; improve the environment and rural landscape; and, promote diversification of the rural economy and quality of life in rural areas. Taking

into account the additional funding provided by the CAP Health Check, the European Economic Recovery Package and Modulation/CMO Wine, the RDP was revised in 2009 to reflect the new challenges facing EU rural areas. RDP amendments included: reinforced efforts in activities contributing to water management, restructuring of the dairy sector, improved broadband internet infrastructure in rural areas, biodiversity, climate change mitigation and adaptation. The RDP 2007-2013 of Emilia-Romagna Region has adopted 30 measures for the rural and agricultural areas. As presented in Table 2, different measures contributed to the preservation of landscapes and focused on the delivery of ES, such as agri-environmental measures (Pillar II, axis 2, measure 214). Moreover they promoted competitiveness and quality of life of the agricultural sector (Pillar II, Axis 1, measures 111 and 123), diversification of rural economy (Pillar II, Axis 3, measures: 311, 313, 321 and 323).

The total public expenditure for 2007-2013 was 1,1 billion euro. At the end of 2013, 765 million euro was spent out of the allocated budget. More specifically, 330 million euro was the public expenditure for Axis 1, 352 for Axis 2, 59 million euro for Axis 3, 18 million euro for Leader and 6 million euro for technical assistance.

Table 2 Selected Measures by the RDP 2007-2013

Axis/Measures			**Public Expenditure**	**Share per Axis**
Axis 1 - Improving the competitiveness of the agricultural and forestry sector				
Promoting knowledge and improving human potential	111	Vocational training and information actions	15.340.909	4,0%
	112	Setting up of young farmers	84.090.909	22,0%
	113	Early retirement	27.532	0,0%
	114	Use of advisory services	11.677.014	3,0%
	115	Setting up of management, relief and advisory services		
Restructuring and developing physical potential and promoting innovation	121	Modernisation of agricultural holdings	160.909.091	42,0%
	122	Improvement of the economic value of forests	5.681.818	1,5%
	123	Adding value to agricultural and forestry products	84.090.909	22,0%
	124	Cooperation for development of new products, processes and technologies in the agriculture and food sector and in the forestry sector	7.727.273	2,0%
	125	Infrastructure related to the development and adaptation of agriculture and forestry		
		Restoring agricultural production potential		
Quality of agricultural production and products	131	Meeting standards based on Community legislation		
	132	Participation of farmers in food quality schemes	9.545.455	2,5%

	133	Information and promotion activities	3.863.636	1,0%
Transitional measures	141	Semi-subsistence farming		
	142	Producer groups		
	143	Providing farm advisory and extension services		
	144	Holdings undergoing restructuring due to a reform of a common market organization		
Axis 2 - Improving the environment and the countryside				
Sustainable use of agricultural land	211	Natural handicap payments to farmers in mountain areas	54.545.455	13,7%
	212	Payments to farmers in areas with handicaps, other than mountain areas	4.545.455	1,1%
	213	Natura 2000 payments and payments linked to Directive 2000/60/EC		
	214	Agri-environment payments	272.587.500	68,6%
	215	Animal welfare payments	3.863.636	1,0%
	216	Non-productive investments	13.863.636	3,5%
Sustainable use of forestry land	221	First afforestation of agricultural land	31.818.182	8,0%
	222	First establishment of agro-forestry systems on agricultural land		
	223	First afforestation of non-agricultural land		
	224	Natura 2000 payments		
	225	Forest-environment payments		
	226	Restoring forestry potential and introducing prevention actions	4.000.000	1,0%
	227	Non-productive investments	11.909.091	3,0%
Axis 3 - The quality of life in rural areas and diversification of the rural economy				
Diversify the rural economy	311	Diversification into non-agricultural activities	34.090.909	35,0%
	312	Support for business creation and development		
	313	Encouragement of tourism activities	4.545.455	4,7%
Improve the quality of life in rural areas	321	Basic services for the economy and rural population	31.840.909	32,7%
	322	Village renewal and development	16.136.364	16,6%
	323	Conservation and upgrading of the rural heritage	3.863.636	4,0%
	331	Training and information	4.772.727	4,9%
	341	Skills-acquisition and animation measure with a view to preparing and implementing a local development strategy	2.250.000	2,3%
Axis 4 – Leader				
Implementing local development strategies	411	Competitiveness	8.295.455	17,4%
	412	Environment/land management	4.772.727	10,0%
	413	Quality of life/diversification	23.636.364	49,5%
	421	Implementing cooperation projects	3.863.636	8,1%
	431	Running the local action group, skills acquisition, animation	7.159.091	15,0%

Source: Region of Emilia-Romagna and own elaboration

Emilia-Romagna's RDP 2014-2020 (E-R, 2015a) will fund action under all six Rural Development priorities with an almost equal emphasis on the four priorities related to competitiveness, food chain organization, restoring, preserving and enhancing ecosystems and resource efficiency and climate:

1. Knowledge transfer and innovation in agriculture, forestry and rural areas: Knowledge transfer and innovation actions will be put in place to increase the economic and environmental performance of agricultural holdings, as well as for the development of rural areas. Over 19.000 places will be made available in training courses and the program will give farmers access to advisory services on topics related to the RDP priorities. The region is planning to help launch more than 360 co-operation projects of which 116 will be Operational Groups under the European Innovation Partnership.

2. Competitiveness of agri sector and sustainable forestry: Support will be targeted to process and product innovation in farms as well as agro-industrial and forestry holdings. The objective is to improve output and product quality, combined with a reduction of production costs. Similarly important are the reinforcement of environmental sustainability, energy efficiency and corporate ethical responsibility in the supported holdings. For the forestry sector, investments will mainly go to infrastructure projects to facilitate the use of harvested wood products. The RDP will support the diversification of farms in order to create new income opportunities, for instance through the valorization of agricultural by-products and waste. Opportunities for social farming are also available, in particular in peri-urban areas. To reach these objectives, the region will support 870 investment projects to restructure or modernize farms and over 1.500 young farmers will be granted business start-up aid.

3. Food chain organization, including processing and marketing of agricultural products, animal welfare and risk management in agriculture: Under this priority, the region wishes to grant support to integrated projects in the supply chain. The objective is to increase and stabilize the profitability of primary producers but the modernization of production processes and support for quality production are also given priority. The region wants to encourage “from farm to fork” approaches and various forms of association in agriculture in order to reduce costs and improve the marketing of products. To reach these objectives, around 1.500 investment projects will be supported for total public cost of 200 million euro.

4. Restoring, preserving and enhancing ecosystems related to agriculture and forestry: Under this priority, Emilia-Romagna wants to safeguard water quality through the promotion of

agricultural production techniques that reduce pressure on the environment, combating erosion in hills and mountain areas and enhancing soil organic matter. The program also proposes actions for the sustainable management of ecosystems and habitats, for preventing agricultural land abandonment and preserving plant and animal agricultural biodiversity. In order to achieve these objectives, the region also aims at strengthening collective approaches at local level. Nearly 21% of the agricultural land will be under management contracts supporting biodiversity, 16% under management contracts supporting water management and 15% of the agricultural land will be under management contracts supporting soil management. Over 7.000 hectares will receive support to convert to organic farming and another 67.500 hectares to maintain organic production.

5. Resource efficiency and climate: The actions proposed for climate change mitigation and adaptation refer to promoting the rational use of water resources, the development of bioenergy and the use of agricultural and agro-industrial by-products, reducing emissions from agro-industrial activities and increasing carbon sequestration through forestry actions. Investments in agricultural holdings with environmental purposes will amount to 58,4 million euro of public expenditure. Farmers will receive support to switch to a more efficient irrigation system, covering more than 3.700 hectares. The region also expects that by investing 20 million euro of public money in renewable energy production, it will raise another 23 million euro of private funding. Finally, around 6,5% of all farmland and forest will come under management contracts targeting reduction of greenhouse gas and ammonia emissions.

6. Social inclusion and local development in rural areas: The main actions refer to fostering local development in rural areas and broadband internet deployment (including the development of ICT-services). The grassroots action of Local Action Groups (LAGs) is vital for social inclusion and the availability of care services in less developed rural areas. More than 110 beneficiaries will receive support for investments in non-agricultural activities in rural areas, while basic services will be improved for more than 6% of the rural population. Around 5,4% of the rural population will also benefit from new or improved broadband infrastructure thanks to investments under this priority, which will focus on areas of sparse population density. Local Development Strategies, which cover 17% of the rural population, will create 111 additional jobs (E-R, 2015b).

The measures adopted in the proposed RDP's and the planned public financing for each one, are presented in Table 3.

Table 3 Adopted Measures by the RDP 2014-2020

No	Measure	Total public expenditure
01	Knowledge transfer and information actions	21.745.887
02	Advisory services, farm management and farm relief services	8.436.808
03	Quality schemes for agricultural products and foodstuffs	8.065.767
04	Investments in physical assets	346.710.937
05	Restoring agricultural production potential damaged by natural disasters and catastrophic events and introduction of appropriate prevention actions	39.842.520
06	Farm and business development	104.748.784
07	Basic services and village renewal in rural areas	69.312.142
08	Investments in forest area development and improvement of the viability of forests	51.147.996
09	Setting-up of producer groups and organizations	-
10	Agri-environment-climate payments	175.924.047
11	Organic farming	100.559.342
12	Natura 2000 and Water Framework Directive payments	8.356.554
13	Payments to areas facing natural or other specific constraints	89.872.378
14	Animal welfare	10.500.000
15	Forest-environmental and climate services and forest conservation	-
16	Cooperation	63.207.650
17	Risk management	-
18	LEADER	-
19	Technical assistance and networking	66.397.799

Source: Region of Emilia-Romagna and own elaboration

As mentioned, Priority 4 is about preserving and enhancing ecosystems dependent on agriculture and forestry. This includes the preservation of biodiversity, in reference to Natura 2000 areas and agricultural areas of high natural value, better management of water resources, including the management of fertilizers and pesticides, and prevention as well as better management of soil. Priority 4 emphasizes also the importance of Sites of Community Importance (SCI) and Special Areas of Conservation (SAC) of the Natura 2000 network, identified as priority areas for rural development from 2014 to 2020 for the promotions of actions in favor of biodiversity and for the development of eco-agricultural activities in favor of sustainable management of the area. The focus areas identified under Priority 4 are:

A. Restoring, preserving and enhancing biodiversity, including Natura 2000 areas, areas facing natural or other specific constraints, High Nature Value farmland, and the state of European landscapes.
B. Improving water management, including fertilizer and pesticide management.
C. Preventing soil erosion and improving soil management.

The Rural Development Programme (RDP) for Emilia-Romagna Region was formally adopted by the European Commission on May 2015, outlining the priorities of Emilia-Romagna for using the 1,19 billion euro of public money that is available for the 7-year period 2014-2020 (nearly 513 million euro from the EU budget and 676 million euro of national co-funding).

The key measures provided for the new Rural Development regulation in relation to Priority 4 about preserving, restore and enhance the ecosystems are shown in Table 4 and are discussed below.

Table 4 Public expenditure for Priority 4 by Focus Area

Measure / type of operation	Total public expenditure	4A Biodiversity	4B Water management	4C Soil Management
M1 Knowledge transfer and information actions	8.808.927	907.857	6.085.356	1.815.714
1.1 Support for vocational training and skills acquisition actions				
1.2 Support for demonstration activities and information actions				
M2 Advisory services, farm management and farm relief services	3.486.640	86.090	3.099.235	301.315
2.1 Support to help benefiting from the use of advisory services				
M4 Investments in physical assets	7.005.180	3.441.771	3.563.409	
4.4.01 Ecosystem Renovation	430.221	430.221		
4.4.02 Prevention of damage caused by wildlife	3.011.550	3.011.550		
4.4.03 Realization of buffer zones and constructed wetlands for managing nitrates	3.563.409		3.563.409	
M7 Basic services and village renewal in rural areas	700.000	700.000		
7.6 Support for studies/investments associated with the maintenance, restoration and upgrading of the cultural and natural heritage of villages, rural landscapes and high nature value sites including related socio-economic aspects, as well as environmental awareness actions				
M8 Investments in forest area development and improvement of the viability of forests				
8.5 Support for investments improving the resilience and environmental value of forest ecosystems	10.928.939	10.928.939		
M10 Agri-environment-climate payments	178.680.060	66.030.145	100.521.389	12.128.526
10.1.01 Integrated production	98.008.354		98.008.354	
10.1.03 Increasing organic material	7.277.116			7.277.116
10.1.04 Conservation agriculture and increasing organic material	4.851.410			4.851.410
10.1.05 Animal Biodiversity	13.571.515	13.571.515		
10.1.06 Plant Biodiversity	308.580	308.580		
10.1.07 Sustainable management of extensive grassland	9.874.566	9.874.566		
10.1.08 Management of buffer strips to reduce pollution by Nitrates	2.513.035		2.513.035	
10.1.09 Management of Natura 2000 sites and conservation of natural and semi-natural areas and the agricultural landscapes	16.354.749	16.354.749		
10.1.10 Setting aside arable land for a 20-year period for use for environmental purposes and management of Natura 2000 sites	25.920.735	25.920.735		
M11 Organic farming	100.559.342		100.559.342	
11.1 Payment to convert to organic farming practices and methods	11.564.324		11.564.324	
11.2 Payment to maintain organic farming practices and methods	88.995.018		88.995.018	
M12 Natura 2000 and Water Framework Directive payments	8.356.554	8.356.554		
12.1 Compensation payment for Natura 2000 agricultural areas				

M13 Payments to areas facing natural or other specific constraints	89.872.378	89.872.378		
13.1.01 Compensation payment in mountain areas	79.986.416	79.986.416		
13.2.01 Compensation payment for other areas facing significant natural constraints	9.885.962	9.885.962		
M16 – Cooperation	17.387.340	4.121.100	11.678.920	1.587.320
16.1.01 Support for the establishment and operation of operational groups of the EIP for agricultural productivity and sustainability	13.266.240		11.678.920	1.587.320
16.5 Support for joint action undertaken with a view to mitigating or adapting to climate change, and for joint approaches to environmental projects and ongoing environmental practices	4.121.100	4.121.100		
TOTAL	414.856.421	173.515.895	225.507.651	15.832.875

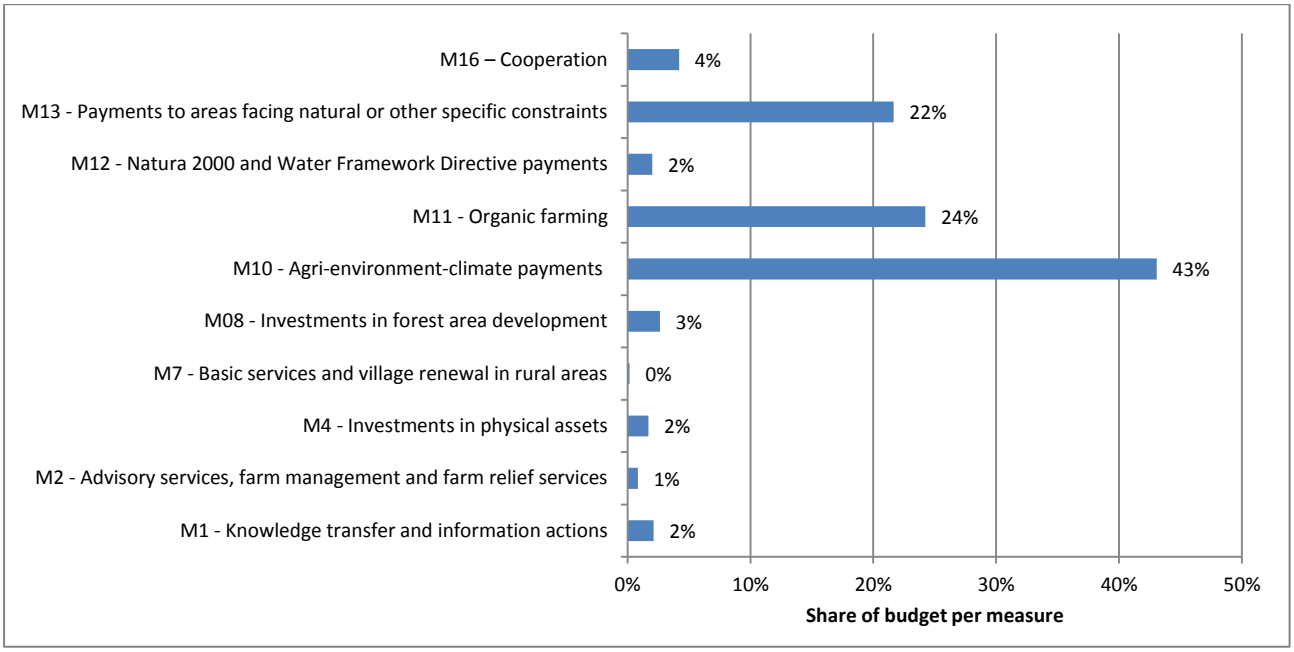
Source: (E-R, 2015a) and own elaboration

The agri-environment-climate payments (Measure 10, Art.28) are introducing or continuing to apply agricultural practices that contribute to climate change mitigation and adaptation and that are compatible with the protection and improvement of the environment, the landscape, natural resources, the soil and genetic diversity. This measure shall aim to preserve and promote the necessary changes to agricultural practices that make a positive contribution to the environment and climate. It will support a collective approach to the management and implementation, extending the categories of possible beneficiaries to associations of farmers or groups of farmers and other land managers, where this is justified for the achievement of environmental objectives. Support for organic farming, unlike in the past, where it was included among the actions related to agro-environment, is now governed by a specific measure (Measure 11, Art.29). There is also the inclusion of the Natura 2000 benefit (Measure 12, Art.30), with important simplifications to promote greater implementation, which provides aid that is supplied to cover additional costs and loss of income due to the constraints imposed by management plans and conservation measures resulting from the enforcement of Directive 2009/147/EC and Directive 92/43/EC. Another measure is non-productive investment (Measure 4, Art.17), linked to the achievement of the objectives of the agro-environment-climate, including the conservation of the biodiversity of species and habitats, as well as enhancing in terms of public utility of the Natura 2000 areas or of other high nature value systems. Support under this measure shall cover investments which improve the overall performance and sustainability of the agricultural holding. They are related to the development, modernization or adaptation of agriculture and forestry, including access to farm and forest land, land consolidation and improvement, and the supply and saving of energy and water. It is also confirmed the measure for basic services and villages renewal in rural areas (Measure 7, Art.20) which is in charge of supporting the drafting and updating of plans for the protection and

management of Natura 2000 sites and other areas of high natural value. Support under this measure shall also cover: investments in renewable energy and energy saving; investments for public use in recreational and tourist infrastructure; and, in addition, investments associated with the maintenance, restoration and upgrading of the cultural and natural heritage of villages and rural landscapes. Another important measure includes investments in forest area development and improvement of the viability of forests (Measure 8, Art.21-26). Support under this measure shall concern investments for afforestation and creation of woodland, establishment of agroforestry systems, prevention and restoration of damage to forests from forest fires, natural disasters and catastrophic events and climate related threats and investments in forestry technologies and in the processing, the mobilizing and the marketing of forest products. The program also envisages tools to promote training and information (Measure 1, Art.14), as well as advice and assistance to farmers (Measure 2, Art.15), in relation to the opportunities linked to the enhancement of biodiversity. Support under the measure to promote training and information is for the benefit of persons engaged in the agricultural, food and forestry sector, land managers and other economic actors which are SMEs operating in rural areas. Support under the measure concerning advice and assistance to farmers is aiming at farm modernization, competitiveness building, sectoral integration, innovation and market orientation, as well as the promotion of entrepreneurship. Advice may also cover other issues and in particular the information related to climate change mitigation and adaptation, biodiversity and the protection of water to Regulation (EU) No 1307/2013 or issues linked to the economic and environmental performance of the agricultural holding, including competitiveness aspects. In addition, there is the measure for payments to areas facing natural or other specific constraints (Measure 13, Art.31), which includes payments to farmers in mountain areas and other areas facing natural or other specific constraints. Payments will be granted annually per hectare of agricultural area in order to compensate farmers for all or part of the additional costs and income foregone related to the constraints for agricultural production in the area concerned. Finally, the new measure concerning cooperation (Measure 16, Art.35) promotes this type of orientation in reference to common approaches to agro-environment-climate projects and practices. Support under this measure shall be granted in order to promote forms of co-operation involving at least two entities and in particular: co-operation approaches among different actors, forestry sector and food chain and other factors that contribute to achieving the objectives and priorities of rural development policy, including producer groups, cooperatives

and inter-branch organizations. The share of budget per measure among those addressing Priority 4 is presented in Figure 2.

Figure 2 Budget distribution per Measure under Priority 4



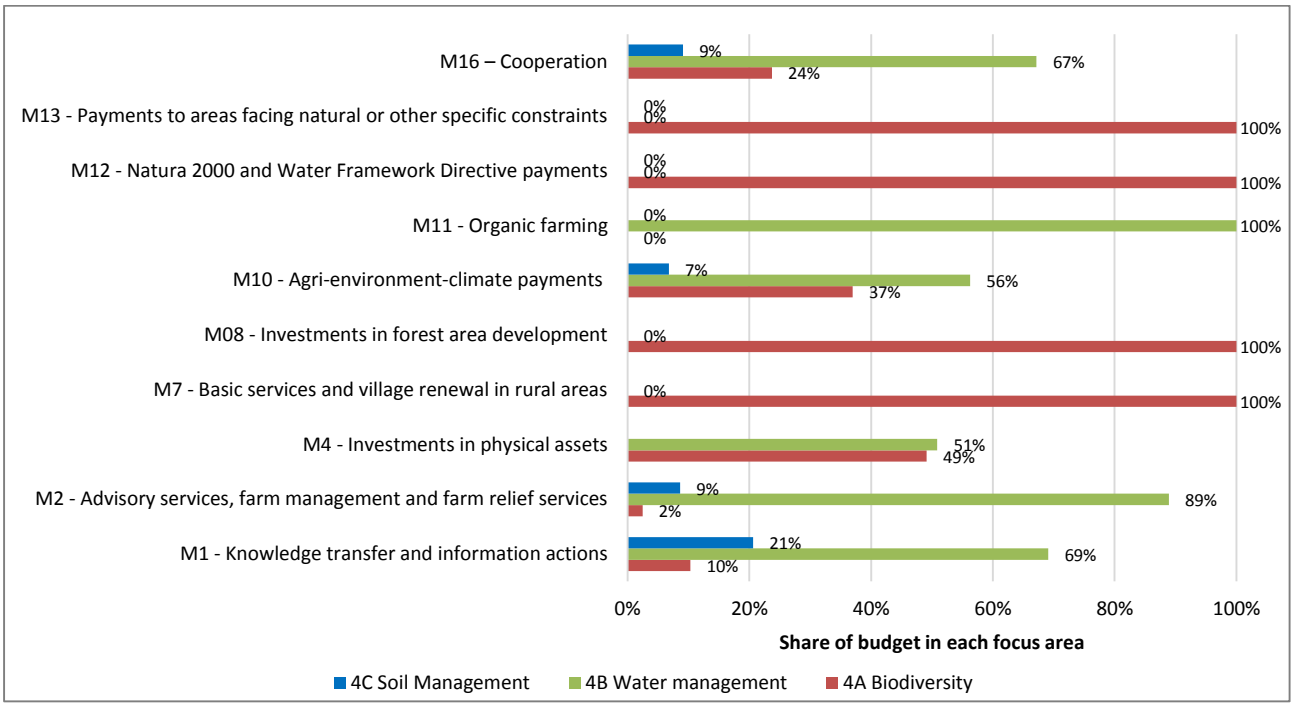
Source: own elaboration

The total public expenditure for Priority 4 is 414.856.421 euro. This budget is distributed into specific measures and operations. More than 40% of the total expenditure is allocated to the Measure 10 Agri-environment-climate payments. Additionally, 24% of the budget is payment to convert or maintain organic farming (Measure 11) and 22% are payments to areas facing natural or other specific constraints (Measure 13). The remaining 15% of budget is distributed among Measures like Cooperation (4%), Investments in forest area (3%), Knowledge transfer and information actions (2%), Investments in physical assets (2%) and Natura 2000 and Water Framework Directive payments (2%). Most of the Measures addressed under Priority 4 are subdivided into different operations. As observed, Measure 10 about agri-environment-climate payments is divided into nine operations. The total budget for Agri-environment-climate payments is distributed into the following operations: 54,8% is allocated to integrated production (10.1.01) and 14,5% to setting aside arable land for a 20-year period for use for environmental purposes and management of Natura 2000 sites (10.1.10). Additionally, 9,2% is allocated to management of Natura 2000 sites and conservation of natural and semi-natural areas (10.1.09) and 7,6% to animal biodiversity (10.1.05). Moreover, 5,5% is allocated to sustainable management of extensive grassland (10.1.07) and 4,1%

to increasing organic material (10.1.03). The rest operations regard minor rate of the total budget: 10.1.04 conservation agriculture and increasing organic material (2,7%), 10.1.08 management of buffer strips to reduce pollution by Nitrates (1,4%) and 10.1.06 plant biodiversity (0,2%). Other example, the budget for Measure 4 is distributed into three operations: 4.4.01 ecosystem renovation (6%), 4.4.02 prevention of damage caused by wildlife (43%) and 4.4.03 realization of buffer zones and constructed wetlands for managing nitrates (51%). The budget for Measure 13 is divided in two operations: 13.1.01 payments in mountain areas (89%) and 13.2.01 payment for other areas facing significant natural constraints (11%). Regarding Measure 11 organic farming, there are two main operations: 11.1 payments to convert to organic farming practices (11%) and 11.2 payments to maintain organic farming practices (89%). Additionally, for Measure 16 there are two operations, 16.1.01 support for the establishment and operation of groups of the EIP for agricultural productivity and sustainability (76%) and 16.5 support for joint action undertaken with a view to mitigating or adapting to climate change, and for joint approaches to environmental projects and ongoing environmental practices (24%).

The total expenditure is also distributed into the three focus areas, 41,8% is allocated to the Biodiversity (4A), 54,4% to the Water management (4B) and 3,8% to the Soil management (4C). The distribution of the budget of each Measure into the focus areas is presented in Figure 3. Among Priority 4 focus areas, the total budget for Measures 7 Basic services and village renewal in rural areas, M8 Investments in forest area, M12 Natura 2000 and Water Framework Directive payments and M13 Payments to areas facing natural or other specific constraints is totally allocated to Biodiversity. Additionally, the budget for Measure 11 Organic farming is all allocated to water management (4B). The budget of the other Measures is distributed into the three focus areas: Regarding Measure 1 Knowledge transfer and information actions, 69% of the budget is allocated to Water management, 21% to Soil management and 10% to Biodiversity. Moreover, 89% of the budget for the Measure 2 Advisory services, farm management and farm relief services is for Water management, 9% is for Soil management and 2% for Biodiversity. Regarding the Measure 4 Investments in physical assets, the budget is almost equally distributed in Water management (51%) and Biodiversity (49%). The budget for Measure 10 Agri-environment-climate payments is distributed by 56% in Water management, by 37% in Biodiversity and by 7% in Soil management. Finally, regarding the budget for Measure 16 Cooperation is distributed by 67% in Water management, by 24% in Biodiversity and by 9% in Soil management.

Figure 3 Budget distribution across focus areas of Measures under Priority 4



Source: own elaboration

Table 5 presents the planned indicators for each Measure addressed under Priority 4. The value of each indicator regards the planned output for 2014-2020. More specifically, 6.107 participants are planned to participate in trainings for knowledge transfer and information actions (M1) and 3.976 beneficiaries are planned to be advised by advisory services, farm management and farm relief services (M2). Regarding the Measure 4, the budget is planned to be allocated to 442 operations of support for non-productive investments. Regarding Measure 4, the operation 4.3.02 Irrigation infrastructures is also included, which is addressed in the focus area 5A: Increasing efficiency in water use by agriculture. The budget is 10.080.000 euro and is planned to be allocated to 3.714 hectares that regard the area concerned by investments for saving water, like more efficient irrigation systems. As regards Measure 8, the total budget is planned to be distributed to 1.311 hectares for investments improving resilience and value of forest ecosystems. The planned area under agri-environment-climate payments is 113.826 hectares, distributed into the nine operations mentioned above. About organic farming, the total area is planned to be 74.601 hectares, 90% of them for maintain and 10% to convert to organic farming practices and methods. Regarding Natura 2000 and Water Framework Directive payments (M12), the output indicator is the area of 2.540 hectares. Finally, for payments to areas facing natural or other specific constraints (M13) the output

indicator is 95.419 hectares, 83% of them are mountain areas and 17% other areas facing significant natural constraints.

Table 5 Planned output indicators for 2014-2020

Measure / type of operation	Value	Output Indicator
M1 Knowledge transfer and information actions	6.107	Number of participants in trainings
M2 Advisory services, farm management and farm relief services	3.976	Number of beneficiaries advised
M4 Investments in physical assets	442	Number of operations of support for non-productive investment (4.4)
4.3.02 Irrigation infrastructures (5A)	3.714	Area (ha) concerned by investments for saving water
M7 Basic services and village renewal in rural areas	10	Number of operations supported for drawing up of village development and N2000/HNV area management plans (7.1)
M8 Investments in forest area development and improvement of the viability of forests	1.311	Area (ha) concerned by investments improving resilience and value of forest ecosystems (8.5)
M10 Agri-environment-climate payments	113.826	Total Area (ha) under agri-environment-climate (10.1)
10.1.01 Integrated production	72.398	Area (ha)
10.1.03 Increasing organic material	6.126	Area (ha)
10.1.04 Conservation agriculture and increasing organic material	3.732	Area (ha)
10.1.05 Animal Biodiversity	10.281	Area (ha)
10.1.06 Plant Biodiversity	54	Area (ha)
10.1.07 Sustainable management of extensive grassland	11.681	Area (ha)
10.1.08 Management of buffer strips to reduce pollution by nitrates	513	Area (ha)
10.1.09 Management of Natura 2000 sites and conservation of natural and semi-natural areas and the agricultural landscapes	3.724	Area (ha)
10.1.10 Setting aside arable land for a 20-year period for use for environmental purposes and management of Natura 2000 sites	5.317	Area (ha)
M11 Organic farming	74.601	Total Area (ha)
11.1 Payment to convert to organic farming practices and methods	7.181	Area (ha) - convertion to organic farming (11.1)
11.2 Payment to maintain organic farming practices and methods	67.420	Area (ha) - maintainance of organic farming (11.2)
M12 Natura 2000 and Water Framework Directive payments	2.540	Area (ha) - NATURA 2000 AG land (12.1)
M13 Payments to areas facing natural or other specific constraints	95.419	Total Area (ha)
13.1.01 Compensation payment in mountain areas	78.804	Area (ha) - mountain areas (13.1)
13.2.01 Compensation payment for other areas facing significant natural constraints	16.615	Area (ha) - other areas with significant NC (13.2)

Source: (E-R, 2015a) and own elaboration

3. Approaches for Ecosystem Services Valuation

3.1 Ecosystem Services Concept

An ecosystem is usually defined as an area, place or environment where organisms interact with the physical and chemical environment. The ecosystem concept describes the interrelationships between living organisms and the non-living environment. *"An ecosystem is a dynamic complex of plant, animal, and microorganism communities and the non-living environment interacting as a functional unit"* (MEA, 2005). There is a full range of ecosystems, from natural forests, to ecosystems managed and modified by humans, such as agricultural land. Ecosystems provide a variety of benefits to people that are divided into market and non-market ecosystem goods or ecosystem services (ES) and classified in multiple ways.

It is common practice to refer to goods and services separately and to include the two concepts under the term services. Definitions of the ES through various publications, give attention to the ecological basis or the economic use, capturing environmental concerns in ecological and socio-economic terms (Diehl et al., 2016). ES have been categorized in a number of different ways, including:

- functional groupings, such as regulation, carrier, habitat, production, and information services (de Groot et al. 2002);
- organizational groupings, such as services that are associated with certain species, that regulate some exogenous input, or that are related to the organization of biotic entities (Norberg, 1999); and,
- descriptive groupings, such as renewable resource goods, nonrenewable resource goods, physical structure services, biotic services, biogeochemical services, information services, and social and cultural services (Moberg and Folke, 1999).

The Millennium Ecosystem Assessment framework (MEA, 2003) categorizes the ES within four categories: provisioning, regulating, supporting and cultural services:

Provisioning services are the services that describe the material or energy outputs from ecosystems:

- food and fiber including the range of food products derived from plants, animals, and microbes; food comes principally from managed agro-ecosystems but marine and freshwater systems or forests also provide food for human consumption;

- raw materials, fuel, wood, and other biological materials that serve as sources of energy, also a great diversity of materials for construction and fuel including wood, biofuels and plant oils that are directly derived from wild and cultivated plant species;
- fresh water, because ecosystems regulate the flow and purification of water; also vegetation and forests influence the quantity of water available; fresh water is an example of linkages between categories, in this case, between provisioning and regulating services;
- genetic resources, that includes the genes and genetic information used for animal and plant breeding and biotechnology;
- biochemical, natural medicines, and pharmaceuticals, since many medicines, biocides, food additives such as biological materials derived from ecosystems and are potential source of medicinal resources;
- ornamental resources including animal products, such as skins and shells, and flowers used as ornaments, although the value of these resources is often also determined culturally.

Regulating services are the benefits obtained from the regulation of ecosystem processes, the services that ecosystems provide by acting as regulators:

- air quality maintenance, because ecosystems contribute to extract chemicals to the atmosphere, influencing many aspects of air quality;
- climate regulation, both locally and globally; for example, at a local scale, changes in land cover can affect both temperature and precipitation; at global scale, ecosystems play an important role in climate by either sequestering or emitting greenhouse gases;
- water regulation, the timing and magnitude of flooding, and aquifer recharge can be strongly influenced by changes in land cover, including, in particular, alterations that change the water storage potential of the system, such as the conversion of wetlands or the replacement of forests with croplands or croplands with urban areas;
- erosion prevention and maintenance of soil fertility: soil erosion is a key factor in the process of land degradation and desertification; vegetation cover provides a vital regulating service by preventing soil erosion. Soil fertility is essential for plant growth and agriculture and well-functioning ecosystems supply the soil with nutrients required to support plant growth;
- water purification and waste treatment: ecosystems can be a source of impurities in fresh water but also can help to filter out and decompose organic wastes introduced into inland waters and coastal and marine ecosystems;

- regulation of human diseases; changes in ecosystems can directly change the abundance of human pathogens, such as cholera, and can alter the abundance of disease vectors, such as mosquitoes;
- biological control: ecosystem changes affect the prevalence of crop and livestock pests and diseases; they regulate pests and diseases through the activities of predators and parasites that all act as natural controls;
- pollination: insects and wind pollinate plants and trees which are essential for the development of fruits, vegetables and seeds; animal pollination is an ecosystem service mainly provided by insects but also by some birds and bats.

Cultural services are tightly bound to human values and behavior, as well as to human institutions and patterns of social, economic, and political organization. They are the non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences, including:

- recreation, mental and physical health: walking and playing sports in green space is not only a good form of physical exercise but also lets people relax; the role that green space plays in maintaining mental and physical health is increasingly being recognized, despite difficulties of measurement;
- spiritual and religious value: many religions attach spiritual and religious values to ecosystems or their components like natural features or specific forests, caves or mountains are considered sacred or have a religious meaning; nature is a common element of all major religions and traditional knowledge;
- educational values because ecosystems and their components and processes provide the basis for both formal and informal education in many societies;
- inspiration for culture, art and design: language, knowledge and the natural environment have been intimately related throughout human history; biodiversity, ecosystems and natural landscapes have been the source of inspiration for much of our art, culture and increasingly for science;
- aesthetic values: many people find beauty or aesthetic value in various aspects of ecosystems, as reflected in the support for parks or even the selection of housing locations;
- social relations, since ecosystems influence the types of social relations that are established in particular cultures; fishing societies, for example, differ in many respects in their social relations from nomadic herding or agricultural societies;

- cultural heritage values: many societies place high value on the maintenance of either historically important landscapes (cultural landscapes) or culturally significant species;
- recreation and ecotourism: ecosystems and biodiversity play an important role for many kinds of tourism which in turn provides considerable economic benefits and is a vital source of income; cultural and eco-tourism can also educate people about the importance of biological diversity.

Supporting services are those that are necessary for the production of all other ES. They differ from provisioning, regulating, and cultural services in that their impacts on people are either indirect or occur over a very long time, whereas changes in the other categories have relatively direct and short-term impacts on people:

- soil formation: humans do not directly use this as a service, but changes in soil formation would indirectly affect people through the impact on other services such as the provisioning service of food production;
- nutrient cycling: this indirect supporting service is required e. g. as the basis for crop production and plant growth;
- biomass production: primary production provides the basis of the food for all consumers;
- production of atmospheric oxygen through photosynthesis is often categorized as a supporting service since oxygen forms the basis for any animal life on Earth; any impacts on the concentration of oxygen in the atmosphere would only occur over an extremely long time;
- habitats for species: Habitats provide everything that an individual plant or animal needs to survive: food; water; and shelter; each ecosystem provides different habitats that can be essential for a species' lifecycle; migratory species including birds, fish, mammals and insects all depend upon different ecosystems during their movements.

Some services, like erosion control, can be categorized as both a supporting and a regulating service, depending on the time scale and immediacy of their impact on people. For example, humans do not directly use soil formation services, although changes in this would indirectly affect people through the impact on the provisioning service of food production. Fresh water is another example of linkages between categories, in this case, between provisioning and regulating services. Similarly, climate regulation is categorized as a regulating service since ecosystem changes can have an impact on local or global climate over time scales relevant to human decision-making. The production of

oxygen gas (through photosynthesis) is categorized as a supporting service since any impacts on the concentration of oxygen in the atmosphere would only occur over an extremely long time.

A new classification of ES is under development at international level, by the Common International Classification of Ecosystem Services (CICES, 2013). According to CICES, there are three types of services: (1) provisioning (products obtained from ecosystems, e.g. food, wood, water), (2) regulation and maintenance (moderation or control of environmental conditions, e.g. flood control, water purification), (3) cultural (non-material benefits obtained from ecosystems, e.g. recreation, education, aesthetics). CICES highlights the importance of making a clear distinction between final ES, ecosystem goods or products and ecosystem benefit, and recommend the following definitions:

- Final ecosystem services are the contributions that ecosystems make to human well-being. These services are final in that they are the outputs of ecosystems (whether natural, semi-natural or highly modified) that most directly affect the well-being of people. A fundamental characteristic is that they retain a connection to the underlying ecosystem functions, processes and structures that generate them.
- Ecosystem goods and benefits are things that people create or derive from final ecosystem services. These final outputs from ecosystems have been turned into products or experiences that are not functionally connected to the systems from which they were derived. Goods and benefits can be referred to collectively as “products”.
- Human well-being is that which arises from adequate access to the basic materials for a good life needed to sustain freedom of choice and action, health, good social relations and security. The state of well-being is dependent on the aggregated output of ecosystem goods and benefits, the provision of which can change the status of well-being.

Ecosystem service capacity and service output are closely related to the notion of stocks and flows. Layke et al. (2012) define stocks of ES as the capacity of an ecosystem to deliver a service while the flow corresponds to the benefits people receive. Stocks may be expressed in total size area or the total biomass whereas the associated ecosystem service flow or output must have units per time period. The capacity of an ecosystem to provide a flow is not necessarily measured in hectares or tons since the capacity does not only contain a quantity aspect but also a quality aspect. For a given quantity, an ecosystem may provide more output if it is in a healthy state, or at least be able to provide a sustained flow of services. As a result, the capacity of such a system to produce services will be higher. Ecosystems in a healthy state are considered resilient systems, which are able to recover after disturbance, and high species diversity and a balanced trophic community characterize

them. Benefits derived from ES are food, drinking water, clear air, fuel, fiber, construction materials, protection against disasters and stable climate. In the case of regulating services (e.g., climate regulation) and supporting services (e.g., nutrient cycling), aggregate stocks are most important. The "efficiency" with which stocks deliver specific ES will vary with ecology. Thus, a forest's capacity to provide climate regulation services will reflect broad patterns of species composition and architecture, but flows of services may not be closely linked to conservation value in terms of diversity (Carnus et al., 2006). Differences in harvesting technologies can lead to different flows of outputs from similar stocks. In timber concessions, chainsaws and powered haulage also change the scale and value of economic flows from a forest. In both cases, such technologies also, of course, have implications for sustainability of revenue flows. The value of provisioning service flows from a given stock of natural capital can therefore vary with the technology used. Technology is also important in demand for ES. The relationship between cultural services and stocks of biodiversity is a little more complex and can vary over time. Thus, the income from tourism based on the reintroduction of a charismatic locally extinct species might be expected to decline as the species becomes widespread. Moreover, different human actors may perceive the relationship between the size of stocks of biodiversity and the value of the flows of services that they provide differently. These relationships between biodiversity and valued ecosystem functions are an important area for further theoretical and experimental research (Vira and Adams, 2009).

3.2 Literature review on ES concept

Improved ways and methods for ES quantification, mapping and assessment are needed to investigate the number and quality of ES produced by individual ecosystems and to increase the ability to feed such knowledge into policy design (TEEB, 2010b). While provisioning ES can often be directly quantified thanks to the availability of primary data, for other ES the collection of such information is often impossible (Maes et al., 2015). Thus, for most regulating, supporting, and cultural services, researchers must rely on proxies for their quantification. As a result, altogether, data on quantifiable ES remain limited and only a small number of indicators are being used for those that cannot be measured directly (Feld et al., 2010). Reviews of indicators used for ES are available from the literature and contribute to developing reliable indicators for modelling and for bridging current data gaps (Cowling et al., 2008; Egoh et al., 2012).

Several studies have assessed changes in land use and their connection with the provision of ES (Carreño et al., 2012; Fontana et al., 2013; Silvert, 2000). In many cases, their output includes

environmental and land use information that are connected to landscape features, although few yield a direct assessment of changes in ES provision (Burkhard et al., 2012; Swetnam et al., 2011). According to de Groot et al. (2010), ES approaches and ES valuation efforts have changed the terms of discussion on nature conservation, natural resource management, and other areas of public policy. These efforts have strengthened both public and private sector development strategies and improved environmental outcomes (de Groot, 2006; de Groot et al., 2002).

In this thesis a literature review has been performed that covers an overview of various methodologies that seek to improve the knowledge base of the contribution of landscape management to the rural economy. This review of the literature is concerning methods relevant to the landscape management taking into account the CAP strategies and linkages with environmental impacts and climate change. Based on the analysis of the literature performed, the methodological tools were classified into three main categories (Table 6):

- identification and valuation of the ES and natural resource management;
- sustainable land use, in terms of assessment of agricultural systems and linking socio-economic requirements with landscape potentials;
- structure of the landscape, and linkages with environmental impacts and climate change.

Table 6 Studies that estimate Ecosystem Services

Method	Used for/example	Key References
Ecosystem services approach	Identification of ES and valuation of them separately	de Groot et al., 2006; 2010; Hein et al., 2006;
	Classification schemes as functions of both ecosystem and ecosystem service characteristics and decision-making	Fisher and Kerry Turner, 2008; Fisher et al., 2009
	Classification of ES - framework for decision-making in natural resource management	Wallace, 2007
	Classifying and valuing ecosystem functions, goods and services - link ecosystem functions to the main ecological, socio–cultural and economic valuation methods	de Groot et al. 2002
Sustainable land use	Potential effects, economic viability and social acceptability of Agri-environmental Regulation – AEI indicators	Onate et al., 2000
	Conceptual framework for the economic valuation and prioritization of sustainability indicators - based on Bayesian decision theory	Pannell and Glenn, 2000
	self-assessment tool based on the IDEA method to support sustainable agriculture - 41 indicators covering the three dimensions of sustainability	Zahm et al. 2008
	Indicators that cover the three components of the sustainability concept - evaluated the three dimensions sustainability with composite indicators	Gomez-Limon & Sanchez-Fernandez, 2010
	Indicators for multifunctional land use -Linking socio-economic requirements with landscape potentials	Wiggering et al., 2006
	Framework for sustainability assessment of agricultural systems, encompassed the three dimensions of sustainability	Glaser and Diele, 2004 Rasul and Thapa, 2004

Landscape structure	Selection of different input–output IOA systems as effective tools for Agri-environmental improvement - environmental indicators based on good agricultural practices	Halberg et al., 2005
	Approach which measures environmental sustainability of urban water system, based on LCA methodology	Lundin and Morrison, 2002
	LCA method, for assessing the environmental impact of production processes	Haas et al., 2000; 2001
	Quantitative measure of human disturbance based on land-use and solar energy (Emergy Accounting) consumption per use	Brown and Vivas, 2005
	Evaluation of ecosystem health and its measurement at a variety of landscape scales - linkages between socioeconomic drivers, biogeochemical indicators	Patil et al., 2001
	Stepwise downscaling procedure based on expert-judgement and pairwise comparison to obtain socio-economic parameters between the evolution of socio-economics and climate change	Abildtrup et al., 2006

Source: own elaboration

In the first category, De Groot (2006) presented a comprehensive framework for integrated assessment of ecological services and socio-economic benefits of natural and semi-natural ecosystems and landscapes. The framework can be applied at different scale levels to different ecosystems or landscape-units and consists of three steps: (1) Function-analysis, which translates ecological complexity into a limited number of ES; (2) Function valuation, which includes ecological, socio-cultural and economic valuation methods; (3) Conflict analysis, to facilitate the application of function-analysis and valuation at different scale levels. Hein et al. (2006) established an enhanced framework for the valuation of ES, with specific attention for stakeholders. The framework included a procedure to assess the value of regulation services that avoids double counting of these services. Moreover, the study analyzed the spatial scales of ES. The analysis has shown that stakeholders at different spatial scales can have very different interests in ES, and it is highly important to consider the scales of ES when valuation of services is applied to support the formulation or implementation of ecosystem management plans.

Moreover, Fisher et al. (2009) offer a definition of ES that is likely to be operational for ecosystem service research and several classification schemes: "*ecosystem services are the aspects of ecosystems utilized (actively or passively) to produce human well-being"*. Defined this way, ES include ecosystem organization or structure as well as process and/or functions if they are consumed or utilized by humanity either directly or indirectly. There is not one classification scheme that will be adequate for the many contexts in which ecosystem service research may be utilized. The paper discusses several examples of how classification schemes will be a function of both ecosystem and ecosystem service characteristics and the decision-making context. In addition, Wallace (2007) developed a classification of ES that provides a framework for decisions in natural

resource management. However, further work is still required to resolve particular issues, such as the classification of socio-cultural services. De Groot et al. (2002) presented a framework and typology for describing, classifying and valuing ecosystem functions, goods and services in a clear and consistent manner. In the second part of the paper, a checklist and matrix is provided, linking these ecosystem functions to the main ecological, socio–cultural and economic valuation methods. As regards the second category, Onate et al. (2000) tried to evaluate the potential effects of Agri-environmental Regulation EC 2078/92 on European agricultural landscapes through the use of agri-environmental indicators (AEIs) on policy effects. The main effects may be catalogued as improvement effects or protection effects since they represent a change in participant over non-participant farmers' decisions. Finally, the importance of this type of policy evaluation approach is discussed in the light of the likely future development of AEP in the European Union. Pannell and Glenn (2000) presented a conceptual framework for the economic valuation and prioritization of sustainability indicators. The framework was based on Bayesian decision theory, particularly its use to calculate the value of information under conditions of uncertainty. They tried to fill the gap of a conceptual framework as basis for evaluation and sustainable development. Moreover, Zahm et al. (2008) based on 41 sustainability indicators covering the three dimensions of sustainability, tried to design a self-assessment tool not only for farmers but also for policy makers to support sustainable agriculture. Gomez-Limon and Sanchez-Fernandez (2010) developed a methodology for evaluating the sustainability of farms by means of composite indicators. This methodology was based on calculating 16 sustainability indicators that cover the three components of the sustainability concept (economic, social and environmental). The evaluation of farm sustainability using the methods suggested is a potentially useful tool for public decision-makers who are tasked with designing and implementing agricultural policy. Wiggering et al. (2006) presented an approach to merge different types of output by defining an indicator of social utility. Social utility in this sense includes environmental and economic services as long as society expresses a demand for them. Within this approach, the integrated indicator concept incorporates the approaches of both sustainability and multifunctionality in land use and management. In addition, Glaser and Diele (2004) presented some central aspects of a sustainability assessment for a North Brazilian mangrove crab fishery, based on a number of criteria from biology, economics and sociology. They intended to contribute to future resource management plans to improve the living conditions of current and future generations while ensuring the health and productivity of the crab population and the mangrove ecosystem they depend on. Rasul and Thapa (2004) examined the sustainability of two production systems in terms

of their environmental soundness, economic viability and social acceptability, based on 12 indicators of sustainability.

In the last category, Halberg et al. (2005) selected ten input–output accounting systems (IOA) covering the topics of the farm's use of nutrients, pesticides and energy, from a survey of 55 systems and compared them. The approaches and indicators used vary from systems based on good agricultural practices (GAP) to accounts based systems that use physical input–output units. Haas et al. (2000, 2001) used the framework of a LCA in 18 grassland dairy farms covering three farming intensity levels. In this study, the selection of appropriate impact categories and functional units are emphasized, to fit specific agricultural and regional requirements in order to compare the impact of farms. The objective of this study was to adapt the LCA method, developed for assessing the environmental impact of production processes, to agriculture on the whole farm level, efficiently and feasibly assessing all relevant environmental impacts (Qureshi et al., 1999). In addition, Lundin and Morisson (2002) presented a procedure for the selection of indicators, which reflects the environmental sustainability of urban water system. The chosen indicators were evaluated in case studies in a developed and a developing region. This procedure combined empirical results with a theoretical framework based on LCA methodology. Brown and Vivas (2005) developed a method of quantitatively evaluating the human disturbance gradient that is applicable to landscapes of varying scales from watersheds to forest patches or isolated wetlands. Moreover, Patil et al. (2001) described the challenges of reporting on changes in an ecosystem health at the different landscape scales. The focus was to show how the integration of recent advances in quantitative techniques and tools will facilitate the evaluation of ecosystem health and its measurement at a variety of landscape scales. The challenge was to characterize, evaluate, and validate linkages between socioeconomic drivers, biogeochemical indicators, multiscale landscape pattern metrics, and quality of human life indicators. Finally, Abildrup et al. (2006) presented an integrated approach to the construction of socio-economic scenarios required for the analysis of climate change impacts on European agricultural land use. The chosen scenarios ensured internal consistency between the evolution of socio-economics and climate change.

A range of methodologies are available to value changes in ES. The type of valuation technique chosen depends on the type of ES to be valued, as well as the quantity and quality of data available. Some valuation methods may be more suited to capturing the values of particular ES than others (Galimberti et al., 2014). The valuation methodologies reviewed are not new in themselves. The challenge is in their appropriate application to ES. The Ecosystem Services Framework emphasizes

the need to consider the ecosystem as a whole and stresses that changes or impacts on one part of an ecosystem have consequences for the whole system (Jopke et al., 2015). Key challenges in the valuation of ES relate to how ecosystems interrelate to provide services and to dealing with issues of irreversibility and high levels of uncertainty in how ecosystems function. All of this suggests that, while valuation is an important and valuable tool for good policy-making, it should be seen as only one of the inputs in decision making (Mace et al., 2012).

3.3 Multicriteria methods in ES evaluation

Ecosystems are multifunctional, complex systems, described by a multitude of characteristics from the point of view of multiple criteria. The multidimensional logic of ES seems highly consistent with multicriteria approaches. According to Chan et al. (2012), ES provide multiple benefits, valued for a range of reasons, and researchers must employ valuation methods that better match the diversity of values in question. How to compare objects with multiple characteristics has been the focus of Multi-Criteria Decision Analysis (MCDA). MCDA is a general framework for supporting complex decision-making situations with multiple and often conflicting objectives. The considered goals are usually too complex to be properly assessed by a single criterion or indicator. Therefore, multiple relevant criteria or indicators are considered at the same time (Kiker et al., 2005). MCDA offer the possibility to use quantitative and qualitative information as obtained, for example, from expert judgments. Thus, data of diverse sources can be applied in an aggregation framework allowing for an examination of the initial problem (Belton and Stewart, 2002).

In order to valuing benefits provided by ecosystems and biodiversity social and economic aspects should be considered along with environmental issues. Multi-Criteria Decision tools allow simultaneous consideration of a wide range of economic, social and environmental decision criteria, representing different dimensions of sustainability. In the ecological domain, recent research by Gorshkov et al. (2000), show how the complexity of ecosystems and the ecological web and the biosphere in general can determine the climatic stability and resilience of the surrounding region or the global system. Recent research by Costanza (2014) contributes to the debate on the evaluation of a multitude of ES. Regan et al. (2006) present a coherent set of environmental criteria for evaluating biodiversity. Moffet (2005) offers an extensive overview of existing applications of multi-criteria methods to the problem of biodiversity evaluation.

Regarding ES evaluation, MCDA methods have been applied as decision support systems that integrate economic and noneconomic values (Newton et al., 2012), used as approaches for cost-

benefit analysis (Wegner and Pascual, 2011), or as a methodological framework for addressing value dimensions related to ES (Mendoza and Prabhu, 2003). Moreover, Koschke et al. (2012) have applied a multicriteria assessment framework for the qualitative estimation of regional potentials to provide ES as a prerequisite to support regional development planning. Oikonomou et al. (2011) proposed a conceptual framework that combines ecosystem function analysis, multi-criteria evaluation and social research methodologies for introducing an ecosystem function-based planning and management approach. Ananda and Herath (2009) provided a review of research contributions on forest management and planning. In studies that focused on a regional or landscape scale, spatial distribution of specific ES has been mapped (Egoh et al., 2008). Availability of data for an assessment of ES provision on a regional scale is often very limited. Up-scaling of detailed data from lower scales does not always contribute to an improvement in the data base on a regional scale. As an example, Kienast et al. (2009) and Burkhard et al. (2009) tested qualitative approaches to assess landscape functions and ES, respectively. Problems may occur in communicating the ES concept to the relevant planning actors (Meinke et al., 2006). Application-oriented studies that have focused on integrated sustainability and impact assessments in conservation planning have faced these challenges (Bell et al., 2003; Zerger et al., 2011) and have used participatory and multi-criteria approaches to solve the problems of data integration and communication.

Abu-Taleb and Mareshal (1995) have applied the PROMETHEE V multicriteria method to evaluate potential water resources and select from a variety of potentially feasible water resources development options, so that the allocation of limited funds to alternative development projects and programs can proceed in the most efficient manner. Bodini and Giavelli (1992) have applied three different evaluation techniques, multicriteria weighted concordance, discordance analysis and a qualitative procedure. These evaluation techniques were used to compare four alternative plans for the socioeconomic development of Salina Island, based on 14 criteria that reflect the socio environmental perception of the inhabitants. Moreover, Hokkanen and Salminen (1997) applied the multicriteria ELECTRE III decision-aid in the context of choosing a solid waste management system in Finland. Girardin et al. (2000) have adopted an interaction matrix to evaluate the effects of farmer production practices on the agro-ecosystem. Evaluation models were aggregated to yield two types of indicators: Agro-Ecological Indicators (AEI) that reflect the impact of one production practice on all environmental components; Indicators of Environmental Impact (IEI) that reflect the impact of all production practices. The evaluation matrix provided the raw material both for the development

of indicators (AEI or IEI) and for the use of multicriteria methods for sorting, selecting, or classifying cropping or farming systems. Paracchini (2011) proposed a further advancement in integrated assessment procedures by setting up an operational multi-scale and transparent framework, which comprised the assessment of European regions in terms of sustainability, and the identification of the impact that policy options might have on the sustainability of these regions. The framework was designed for use in ex ante sustainability impact assessment of policy scenarios on multifunctionality of land use and integrates economic, environmental and social issues (Paracchini and Capitani, 2011). Additionally, Posthumus et al. (2010) applied a multi-criteria analysis that enables a comparative assessment of ES for alternative land and water management scenarios, especially regarding the assessment of non-monetary values. They focused on a methodology that was developed to measure and value ES under different land management scenarios that reflect different priorities for food plain areas. Stewart and Scott (1995) introduced a framework in which MCDA tools are used for evaluating strategic planning options. This framework was based on direct evaluation of sequences of policy scenarios. Finally, Van Cauwenberg et al. (2007) proposed a framework for sustainability assessment of agricultural systems, (Sustainability Assessment of Farming and the Environment - SAFE). The framework was composed of principles, criteria, indicators and reference values in a structured way. Principles were related to the multiple functions of the agro-ecosystem and consistent approaches were used for the identification and selection of the indicators.

4. Methodology

4.1 Choice of the MCDA method (PROMETHEE II)

Multi-Criteria Decision Analysis (MCDA) is a set of methods that can be used to support the process of decision making by taking into consideration multiple criteria in a flexible manner, by means of a structured and intelligible framework. MCDA are integrative evaluation methods in the sense that they combine information about the performance of the alternatives with respect to the criteria (scoring) with subjective judgements about the relative importance of the evaluation criteria in the particular decision-making context (weighting). Hobbs (1980) highlighted the use of multi-criteria decision analysis when faced with a mix of monetary values, quantified data and qualitative considerations. Weighting and scoring can be used to bring data expressed in different units into the appraisal process. This approach usually involves an explicit relative weighting system for the different criteria relevant to the decision. MCDA methods can structure an assessment of a complex problem along both cognitive and normative dimensions, both of which are essential in evaluating ES (Vatn, 2009). They are helpful in illustrating trade-offs between different ES and the distributional impacts of the decisions to use of conserve ES. (Daily et al., 2009). They are also suited well for capturing social and ethical concerns that might escape from monetary valuation approaches.

The selection of a certain MCDA method has to be based on an appropriate knowledge of the basics of the approach and of the characteristics of the evaluation to be performed (Dembczyński et al., 2009). Cinelli et al. (2014) presented the performance of different MCDA methods (MAUT, AHP, PROMETHEE, ELECTRE and DRSA), with respect to ten crucial criteria that evaluation tools should satisfy, among which are thresholds and uncertainty management, software support and ease of use. The analysis has shown that most of the requirements are satisfied by the MCDA methods although to different extents. This implies the recognition that some aspects can be covered only by certain methods and not by others and the choice of the methodology for a specific evaluation problem is a non-trivial issue.

Outranking approaches (specifically ELECTRE and PROMETHEE) have been the most widely MCDA tools in evaluation and sustainability-related research as reported in various publications (Herva and Roca, 2013; Huang et al., 2011; Wang et al., 2012). The approach used in the present study is based on the outranking method Preference Ranking Organisation Methods for Enrichment Evaluations (PROMETHEE II). PROMETHEE methods are the most widely software supported approach in terms

of data management, specifically due to the problem representation, supporting comparisons of scenarios, visualization of the influence that different weights, criteria, and preference functions they have (Geldermann and Zhang, 2001; Mareschal et al., 2008). PROMETHEE applies the outranking method and provides a complete ranking of a discrete set of possible alternatives, from the best to the worst, using the concept of net flow (see more details below) (Brans and Mareschal, 2005; Brans and Vincke, 1985). It is well adapted to problems where a finite number of alternatives are to be ranked whilst considering several and sometimes-conflicting criteria (Brans et al., 1998). In addition, the mathematical model is relatively easy to understand and is capable of determining preferences among multiple decisions (Vinodh and Jeya Girubha, 2012). PROMETHEE, unlike other outranking methods, does not aggregate good scores on some criteria and bad scores on others (it is non-compensatory), uses less pairwise comparisons, does not have the artificial limitation of rigid scoring systems (e.g. the use of a 9-point scale for evaluation) and allows more flexibility in the determination of the weights (Albadvi, 2007).

A considerable number of successful applications of the PROMETHEE methodology is available in various fields such as banking, manpower planning, water resources, investments, medicine, chemistry, health care, tourism, and dynamic management (Andreopoulou et al., 2011, 2009; Behzadian et al., 2010, 2013; Olson, 2001; Olson et al., 1998). Wolfslehner et al. (2011) based on a PROMETHEE II algorithm, calculated relative sustainability impact rating. Moreover, Madlenera et al. (2007) used the PROMETHEE method to compare and rank different energy scenarios according to 16 economic, social, environmental, and technological criteria.

Regarding ES evaluation and assessment, different studies have used ranking approaches as a tool to evaluate ES. At times those tools are used as part of a larger ES assessment process that can involve simultaneously identifying ES and drivers of change, as well as ranking of the most important services (López-Marrero and Hermansen-Báez, 2011; Shelton, 2001). Segura et al. (2015) applied a PROMETHEE-based method to obtain new composite indicators for provisioning, maintenance and “direct to citizen services”. Fontana et al. (2013) have used PROMETHEE to compare land use alternatives considering ES as criteria. Queiruga et al. (2008) applied PROMETHEE to rank Spanish municipalities according to their appropriateness for the installation of waste electrical and electronic equipment recycling plants. Hermans et al. (2007) used PROMETHEE to evaluate river management alternatives and elicit preferences to rank and compare individual and group preferences. PROMETHEE has also been used in environmental management for ranking and selecting environmental projects (Yan et al., 2007) and environmental impact assessments for

ranking waste management alternatives and air quality/emission problems (Huang and Wang, 2014).

As well as for supporting decision making through ranking of alternatives, PROMETHEE has also been used to classify regions or areas. For example, Vaillancourt and Waaub (2004) used PROMETHEE to rank regions in order to allocate greenhouse gas emission rights. Chatzinikolaou et al. (2013) applied PROMETHEE for the comparison and ranking of EU rural areas based on social sustainability indicators. In these cases, the classification derived from the implementation of the PROMETHEE outranking can be used as a support to the comparative evaluation of the ecosystem/social endowment of the ranked regions and/or to support policy design with respect to zoning/targeting.

4.2 PROMETHEE II Modeling Framework

4.2.1. The Multicriteria Problem

For the implementation of the PROMETHEE II, the procedure proposed by Brans et al. (1986) is recommended. The procedure starts by considering the multi-criteria problem (1):

$$Max\{f_1(a), \dots f_k(a), \backslash\ a \in K\} \quad (1)$$

where K is a finite set of actions a, and $f_i, i = 1, \dots k$, are k criteria to be maximized.

The PROMETHEE methods include two phases (Roy, 1991):

- the construction of an outranking relation on K,
- the exploitation of this relation in order to provide an answer to (1).

In the first phase, a valued outranking relation based on a generalization of the notion of criterion is considered: a preference index representing the preferences of the decision maker is defined.

The exploitation of the outranking relation is realised by considering a positive and a negative flow for each action. A partial preorder (PROMETHEE I) or a complete preorder (PROMETHEE II) on the set of possible actions can be proposed to the decision maker in order to achieve the decision problem.

4.2.2. Identification of alternatives

The procedure is carried out by choosing between different elements to be examined and assessed using the set of criteria. These elements are called actions or alternatives and need to be identified

before the further steps. In the present study, we use an extended notion of alternative where the objects to be compared are not actions, but rather different items. Specifically, in this exercise, the "alternatives" to be examined and evaluated (ranked) are the 26 municipalities of the province of Ferrara.

4.2.3. Defining a set of criteria

The criteria represent the tools that enable alternatives to be compared from a specific point of view. The alternatives are compared pairwise under each criterion. Two alternatives a and b, can express an outright preference, a weak preference or indifference. In the present study, criteria are represented by a set of ES indicators, which are presented in the next section.

4.2.4. Evaluation matrix

Once the set of criteria and the alternatives have been selected, then the payoff matrix is built. This matrix tabulates, for each criterion - alternative pair, the quantitative and qualitative measures of the effect produced by that alternative with respect to that criterion.

4.2.5. Determining the multi-criteria preference index

The preference structure of PROMETHEE is based on pairwise comparisons. The preference index, for each pair of alternatives $a, b \in K$, ranges between 0 and 1. The higher it is (closer to 1), the higher the strength of the preference for a over b. When the pairs of alternatives a and b is compared, the outcome of the comparison is expressed as follows:

- $\mathrm{P(a,b)} = 0$ means indifference between a and b, or no preference of a over b;
- $\mathrm{P(a,b)} \sim 0$ means a weak preference of a over b;
- $\mathrm{P(a,b)} \sim 1$ means a strong preference of a over b;
- $\mathrm{P(a,b)} = 1$ means a strict preference of a over b.

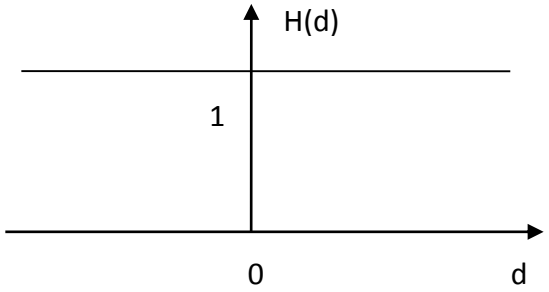
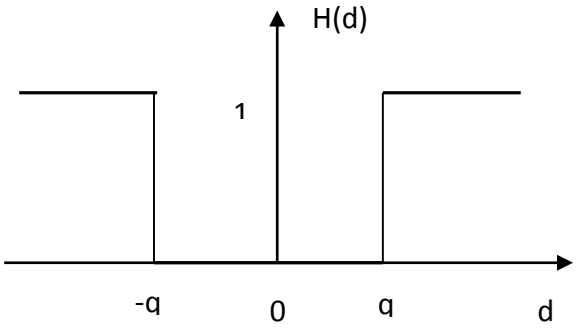
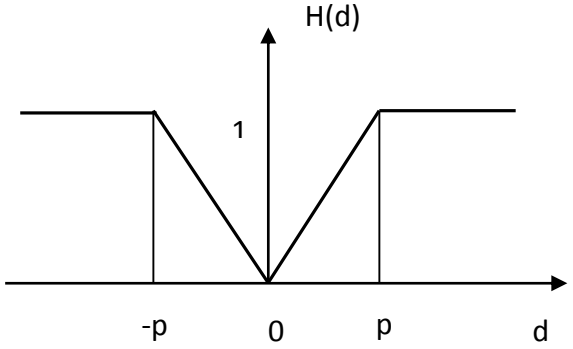
For each criterion f, we consider a generalized criterion defined by f and a corresponding preference function P.

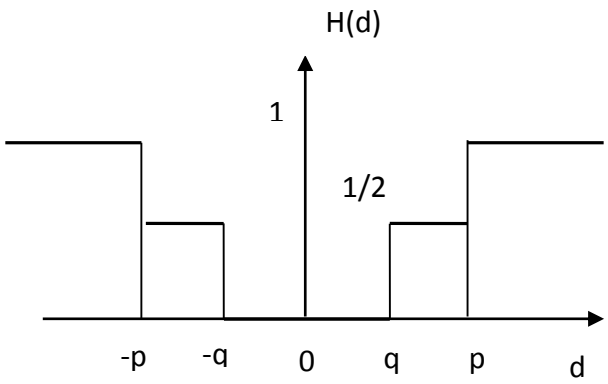
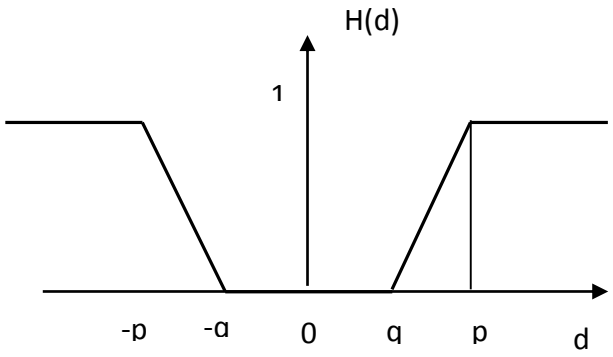
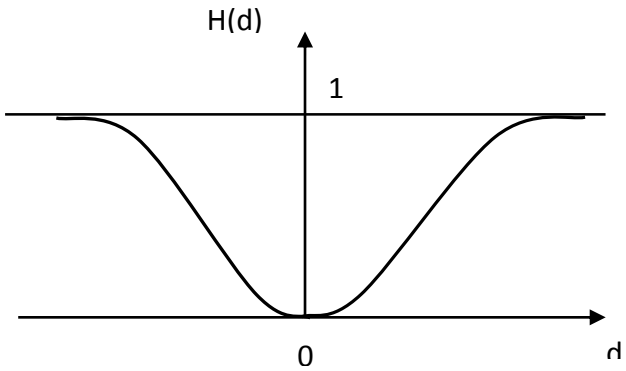
$\mathrm{H(d)}$ is an increasing function of the difference d, between the performances of alternatives a and b on each criterion and d is the deviation between the evaluations of two alternatives on each criterion (2) (Vincke, 1992):

$$H(d) = \begin{cases} P(a,b), d \geq 0 \\ P(b,a), d \leq 0 \end{cases} \quad (2)$$

The $H(d)$ function can be of various different forms, depending upon the judgment policy of the decision maker (Kalogeras et al., 2005; Zopounidis, 1999; Zopounidis and Doumpos, 2001). Generally, six forms of the $H(d)$ function are commonly used and are presented in the table below (Table 7):

Table 7 Forms of the Preference function

Criterion	Graphical form of generalized criteria	Parameters
I. Usual criterion		-
II. Quasi-criterion		q
III. Criterion with linear preference		p

IV. Level criterion		q, p
V. Criterion with linear preference and indifference area		q, p
VI. Gaussian criterion		σ

Source: (Brans and Mareschal, 1990)

In each case 0, 1 or 2 parameters have to be defined: q is a threshold or indifference; p is a threshold of strict preference; and σ is an intermediate value between and q and p. The following overview provides the shape of the six possible types of generalized criteria.

I. Usual criterion

$$H(d) = \begin{cases} 0 \; if \; d = 0 \\ 1 \; if d \neq 0 \end{cases} \tag{3}$$

In this case, there is indifference between a and b if and only if $f(a) = f(b)$ as soon as the two evaluations are different, the decision maker has a strict preference for the action having the

greatest evaluation. In this case, no parameter has to be defined. This generalized criterion corresponds to the usual meaning of criterion.

II. Quasi-criterion

$$H(d) = \begin{cases} 0 \; if \; -q \leq d \leq q \\ 1 \; if \; d < -q \; or \; d > q \end{cases} \tag{4}$$

The two actions are indifferent to the decision maker as long as the difference between their evaluations, i.e. d, does not exceed the indifference threshold q; if this is not the case, there is strict preference. If the decision maker wishes to use a quasi criterion, he has only to determine the value of q, which is the greatest value of the difference between two evaluations, below which the decision maker considers the corresponding actions as indifferent.

III. Criterion with linear preference

$$H(d) = \begin{cases} {}^{d}/_{p} \; if \; -p \leq d \leq p \\ 1 \; if \; d < -p \; or \; d > p \end{cases} \tag{5}$$

As long as d is lower than p, the preference of the decision maker increases linearly with d. If d becomes greater than p, we have a strict preference situation. When the decision maker identifies some criterion to be of that type, he has to determine the value of the preference threshold p: This is the lowest value of d above which he considers that there is strict preference of one of the corresponding actions.

IV. Level criterion

$$H(d) = \begin{cases} 0 \; if \; |d| \leq q \\ {}^{1}/_{2} \; if q < |d| \leq p \\ 1 \; if \; p < |d| \end{cases} \tag{6}$$

In this case, an indifference threshold q and a preference threshold p are simultaneously defined. If d lies between q and p, there is a weak preference situation $(H(d) = 1/2)$. The decision maker has this time two thresholds to define.

V. Criterion with linear preference and indifference area

$$H(d) = \begin{cases} 0 \; if \; |d| \leq q \\ {}^{(|d| - q)}/_{(p - q)} \; if q < |d| \leq p \\ 1 \; if \; p < |d| \end{cases} \tag{7}$$

In this case, the decision maker considers that his preference increases linearly from indifference to strict preference in the area between the two thresholds q and p. Two parameters are to be defined.

VI. Gaussian criterion

$$H(d) = 1 - exp\{-d^2/2\sigma^2\} \quad (8)$$

This function requires the determination of σ, which should be defined between q (threshold) and p (strict preference threshold). This function having no discontinuities, is interesting in order to guarantee stability of the results. In the present study, the shape of the $H(d)$ function selected is the Gaussian form (8), (Koutroumanidis et al., 2002), where d is the difference among the alternatives a and b $[d = f(a) = f(b)]$ and σ is the standard deviation of all differences d. It has been observed that the Gaussian criterion has been the most selected by users for practical applications.

4.2.6. Weighting

Once the preference function Pi $(i = 1,2,3, \ldots . k$ represent the criteria) is defined, the weights of each criterion must be determined. The weights π represent the relative importance of the criteria used, if all criteria are equally important then the value assigned to each of them will be identical (Hermans, 2007). The multicriteria indicator of preference $\Pi(a,b)$, which is a weighted mean of the preference functions $P(a,b)$ with weights π_i for each criterion, express the superiority of the alternative a against alternative b after all of the criteria are tested. The values of $\Pi(a,b)$ are calculated using the following equation (Brans and Mareschal, 2005) (9):

$$\Pi(a,b) = \frac{\sum_{i=1}^{k} \pi_i P_i(a,b)}{\sum_{i=1}^{k} \pi_i} \quad (9)$$

4.2.7. Ranking the alternatives

The traditionally non-compensatory models include some for which the preferences are aggregated by means of outranking relations. When each alternative is facing other alternatives the following outranking flows are defined: The positive outranking flow, which expresses how an alternative is outranking all the others. It is its outranking character (10):

$$\varphi^+(a) = \sum_{b \in k} \Pi(a,b) \quad (10)$$

The negative outranking flow, which expresses how an alternative is outranked by all the others. It is its outranked character (11):

$$\varphi^{-}(a) = \sum_{b \in k} \Pi(b, a) \quad (11)$$

Finally, the net outranking flow, which is the balance between the positive and the negative outranking flows; the higher the net flow, the better the alternative (12):

$$\varphi(a) = \varphi^{+}(a) - \varphi^{-}(a) \quad (12)$$

The results are expressed by the preference functions, which are calculated for each pair of options. The weighted preference index is defined by representing the preferences of the decision maker. Initially, the model assumes that the criteria are equally important. As a further step, the model is integrated with an approach to elicit weights. In the final stage, two alternatives (a, b) are compared with each other and each one is assigned two values of flows. The positive flow expresses the total superiority of the alternative a against all of the other alternatives for all of the criteria. The negative flow expresses the total superiority of all of the other alternatives against alternative a for all of the criteria. $\Phi(x)$ is the net flow of each alternative (the difference between the positive and the negative flow) and is used to obtain the final evaluation.

4.3 Agricultural Policy Scenarios

The methodology simulated two agricultural policy scenarios. The alternatives scenarios are referring to the Rural Development Policy adopted by the Region of Emilia-Romagna and the two latest reforms: The Rural Development Programme (RDP) 2007-2013 for Emilia-Romagna, Council Regulation (EU) No 1698/2005 - CCI 2007IT06RPO003 that was formally adopted on 12 September 2007 and the RDP 2014-2020 for Emilia-Romagna, Council Regulation (EU) No 1305/2013 - CCI 2014IT06RDRP003 that was formally adopted by the European Commission on 26 May 2015. In a first stage, the evaluation of the ES was based on the pre-2014 CAP and, in particular, by the provisions of RDP 2007-2013. This represented the "Baseline scenario". In the next stage, the model simulated a "New CAP scenario", based on the measures of the RDP 2014-2020 of Emilia-Romagna Region and the specific operations of the Priority 4 that are addressed on restoring, preserving and enhancing ecosystems. All the key measures of Priority 4 support preserving, restore and enhance the ecosystems. However, only some of these measures have a direct influence on the values of the selected ES indicators. In order to understand which of the selected ES indicators are directly affected by the key measures addressed in the Priority 4, a detailed review of the different operations and output indicators of each measure has been performed. In the case of the New CAP scenario, the methodology was implemented according to the new values of the ES indicators.

4.4 Weighting Approach

Several methodologies have been proposed to elicit weights. These methodologies can be grouped in two different approaches: statistical and subjective (Schoemaker and Waid, 1982). The first group includes mainly multiple regression models, while the latter approach includes analytic hierarchy process, trade-off estimation, swing weights and direct point allocation (Hayashi, 2000; Weber and Borcherding, 1993). Different studies have attempted to evaluate which method offers the best results (Borcherding et al., 1991; Easley et al., 2000), but overall none of these methods are dominant or display superior performance. However, several authors have pointed out that the methods that derive weights as a ratio (i.e. swing weights or AHP) have higher internal consistency compared to the others (Borcherding et al., 1991; Schoemaker and Waid, 1982; Stewart, 1992).

In the case of PROMETHEE, the methodology does not explicitly provide an own way to elicitate appropriate weights and it is then usually integrated with an approach to elicit weights. Macharis et al. (2004) advise to determine weights according to several methods: AHP, direct rating, point allocation, trade-off and pairwise comparisons (Murat et al., 2015). Turcksin et al. (2011) applied an integrated approach that combines the Analytic Hierarchy Process (AHP) and the PROMETHEE. AHP was used to structure the decision problem and to attribute weights to the criteria, whereas PROMETHEE was used to obtain a final ranking of the proposed alternatives and to perform sensitivity analyses by changing the weights. Furthermore, Kilic et al. (2015) used a combined methodology, first ANP to determine the weights of all criteria, and then, the obtained weights were used in the PROMETHEE for the selection of the best enterprise resource planning (ERP) for a Small Medium Enterprises (SMEs) in Istanbul, Turkey.

The approach adopted in the present study is based on individual judgment elicitation (Bartolini et al., 2011). The approach is characterized by the use of an individual questionnaire, the design of a hierarchical series of questions to elicit the importance of the different components for each level; and the use of a ratio method to compare the importance of the different objects within the same level. The choice of this method is somehow a compromise, using some elements of the ration methods, which are considered the better performing of the weighting methods (Borcherding et al., 1991; Schoemaker and Waid, 1982), while making explicit the hierarchical structure given to the problem, which is maintained during the elicitation of weights (Bartolini and Viaggi, 2010). In order to collect all the necessary information, a questionnaire was submitted to experts on ecosystems and landscape management (Bartolini et al., 2005). The selected ES have a hierarchical structure,

divided into three levels, covering the four ES categories and the main ES groups on each category. In each question, we asked the interviewee to express the relative weights for indicators of the same level, quantifying their importance with respect to the upper level. Importance is quantified through the choice of the level of importance on a Ratio scale, on 9 levels plus the zero option (Harker and Vargas, 1987). The structure was the same for all questions. Changes are only due to the different number and content of indicators for each sub-level (Bartolini et al., 2005, 2007). The questionnaire is available as annex II.

Following the hierarchical structure, in each question we asked the interviewee to express the relative importance of each element of the same group with respect to the upper level. This hierarchical structure enables the quantification of the importance of each element in the upper level, as the sum of the importance of the elements of each group (I) immediately below them (Bartolini et al., 2010). Respondents were asked to identify first which element(s) within each group is/are more important with respect to the upper level objective, and then to assign the highest score to this/these elements. Then, the other elements of the same level were assigned a direct rating using a scale between 0 and 9, representing the importance of each element in comparison to the most important one previously identified. The aim is to derive a set of weights for each ES indicator (w_i) that takes into account the priorities of the elements at the upper hierarchical level (Bartolini et al., 2005). The procedure is split into two parts:

First, the set of individual weights w_{ij}^{l} is obtained by two normalisation procedures from the questionnaire answers (13). This operation was undertaken firstly using the maximum value $maxwe$ as a normalising factor for the elicited weights w_{ij}^{l} and secondly using the sum of the weights for all elements belonging to the same group:

$$w_{ij}^{l} = \frac{\frac{we_{ij}^{l}}{maxwe}}{\sum_{i=1}^{I}\frac{we_{ij}^{l}}{maxwe}} = \frac{we_{ij}^{l}}{\sum_{i=1}^{I} we_{ij}^{l}} \quad (13)$$

with: l= hierarchical level (1,2,3,4); j = expert; i= element; I = group; we_{ij}^{l}= relative importance of the element i within the group I as answered by expert j for the level l; $maxwe$ = maximum value among we_{ij}^{l} expressed by the DM within the same group (I).

The second part aims to obtain a single judgment (w_i) importance using a multiplicative function across levels and then an average across experts. The weight of each element i for the expert j (w_{ij}) with respect of the full set of elements placed in the same level l is obtained through a multiplicative function between the weights of the elements present for all the upper hierarchical levels (14).

$$w_{ij} = \prod_{i=1}^{L} w_{ij}^{l} \text{ with } l = 1; 2; 3 \quad (14)$$

Considering the hierarchical structure, the value of the importance of a generic element w_{ij} is dependent on the element placed at the upper hierarchical level. It helps consider within the analysis the zero value of the element placed on an upper level. This means that if one element placed at level 1 has importance equal to zero, then the entire lower level has a zero value. The synthesis of the judgment expressed by all experts (w_{ij}) for the same element, is obtained by using an arithmetical mean of the weights, in order to give the same importance to all experts. In this way, the weight allows a direct comparison of the importance of each element of a level with all the other elements of the same level (15).

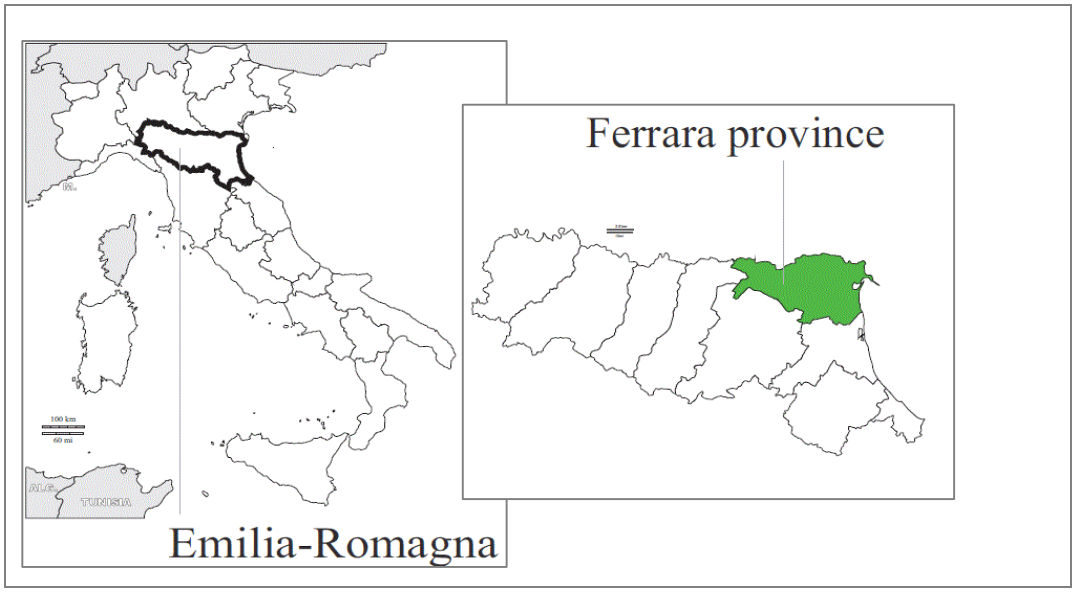
$$w_i = \frac{1}{j} \sum_{j=1}^{J} w_{ij} \quad (15)$$

5. Case Study and Empirical Implementation

5.1 General features of the Study Area

The study area is the province of Ferrara, located on the eastern side of the Emilia-Romagna Region (Figure 4). This section presents the description of the area. More specifically, it analyzes some key variables regarding territorial and demographic aspects and the employment in agriculture. The province of Ferrara is composed of 26 municipalities, covers an area of 2,635 km^2 and has total population of about 353,000 (ISTAT).

Figure 4 Area of Study



Source: own elaboration

Agriculture has traditionally played a significant role in the local economy, whereas the tourism sector has been developing gradually in recent decades (Zavalloni et al., 2015). Agriculture and trade are the most important sectors in the area, followed by building and industry. Several areas are characterised by an enjoyable natural environment, which led to the development of human activities linked to fishing, agriculture, tradition, culture and art. Artificial areas (urban areas, small villages) are characterized by their ancient history and the high presence of historic buildings. Agriculture management is medium-high intensive, and includes production aimed at international agri-food supply chains. Twelve percent of the total area is occupied by an average size of farms of 10-20 ha, while 40% of the area is occupied by large dimension farms larger than 100 ha. The coastal area, presenting beaches and dunes, was significantly changed by agriculture activities and the

development of tourism. The coastal territory, consisting of 48,27 km of low and sandy coast, includes 21,17 km of bathing areas. The bathing area stretches from the Sacca di Goro, near Lido di Volano, to the mouth of Bellocchio canal, in the municipality of Comacchio. Land reclamation activities have influenced the area; most important, they currently assure the stability and good hydraulic regime, a correct water drainage and good hydraulic conditions of the territory, the adaptation and realization of reclamation, and assure the maintenance of the activities to protect and increment the surface water resources for agricultural use. Local summer tourism is also an important market for horticultural farms (mainly placed on the beach side). During holiday time, the demand for beaches, the presence of areas of high naturalistic value, and the historical places have promoted a development of hospitality structures, rental houses, hotels, camping areas, beaches with restaurants, etc. This has damaged the coastal line and threatened coastal habitats (e.g. dunes and coastal vegetation).

The Rural Development Plan (RDP) of Emilia-Romagna Region has been implemented in the province, proposing different measures that contribute to the preservation of landscapes and focus on the delivery of ES. More specifically, these measures include reinforced efforts contributing to water management, restructuring of the dairy sector, improved broadband internet infrastructure in rural areas, biodiversity, climate change mitigation and adaptation. Furthermore, thanks to this policy action the Po Delta Park, the main protected area of the province, is improving agriculture in a positive, and sustainable, manner, e.g. through organic production. Since reclaimed lands have replaced the wetlands, agriculture has replaced the typical landscape elements (marshes, pine woods) with large extensions of embankments and water channels (Viaggi et al., 2014).

Regarding the territory and main demographic aspects in the province, Table 8 presents the population in each municipality in 2014, the surface in km^2 and the density of the population. Moreover, the average age and the average annual variation of the population the last 6 years are presented. In particular, as regards the territory, the municipalities with the largest surface (km^2) are Ferrara (405,16), Argenta (311,67) and Comacchio (284,13). The population density, which indicates the number of inhabitants per km, is very high in Cento (553,5), Ferara (330), Tresigallo (220,1) and Mirabelo (203,1). Regarding the average age of the population, there is a small variation between 43,6 in Cento and 51,3 in Berra. Finally the average annual variation the last six years is negative in the most of municipalities and the lower average annual variation is observed in Berra (-1,54), Mirabello (-0,87), Ro (-0,86) and Jolanda di Savoia (-0,83). However, a positive average

annual variation of the population is observed in Cento (0,59), Lagosanto (0,59), Massa Fiscaglia (0,82), Vigarano Mainarda (1,00) and Poggio Renatico (1,17).

Table 8 Municipalities territory and demographic data

Code	Territory	Surface (km^2)	Population	Population density	Average age	Average annual variation (2008-2014)
X1	Argenta	311,67	22.087	70,7	48,1	-0,35
X2	Berra	68,64	5.088	72,2	51,3	-1,54
X3	Bondeno	174,76	14.864	84,3	49	-0,82
X4	Cento	64,74	35.444	553,5	43,6	0,59
X5	Codigoro	170,01	12.337	71,4	50	-0,80
X6	Comacchio	284,13	22.428	80	47,1	-0,31
X7	Copparo	157,01	16.943	106,7	50,6	-0,69
X8	Ferrara	405,16	131.842	330	48,3	-0,10
X9	Formignana	22,43	2.802	125,5	49,6	-0,02
X10	Goro	33,18	3.879	115,4	47,3	-0,64
X11	Jolanda di Savoia	108,34	3.016	27,9	50,1	-0,83
X12	Lagosanto	34,44	4.978	143,9	46,9	0,59
X13	Masi Torello	22,71	2.344	103,9	49	-0,61
X14	Massa Fiscaglia	58,34	3.543	61,23	50,08	0,82
X15	Mesola	84,31	7.092	83,1	49,3	-0,58
X16	Migliarino	35,47	3.621	102,08	48,5	-0,34
X17	Migliaro	22,38	2.225	99,04	48,3	-0,40
X18	Mirabello	16,25	3.420	203,1	47,8	-0,87
X19	Ostellato	173,34	6.462	36,4	49,8	-0,68
X20	Poggio Renatico	80,23	9.771	123,7	44,2	1,17
X21	Portomaggiore	126,64	12.085	95,4	48,2	-0,31
X22	Ro	43,2	3.291	76,2	50,9	-0,86
X23	Sant'Agostino	34,79	7.052	199,6	44,4	-0,19
X24	Tresigallo	20,62	4.553	220,1	48,8	-0,49
X25	Vigarano Mainarda	42,02	7.491	183,2	46,1	1,00
X26	Voghiera	40,33	3.823	93,8	49,7	-0,55

Source: URBISTAT and own elaboration, 2014

The next tables present some key variables regarding employment in the province. In the sector enterprises and human resources, Table 9 presents the number of active enterprises by sector and the number of employees for different enterprises. As observed, the sectors with more active enterprises are wholesale and retail trade repair of motor vehicles and motorcycles (25,21%),

construction (14,24%), professional, scientific and technical activities (14,13%) and manufacturing (8,65%). Additionally, other important sectors are accommodation and food service activities (7,80%), human health and social work activities (6,16%) and real estate activities (6%). In the province there are more than 82.000 persons employed in different sectors, 25,42% of them work in manufacturing, 19,73% work in wholesale and retail trade repair of motor vehicles and motorcycles, 8,89% work in accommodation and food service activities, 6,87% work in professional, scientific and technical activities and 5,48% work in human health and social work activities.

Table 9 Enterprises and human resources

Enterprises	Number of active enterprises	Number of persons employed
Total	25.139	82.309
Mining and quarrying	6	25
Manufacturing	2.175	20.918
Electricity, gas, steam and air conditioning supply	32	185
Water supply sewerage, waste management and remediation activities	58	1.251
Construction	3.625	7.556
Wholesale and retail trade repair of motor vehicles and motorcycles	6.338	16.241
Transportation and storage	899	3.482
Accommodation and food service activities	1.960	7.313
Information and communication	441	1.332
Financial and insurance activities	485	2.484
Real estate activities	1.509	2.074
Professional, scientific and technical activities	3.553	5.657
Administrative and support service activities	704	3.926
Education	114	306
Human health and social work activities	1.548	4.510
Arts, entertainment and recreation	290	912
Other service activities	1.402	4.129

Source: EUROSTAT and own elaboration, 2007

The employment rate in the province by gender and by age class from 2010 to 2014 is presented in Table 10. Regarding the active population (15-64 years) there is a decrease since 2010. The total employment rate in 2010 was 66,7% while in 2014 was 63,3%. Observing the rates by gender, we have the same trend. Male employment rate (15-64 years) in 2010 was 73,9% but in 2014 was 69,5%. Respectively female employment rate in 2010 was 59,6% and in 2014 was 57,2%.

Table 10 Employment rate by age class and gender

Year	2010			2011			2012			2013			2014		
Gender / Age Class	M	F	Total	M	F	Total	M	F	Total	M	F	Total	M	F	Total
15 years and over	56,8	40,9	48,4	58,3	42,0	49,7	54,3	42,3	47,9	50,2	38,7	44,1	52,7	38,9	45,4
15-24 years	34,7	32,7	33,8	23,1	33,0	27,9	21,7	23,3	22,5	23,3	8,3	16,7	22,5	10,2	16,7
15-29 years	51,9	43,8	47,9	49,3	43,9	46,6	36,6	42,0	39,3	36,2	26,9	31,6	37,3	27,0	32,2
15-64 years	73,9	59,6	66,7	75,9	60,5	68,1	70,3	61,3	65,7	66,4	56,7	61,5	69,5	57,2	63,3
18-29 years	63,3	52,6	58,0	55,9	54,2	55,1	41,0	55,4	47,5	41,8	34,8	38,6	46,6	32,4	39,5
20-64 years	77,4	63,1	70,2	79,8	63,7	71,7	73,7	65,2	69,4	70,0	60,0	65,0	73,9	60,4	67,1
25-34 years	88,3	65,0	75,3	91,0	69,0	78,9	75,8	64,8	69,9	69,7	57,2	62,5	77,8	61,1	69,6
35-44 years	93,8	83,8	89,2	93,4	76,4	85,3	88,6	72,8	81,0	86,2	75,2	81,0	88,0	71,8	79,5
45-54 years	91,5	74,8	82,7	91,8	75,0	83,4	87,4	79,6	83,5	83,5	74,4	78,8	84,3	72,7	78,6
55-64 years	45,9	28,5	37,2	49,5	29,9	39,2	46,9	42,0	44,2	45,2	38,1	41,5	53,8	45,3	49,4

Source: ISTAT and own elaboration, 2010

5.2 Agricultural Characteristics

The entire territory of the province of Ferrara is located in the plain and is intensively farmed, due to its flat topography. The next tables present some key information regarding territorial aspects, in the province. More specifically, the distribution of total area into basic land cover and into land use categories is presented. Table 11 presents the distribution of number of farms and agricultural area by class of utilized agricultural area. Table 12 shows the use and distribution of the land use in the province. The utilized agricultural area covers 92% of the agriculture land use. The rest is distributed in land with short rotation coppices, wooded area connected to the holding, unutilised agricultural land and other land. Regarding the distribution of the utilized agricultural area, the arable land has the higher percentage (73%) among the different land use categories. The rest agricultural area consists of permanent crops, such as vineyard, olive plantation, fruit plantations, nurseries and other permanent crops. In Figure 5 it is observed the distribution of the arable land in the province. Cereals for the production of grain cover 64%, temporary grass covers 11% and fresh vegetables cover 8% of the total area. The rest of the arable land consists of dried pulses, potatoes, sugar beet, fodder roots, industrial crops, flowers and ornamental plants, seeds and fallow land.

Table 11 Distribution of total area

Class of Utilized Agricultural Area	Number of farms	Utilized agricultural area - hectares
0.01-0.99 hectares	255	151,82
1-1.99 hectares	550	798,12
2-2.99 hectares	480	1.171,69
3-4.99 hectares	915	3.607,13
5-9.99 hectares	1.712	12.325,63
10-19.99 hectares	1.702	24.656,54
20-29.99 hectares	772	18.769,07
30-49.99 hectares	639	24.390,12
50-99.99 hectares	438	29.867,84
100 hectares and over	240	61.137,67
Total	7.747	176.875,63

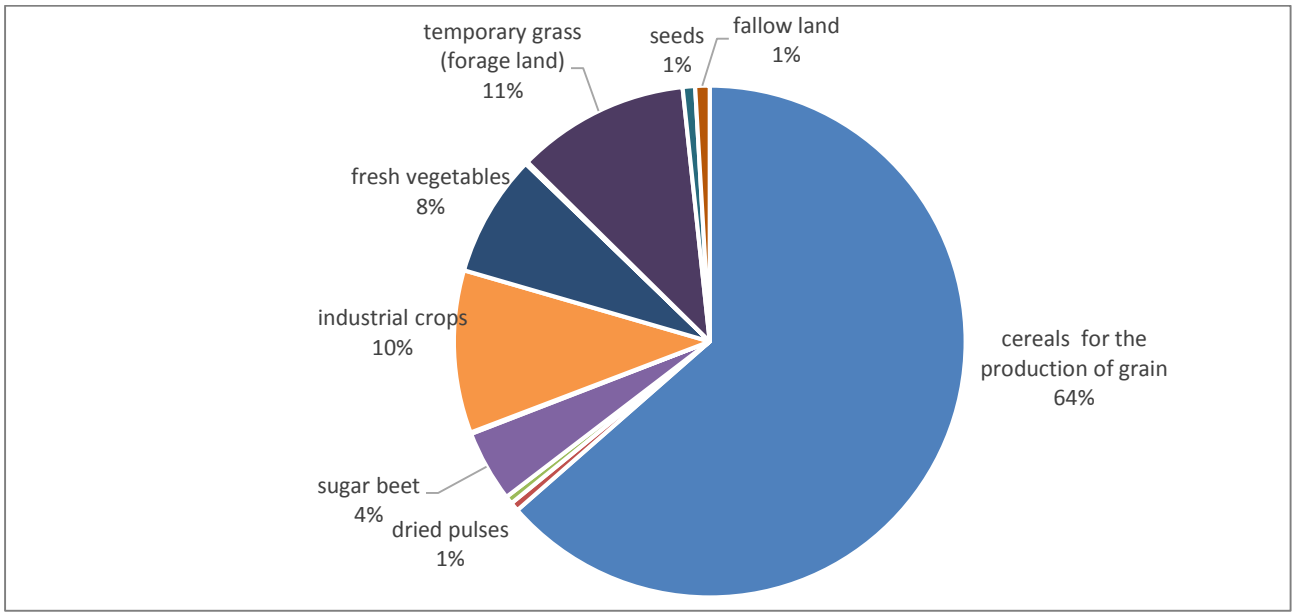
Source: ISTAT and own elaboration, 2010

Table 12 Distribution of land use

				Number of farms	Area (ha)
Total agriculatural area				7.746	193.309,9
Total agricultural area	UAA			7.703	176.875,63
	UAA	arable land		7.095	160.875,46
		arable land	cereals	5.991	102.229,63
			dried pulses	62	914,95
			potato	148	804,01
			sugar beet	821	7.254,39
			fodder roots	13	146,91
			industrial crops	1.554	16.530,46
			fresh vegetables	1.160	12.444,86
			flowers and ornamental plants	56	59,26
			Seedlings	40	186,15
			temporary grass (forage land)	1.008	17.574,63
			Seeds	88	1.259,91
			fallow land	370	1.470,3
		permanent crops		2.704	15.310,84
		permanent crops	Vineyard	659	573,82
			olive plantation	7	11,56
			fruit plantations	2.231	1.4017,5
			Nurseries	103	694,98
			other permanent crops	6	11,11
			permanent crops in greenhouses	3	1,87
	land with short rotation coppices connected to the holding			184	841,02
	wooded area connected to the holding			246	790,21
	unutilized agricultural land			430	1.611,88

Source: ISTAT and own elaboration, 2010

Figure 5 Distribution of Arable land



Source: own elaboration

The labour force in agriculture, divided in family and non-family labour but regularly employed, by age class is presented in Table 13. In the province there are 14.600 persons working in agriculture and 90% of them belong to the farm family. From 13.196 persons who belong to the family and are working on the farm, half are 30-59 years old, around 4% are younger than 30 years, and 45% are more than 60 years old. From 1.408 persons that are non-family regularly employed, 82% are 35-59 years, 9% are younger than 30 years and 8% are more than 60 years.

Table 13 Labour force in agriculture

Age Class	Family labour	Non-family labour
until 19 years	85	17
20-24 years	213	47
25-29 years	265	73
30-34 years	458	110
35-39 years	737	138
40-44 years	1.081	224
45-49 years	1.402	246
50-54 years	1.509	259
55-59 years	1.479	181
60-64 years	1.602	56
65-69 years	1.269	25
70-74 years	1.289	22
75 years and over	1.807	10
Total	13.196	1.408

Source: ISTAT and own elaboration, 2010

5.3 The Park of the Po Delta

The Delta of the River Po is one of the most important European natural areas, considering the integration between works of art, culture and natural features. The Park of Po Delta supports the provision of ecosystem services by biodiversity preservation, environmental protection and habitat restoration. Additionally, the presence of the Park offers many cultural services, such as recreation activities, contributing to the development of the tourism sector in the area. The natural park is composed of a wide variety of habitats and biotopes which are sites of national and international interest. The Po River Delta Park was set up in 1988 through a special Regional Law (Regional Law 27/88) to protect and increase the value of this unique environment, where the aim of biodiversity protection meets the preservation and valorization of an important historical heritage. The Emilia-Romagna Regional Law (n° 6/2005) established the Regional Ecological Network of areas belonging to Natura 2000 Network, in order to protect biodiversity in the different geographical areas. Within this network, the most important wetland and coastal environments are located in the province of Ferrara within the Emilia-Romagna Po River Delta Regional Park, comprising the freshwater ones of Campotto and Vallesanta, the saltwater closed embayment of the Valli di Comacchio and the Sacca di Goro Lagoon. In 1999 the territory was included in the Unesco site as World Heritage “Ferrara, city of the Renaissance and its Po Delta”. The park is divided into six “stations” around the southern area of the Po Delta, which are characterised by particular environmental and landscape features. The area is also known internationally for numerous scientific studies which have been reviewed the historical and recent evolution of the Po Delta, to present the geo-environmental problems of the Delta and to show how natural and human factors have influences this area (Simeoni and Corbau, 2009; Viaroli et al., 2006; Villanueva et al., 2015). The park has participated in scientific studies and international projects, in particular in environmental protection and in the preservation of biodiversity, aiming at improving landscape value through conservation of natural areas and valorisation of local products, restoration of ecological and forested areas as tourist attractions. However, problems like the concentration of population, the increased expansion and the intensity of agricultural production along the Po Delta have affected the standards of environmental quality, and the wetland conservation, and resulted in the erosion of the coastline, land subsidence and pollution. The complexity and the diversity of the problems that affect the Delta require management strategies that protect and promote its industrial economy, and sustain the ecosystem

productivity, taking into account the importance of the human factor and the potential effects of climatic changes.

5.4 The municipalities of the Province

The province of Ferrara is composed of 26 municipalities: Argenta, Berra, Bondeno, Cento, Codigoro, Comacchio, Copparo, Ferrara, Formignana, Jolanda di Savoia, Lagosanto, Masi Torello, Massa Fiscaglia, Mesola, Migliarino, Mirabello, Ostellato, Poggio Renatico, Portomaggiore, Ro, Sant'Agostino, Vigarano Mainarda, Voghiera, Tresigallo, Goro and Migliaro. Since 1st January 2014 the municipalities formally are 24, and the new municipality of Fiscaglia was founded from the municipalities of Massa Fiscaglia, Migliarino and Migliaro. The present study considers 26 municipalities, since most of the data used for the analysis refer to years before 2014 and are available for the 26 municipalities. The territory of the province of Ferrara is characterized by a typically plain structure, with the transition to the east between continental and marine environment and the presence of the Delta of the Po river. Comacchio is a lagoon town, built on 13 islands in the middle of extensive wetlands. The valleys of Comacchio is one of the largest coastal lagoons in the Mediterranean region and Europe, and one of the most important wetlands in Italy (Special Area of Conservation, under the Habitat Directive 1992/43/EC, and Special Protection Area, under the Bird Directive 2009/147/EC). However, the ecological and biological integrity of the lagoon have declined during the last 50 years, probably due to the decline in water quality (Munari and Mistri, 2014). Since 1984 the wetlands have been maintained as a natural site for biodiversity, bird nesting and naturalistic tourism (Nordstrom et al., 2015). The valleys have always been also an area of intensive economic activity for fisheries. Recently, different scientific studies have been carried out in the area, aimed at studying its naturalistic and environmental aspects (Giambastiani et al., 2013; Mistri et al., 2000; Munari, 2011; Munari and Mistri, 2012). Ferrara, the City of the Renaissance, is a cultural landscape that is exceptionally well preserved and is authentic in its form and design. From 1995, Unesco has included the historical center of Ferrara in the list of World Cultural Heritage as a wonderful example of a town planned in the Renaissance and still keeping its historical center intact (UNESCO). Argenta, one of the largest towns in the province of Ferrara, is among the most interesting in the province, thanks to one of the few ecological museums existing in Italy. Copparo and Formignana are two of the most important agricultural towns in the province. Masi Torello and the near villages are typical of the Po Valley towns traditionally tied to agriculture. Berra and Bondeno are also farming towns situated near the Po river. Ro is an agrarian village

situated very close to the Po and has shared its entire history with the river, most notably the floods that periodically have influenced the area. Economic prosperity came in the 19th century, thanks to the improved hydrological conditions and the consequent development of agriculture. Voghiera is practically united to Voghenza, one of the oldest villages in the province of Ferrara. Vigarano Mainarda is also a typical agrarian village built up around a square located west of Ferrara. Cento is a small capital of art, cuisine and economy. Land reclamation activities have influenced the area; Codigoro, the wide area of the land reclamation, with its territory abounds in drainage systems for water control. Its economy is based on agriculture although in the last years its industrial settlement has acquired a certain importance particularly in the field of farm products processing. Goro is a small town located about 50 km east of Ferrara, near the Po River. Goro's economy is based on farm and fishing products, on food processing and recently on tourism. The life of Lagosanto, like that of all other nearby villages, was greatly influenced by the drainage of the land, which transformed it into an agrarian village and profoundly modified the territory. Additionally, Jolanda di Savoia did not develop until drainage took place on a large scale and displays all the typical architectural and planning features of the towns that grew up in the areas reclaimed for agriculture in the 20th century. Ostellato experienced an economic decline that was only reversed the last century following large-scale drainage and agrarian reforms. Today green tourism has become an important element of the local economy (Ferrara - Portale della Provincia).

In order to evaluate the provision of ecosystem services, we used as case studies the 26 municipalities of the province of Ferrara and as criteria a set of ecosystem services indicators from the Millennium Ecosystem Assessment, presented in the following section. The area can be considered a traditional cultural landscape, characterised by historical-cultural sites, the urban centre of Ferrara, agricultural areas and protected areas of natural importance.

5.5 Proposed Ecosystem Services Indicators

This section provides a literature review on the ES indicators used for the different categories of ES. The review was based on the Millenium Ecosystem Assessment Framework and the literature available within each category of the ES. Though based on this review, in order to ensure applicability in different contexts, the selection of indicators was based on the data availability at municipality level.

Identifying consistent, quantifiable and comparable indicators supports the development of models and evaluation of ES. Determining what to measure and what method to use is directly related to

the availability of data and the type of indicator. However, mainstreaming ES concepts more broadly will require information designed for policy-makers, including data, decision support tools, and indicators, information that condenses complexity to a manageable level and informs decisions and actions (Bossel, 2001). Although global indicators provide an overview permitting a regional or national scale analysis, in many cases there is limited information available. The demand for ES is increasing in many European countries, yet there is still a scarcity of data on values at regional scale (Gatto et al., 2013). As a result, proxy indicators are often used as surrogates. Proxy methods are especially used for cultural services, as these services are difficult to directly measure and model. Yet there are limitations to their use. Several reviews have tried to assess and summarize the use of indicators to provide information (Feld et al., 2009; Layke et al., 2012). Moreover, Egoh et al. (2007) provided an extensive literature review of studies, excluding sub-global assessments, and identifying ES indicators.

The present study trying to cover the range of ecosystem service categories selected a total of twenty two ecosystem indicators, seven representing provisioning services, ten representing cultural services, three representing regulating and two representing supporting services. Measurable proxies were chosen for more than one ES indicator as they were the only measurement available to represent the ES provision at municipality level. The availability of better data to describe some of the ES more precisely could improve the analysis; however, the proxies that were chosen were sufficient to describe ES provision in the area, especially related to the contribution of agriculture to ES provision. The selected ES indicators in each category are described below in this section.

Provisioning services

Among the studies that evaluate provisioning services, food provision receives the highest attention. Indicators used for food production include agricultural production (potential) measured in hectares of land, livestock numbers or vegetation suitability for fodder production and grain yield (Fezzi et al., 2014; Palacios-Agundez et al., 2015). Other provisioning services directly linked to human well-being are crop production, capture fisheries, and livestock production (Pohle et al., 2013). In the present study, the number of agricultural holdings, the utilised agricultural area and the area of arable land have been used as indicators to measure food provision. Regarding raw materials, the indicator used in the present study is the wooded area. Another service is water provision. It is important to note that water provision or supply is not the same as water regulation. The latter is the process through which clean water becomes available, whilst water provision or

supply is water that is already available for use. A number of previous ecosystem service studies have used water production, i.e. the volume of water produced by area, as an indicator or as a surrogate for an indicator. Water provision is measured through different indicators that include surface or ground water availability (Fan and Shibata, 2014; Karabulut et al., 2015). In the present study, the indicators for water provision are related to the irrigated area, by distinguishing the area of surface water use (natural, artificial basins, lakes, rivers or waterflows) from the area of underground water use.

Regulating services

Generally, there is a lower number of indicators for regulating services as they are not directly consumed, or physically perceived by people. The majority of studies that evaluate regulating services have evaluated in particular climate and water regulation (Larondelle et al., 2014; Pan et al., 2014). Climate regulation services mainly relate to the regulation of greenhouse gases; therefore, the indicators for climate regulation include carbon storage, carbon sequestration, and greenhouse gas regulation. Another common regulating service that is mapped is water flow regulation (Simonit and Perrings, 2011; Stürck et al., 2015). Indicators used for mapping water flow regulation are nutrient retention and land cover (Boyanova et al., 2014; Schmalz et al., 2015). The total benefit to people from water supply is a function of both the quantity and quality. However, due to the lack of suitable municipality scale data on water quality for quantifying the service, proxies are used as an estimation of the benefit (Egoh et al., 2008; Müller and Burkhard, 2012). In the present study, the proxies for regulating ecosystem services are the volume of irrigation water, surface water (natural and artificial basins, lakes, rivers or waterflows) and underground, aqueduct and restoration consortiums.

Supporting services

This category of ES, according to the conceptual framework of the Common International Classification of Ecosystem Services (CICES), is categorized under regulating and maintenance services. The few indicators that have been identified relate to species and habitat. The comparatively lower numbers of indicators for supporting services could be attributed to the lack of information on these services (Barbier, 2007, 2013). The identification of indicators for services such as the life cycle maintenance and maintenance of genetic diversity, are rather generic and it is hence difficult to find suitable indicators (Balvanera et al., 2006; Swinton et al., 2007). The most common examples include indicators for primary production, production quality and controls and nutrient cycling (Benayas et al., 2009; Crafford and Hassan, 2013). In the present study, the indicator

used for biological control is the organic agricultural area and the area of protected designation of origin (PDO farms) and the area of protected geographical indications (PGI farms) are applied for production quality. Limitations regarding the availability of the data allowed us to focus only at these indicators.

Cultural services

Cultural services are non-material benefits that include recreation, spiritual and aesthetic value. Identifying an indicator that represents these challenges, and that is spatially represented, is fundamental for the measurement of the capacity of ecosystems to generate human benefits. Schaich et al. (2010) proposed an alternative approach to fill the knowledge gaps in cultural services, linking ES research with cultural landscape research. These indicators represent social cohesion, education, health, leisure time, safety and security (Guhn et al., 2012; Huntington, 2000). The majority of these indicators describe the quantity and quality of ecosystems, economic drivers, and social inputs. However, these types of measures are not directly used in quantifying the delivery of ES. The individual indicators are usually used to develop composite measures and are based on quantitative values, such as generally recognised qualitative assessments (Smith et al., 2013). The most common indicators for cultural services include recreation and ecotourism, which can be directly measured through a number count of visitors (Milcu et al., 2013). Visitor information can be also obtained from national statistics or from park inventories. In the present study, we used the number of foreign or Italian visitors. Indicators used for recreational activities vary among studies, from accommodation suitability and summer cottages, deer hunting and fishing to natural areas and forested area for recreational purposes (Naidoo et al., 2011). Indicators include scenic sites, water bodies or forest as well as visitor numbers and accessibility to natural areas. In the present study, with respect to recreation, we used the active enterprises in agriculture, the active enterprises in accommodation and food service activities and the farms with other gainful activities, such as agritourism, recreational and social activities. Although these indicators are relatively easy to quantify, indicators for aesthetic and spiritual activities are still in the early stages of development and those that exist are difficult to quantify and compare between countries or regions (Eagles, 2002). In addition, in the present study, for accommodation establishments we used the collective establishments, hotels and similar establishments, holiday and other short-stay accommodation, camp grounds, recreational vehicle parks and trailer parks as proxy indicators for aesthetic services. The selected ES indicators in the present study are those that are considered to give sufficient information on the benefits that people derive from an ecosystem (de Groot et al., 2012) among

those available in the regional databases (i.e. publicly available for the entire Emilia-Romagna region). This was partly done on purpose in order to assess the usability of secondary data to assess the provision of ES at the municipality level. The data obtained from statistics usable as proxies of ES provision in the area were provided by the National Institute of Statistics (ISTAT), other statistical databases (EUROSTAT; FAOSTAT) and regional sources (E-R; PR Ferrara). Provisioning and cultural services have the greatest number of indicators compared to regulating and supporting services. Land cover proved to be an important indicator for all four categories of services. Land cover data typically contains land use, such as agricultural land, vegetation types, and forest. The selected ES indicators are presented in Table 14 and are divided according the different categories and groups of ES.

Table 14 Ecosystem Services Indicators

Ecosystem Service category (MEA)	**Ecosystem Service group**	**Ecosystem Service Indicators**		
		Code	Indicator	Source
Provisioning	Food provision	K1	Number of agricultural holdings	Eurostat -2012
	Food provision	K2	Utilised agricultural area	Eurostat-2012
	Food provision	K3	Arable land	Faostat -2010
	Water provision	K4	Irrigated area	Istat-2010
	Water provision	K5	Irrigated area - surface water (natural and artificial basins, lakes, rivers or waterflows)	Istat-2010
	Water provision	K6	Irrigated area - underground water	Istat-2010
	Raw materials	K7	Wooded area	Istat-2010
Regulating	Regulation of water	K8	Volume of irrigation water	Istat-2010
	Regulation of water	K9	Volume of irrigation water - surface water (natural and artificial basins, lakes, rivers or waterflows)	Istat-2010
	Regulation of water	K10	Volume of underground water, irrigation and restoration consortiums	Istat-2010
Supporting	Biological control	K11	Organic agricultural area	Istat-2010
	Production quality	K12	Agricultural area of PDO and/or PGI farms	Istat-2010
Cultural	Recreation and tourism	K13	Visitors arrivals	PR Ferrara - 2010
	Recreation and tourism	K14	Italian visitors, arrivals	PR Ferrara - 2010
	Recreation and tourism	K15	Foreign visitors, arrivals	PR Ferrara - 2010
	Accommodation establishments	K16	Collective accommodation establishments	E-R -2010
	Accommodation establishments	K17	Hotels and similar establishments	E-R -2010
	Accommodation establishments	K18	Holiday and other short-stay accommodation, camping grounds, recreational vehicle parks and trailer parks	E-R -2010
	Recreation and tourism	K19	Number of active enterprises	E-R -2010
	Recreation and tourism	K20	Number of active enterprises in agriculture (crop and animal production, support activities to	E-R -2010

			agriculture and post-harvest crop activities, forestry and logging, fishing and aquaculture)	
	Recreation and tourism	K21	Number of active enterprises in accommodation and food services activities	E-R -2010
	Recreation and tourism	K22	Number of farms with other gainful activities (agritourism, recreational and social activities, initial processing of agricultural products, renewable energy production, wood processing)	E-R -2010

Source: MEA and own elaboration

5.6 Agricultural Policy Scenarios

5.6.1. Baseline Scenario

The evaluation of the ES was based on the pre-2014 CAP and, in particular, by the provisions of RDP 2007-2013. This represented the "Baseline scenario". In our analysis, the alternatives are the 26 municipalities of the province of Ferrara (X1-X26 Table 8) and the criteria are the 22 ES indicators (K1-K22 Table 14). The performance of each alternative in relation to each criterion is presented in Table A1 and the evaluation matrix is presented in Table A2 (See Appendix I). Using the data contained in the evaluation matrix, the alternatives are compared pairwise with respect to each criterion. The next stage involves the exploration of the outranking relation.

5.6.2. New CAP Scenario

As a next stage, the model simulates the “New CAP scenario”, based on future agricultural policies that may affect the supply or demand of ES. The revised measures of the RDP 2014-2020 of the Region and the specific operations of the Priority 4 that are addressed on restoring, preserving and enhancing ecosystems, are presented in previous chapter. The next step is to evaluate which of the selected ES indicators in the present study are directly affected by the measures and operations addressed in the Priority 4. All the key measures of Priority 4 support preserving, restore and enhance the ecosystems and will no doubt continue to do so in the future CAP. The relevant measures currently include not only agri-environment payments but also payments related to Natura 2000 areas, the Water Framework Directive, forests and environmental investments. Also measures that support training and the diffusion of knowledge and information, as well as support to the setting-up and use of advisory services play an important role in improving knowledge of farmers and foresters on environmental matters and in the uptake of more environment-friendly

management practices. However, only some of these measures have a direct influence on the values of the selected ES indicators in the present study. In order to understand which of the selected ES indicators are directly affected by the key measures and operations addressed in the Priority 4, a detailed review of the different operations and output indicators of each measure has been performed. The review was performed comparing the overall description of the current situation of the programming area (E-R, 2010), based on common and specific context indicators (EC, 2014) and other qualitative information like Mid Term Evaluations (EC, 2011c, 2012, 2013a). The agri-environment measure is especially important, applying agricultural practices that contribute to climate change mitigation, compatible with the protection and improvement of the landscape and the natural resources. The operation 10.01.10 of the Agri-environment-climate payments provides a financing of 25 million euro for actions devoted to setting aside arable land for a 20-year period for use for environmental purposes and management of Natura 2000 sites. The greening component of direct payments would operate as follows: each farmer will be required to undertake a number of environmental actions, such as maintenance of permanent grassland, use of green cover, crop rotation and ecological set aside as applicable. The ecological set aside shall be applicable on arable land (EC, 2011d). According to the PSR of Emilia-Romagna Region, the output indicator of this operation is the area of the arable land that will be setting aside, which is 5.317 ha. Moreover, and according to the PSR of the region, the context indicator is the total arable land of the region, which is 830.083 ha. That means that with the implication of this operation, there shall be a reduction of 0,64% of the arable land and as a consequence a reduction of 0,50% of the total utilized agricultural area of the region. Another measure with a direct influence on the selected ES indicators is the support for organic farming, (M11) which provides a financing of 100 million euro for actions devoted to converting or maintaining organic farming practices and methods. According to the Article 29, support under this measure shall be granted, per hectare of agricultural area, to farmers who undertake to convert to or maintain organic farming practices and methods as defined in Regulation (EC) No 834/2007. The output indicators of these operations are the hectares of the organic farming, which is respectively 67.420 ha to maintain and 7.181 ha to convert to organic farming practices. The context indicator, which is the utilized agricultural area under organic farming in the region, is 81.511 ha. Taking into account the implementation of the operation 11.1 payments to convert to organic farming practices and methods, as a result, the area under organic farming shall be increased by 8,81% in the region. The operation 4.3.02 for irrigation infrastructures of Measure 4 provides a financing of 10 million euro for actions mainly devoted to improve the

efficiency of existing infrastructures and the possible extension of irrigation on new surfaces, on condition to the possible water saving through a more efficient use of water. The output indicator for this operation is the area concerned by investments for saving water like more efficient irrigation systems, which is 3.714 ha. That means that 1,45% of total irrigated land is switching to more efficient irrigation system. According to Article 46 (EC, 2013b) the investments shall ensure an effective reduction in water use, amounting to at least 50% of the potential water saving made possible by the investment. The context indicator in this case is the volume of irrigation water in Emilia-Romagna, which is 3.012 m^3/ha. With a reduction by the investments, it shall be 1.506m^3/ha. Taking under consideration the total area concerned by investments for saving water and the level of the reduction, with the implication of this operation, the potential water saving shall be 5.593.284 m^3 (a reduction of 0,73% of the volume of irrigated water). Another measure that affects directly the values of the selected ES indicators is the Measure 8 about forest area development and improvement of the viability of forests. The operation 8.5 provides a financing of 10 million euro for investments improving the resilience and environmental value of forest ecosystems. The investments under Measure 8 shall be aimed at the achievement of commitments for environmental aims, for the provision of ecosystem services and/or for the enhancement of the public amenity value of forest and wooded land in the area concerned. Under the operation 8.5, according to the Article 21 (EC, 2013b), the investments in forest area and improvement of the viability of forests shall concern afforestation and creation of woodland and establishment of agroforestry systems. The operation should cover the extension of forest resources through the afforestation of land and the creation of agroforestry systems, which means land use systems in which trees are grown in combination with agriculture on the same land. The context indicator for this operation is the forest area in the region (611.000 ha) while the output indicator is the area concerned for creation of woodland and agroforestry systems (1.311 ha). As a result of the implication of this operation, shall be an increase of the forest area in the region by 0,21% according to the output indicator of this operation. Table 15 presents the specific operations that affect the selected ES indicators, and the change of the value of each one.

Table 15 Key Measures and changes

Measure / type of operation	Common Context Indicators	Value	Output Indicators	Value	Expected Value
M4 Investments in physical assets					
4.3.02 Irrigation infrastructures	Irrigated area (24,1% of UAA)	256.980	Area (ha) concerned by investments for saving water	3.714	
	Volume of irrigation water (m^3)	775.566.900	Reduction in water use at the level of the investment	50%	769.973.616
	Volume of irrigation water (m^3/ha)	3.012	Volume of water reduction from efficient irrigation systems	5.593.284	1.506
	Volume of irrigation surface water (m^3)	122.209.036	Surface water passing to irrigation systems more efficient (16,10% of volume)	900.518	121.308.518
	Volume of irrigation underground water	186.441.270	Underground water passing to irrigation systems more efficient (24,56% of volume)	1.373.710	185.067.559
M8 Investments in forest area development and improvement of the viability of forests					
8.5 support for improving the resilience and environmental value of forest ecosystems	Forest Area (ha)	611.000	Area (ha) concerned for creating woodland and agroforestry systems	1.311	612.311
M10 Agro-environmental climate payments					
10.1.10 Setting aside arable land for a 20-year period for use for environmental purposes and management of Natura 2000 sites	UAA (ha)	1.064.210	Area (ha)	5.317	1.058.893
	Arable land (78% of UAA)	830.083	Area (ha) arable land setting aside	5.317	824.766
M11 Organic farming					
11.1 payment to convert to organic farming practices	Area (ha) under organic farming	81.511	Area (ha) - convertion to organic farming	7.181	88.692

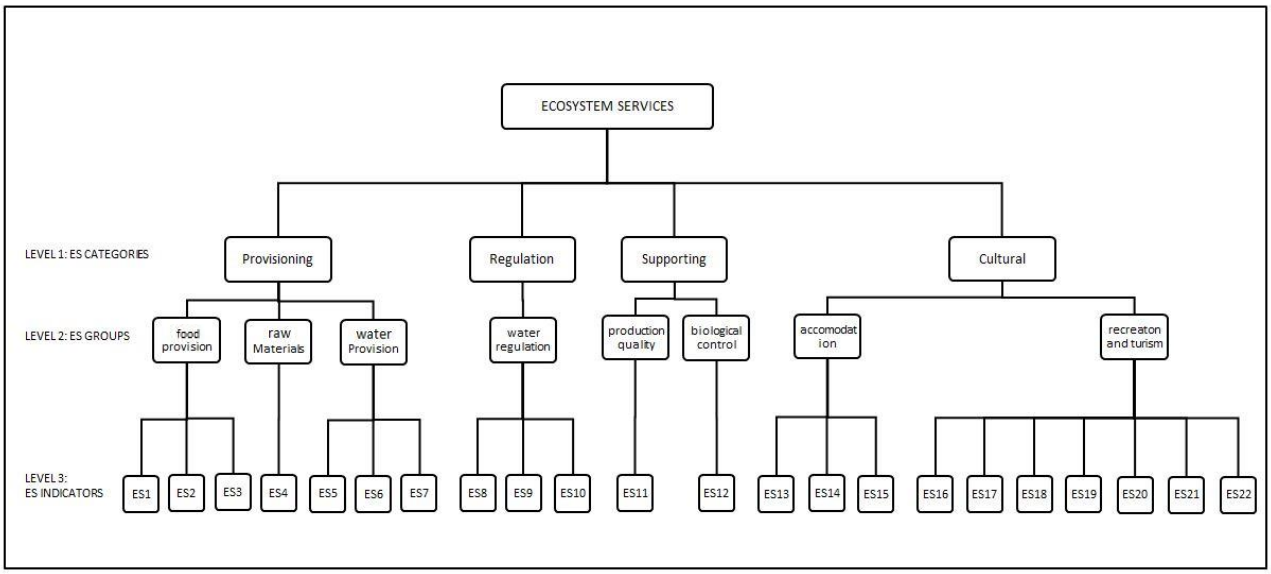
Source: (E-R, 2015a) and own elaboration

The common context indicators and the expected value of each one presented above, refer to the Region of Emilia-Romagna. In order to calculate the expected values in municipality level, the same proportion was applied for each indicator to all the municipalities. The same procedure was applied in all the ES indicators presented in the table above, in order to obtain the new values of the ES indicators for the present analysis. The new performance of each alternative in relation to each criterion is presented in Table A3 and evaluation matrix of the performances of the criteria with the simulation of the New CAP is presented in Table A4 (See Appendix I). The application of the methodology follows the same procedure: using the data contained in the evaluation matrix, the alternatives are initially compared pairwise with respect to each criterion, then there is the exploration of the outranking relation without and with the integration of the weighting approach, and finally, in order to obtain the final evaluation, the positive the negative and the net flow of each alternative is calculated.

5.7 Weights

The approach adopted in the present study is based on individual judgment elicitation (Bartolini et al., 2011). Given that the ES indicators are based on a hierarchical structure, starting from the four ES categories (MEA, 2003), the best way identified to elicit weights was through a number of hierarchical questions, each related to a node in the hierarchical tree demonstrated in Figure 6.

Figure 6 Hierarchical structure of Ecosystem Services



Source: own elaboration

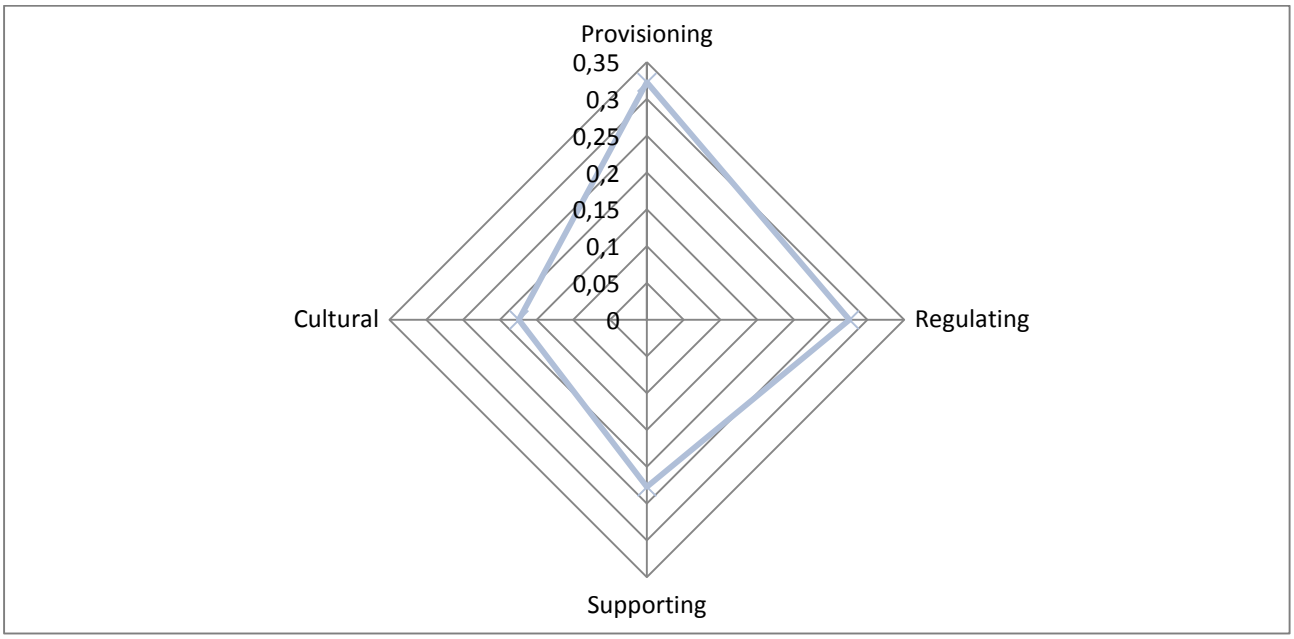
Moving from top to bottom of the hierarchy, we identified three hierarchical levels: ES categories (level 1), ES groups (level 2) and ES indicators (level 3). Thus, the ES category provisioning, placed at level 1 is composed of food and water provision and raw materials, that are located at level 2 (ES groups). The questionnaire was developed through a number of hierarchical questions, each related to a node of the hierarchical tree. The structure was the same for all questions. The questionnaire is available as annex II. The target sample was composed of representatives from Universities, Research Centers, private and public administrations. More specifically, the questionnaire was sent to different representatives from:

- the Universities of Bologna and Ferrara;
- the Province of Ferrara;
- the Region of Emilia-Romagna;
- the Institution of the Park Delta Po (http://www.parcodeltapo.it/);

- the private estate Agency 'Tomasi Case', which builds and sells houses and residential vacation rentals in the province of Ferrara: (Tomasi Case s.r.l.);
- the Regional Agency 'Ente Nazionale Risi' production regional authorization and trade in plant (http://www.enterisi.it/);
- the public Corporation 'Consorzio di Bonifica Pianura di Ferrara', whose main tasks are irrigation and drainage of water, through the complex network of canals and drainage systems (http://www.bonificaferrara.it/);
- the company 'ANTEA s.r.l.', which offers tourism and environmental services, excursions and nature tours in the Po Delta Park, Ferrara and Ravenna (www.anteasrl.net);
- the Institute Delta, which is a spin-off company of the University of Ferrara, created by a group of researchers of the Biology Department, offering a wide range of services for public and private organizations in the field of eco-compatible businesses (http://www.istitutodelta.it/);
- the Regional Agency 'ARPA E-R' for the prevention, environment and energy of Emilia-Romagna in the following areas: water resources, air pollution, waste management and contaminated sites, use of public water resources, mineral and thermal water (http://www.arpa.emr.it/);
- the Consortium 'LAG Delta 2000', focused in local resources and economic activities in an organic way, being an integrated system of natural, environmental, social, economic and cultural resources (http://www.deltaduemila.net/).

The questionnaires were sent during February 2016 and the responses were from the University of Bologna, Department of Agricultural Sciences and the Regional Agency ARPA E-R. The weights expressed for each hierarchical level are presented below. Figure 7 presents a comparison of the average weights among ES categories (level 1). The average of the weights for ES categories shows that provisioning services have the highest importance of all categories at 0,32. On the contrary, cultural services have the lower importance at 0,17 (about half of provisioning), while the scores are intermediate for the remaining categories (0,22 for supporting and 0,27 for regulating services).

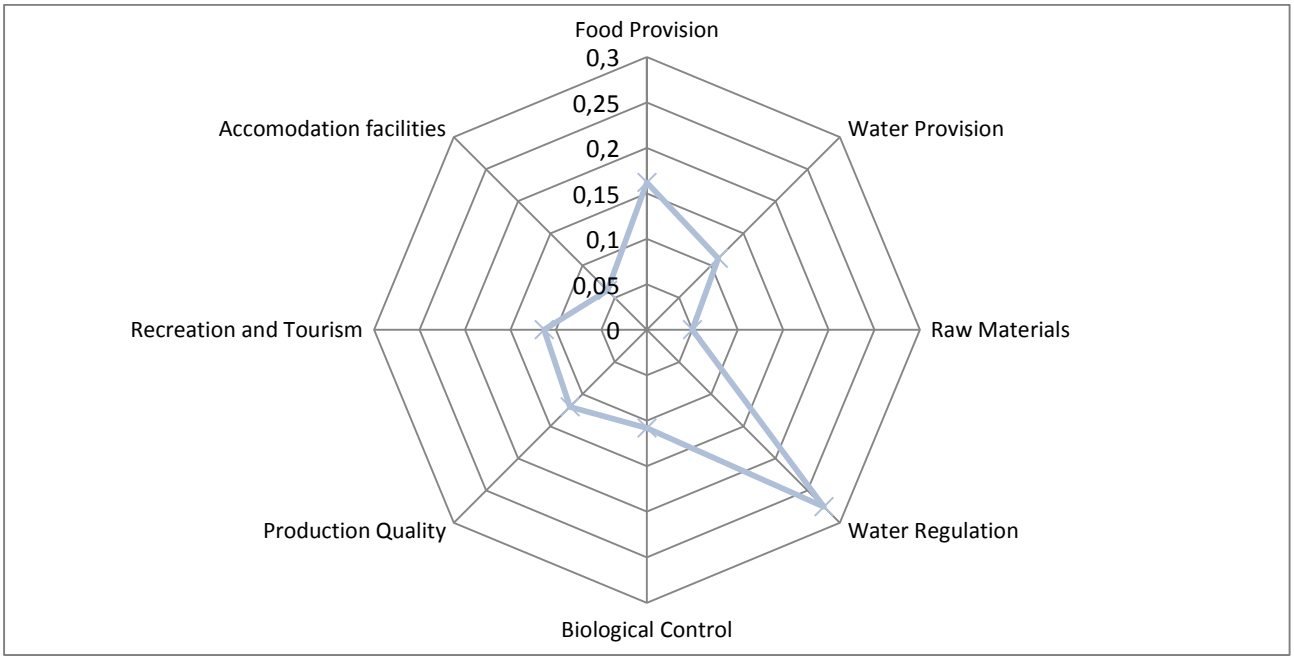
Figure 7 Weights of ES Categories



Source: own elaboration

The average weights among ES groups (level 2) and a comparison between them is presented in Figure 8. The most important ES groups are water regulation that has the higher importance at 0,27 and food provision at 0,16. Next ES groups are Water provision and recreation and tourism at 0,11 and biological control at 0,10. Accommodation facilities have a slightly lower importance at 0,06 and raw materials with 0,049 is the less important ES group.

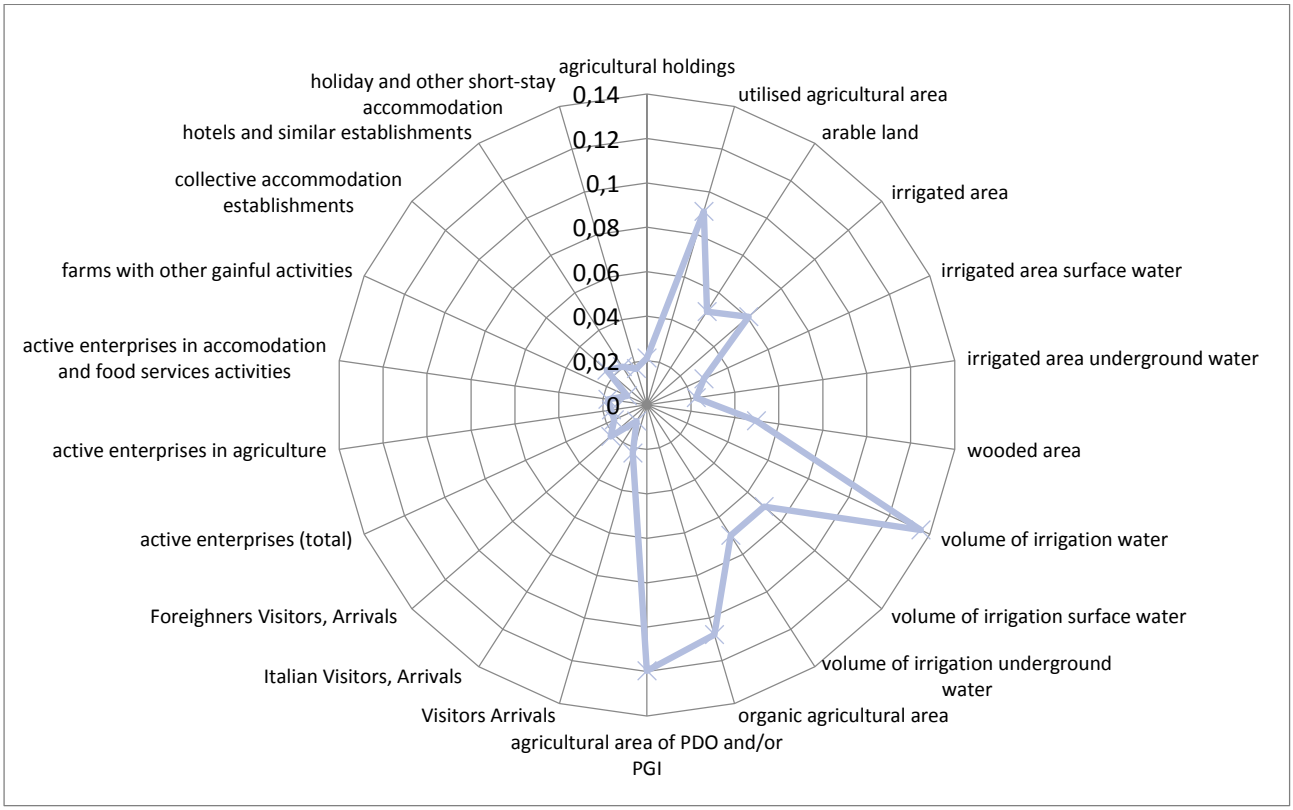
Figure 8 Weights of ES Groups



Source: own elaboration

The average weights among ES indicators (level 3) are presented in Figure 9. As observed the indicators with higher importance are volume of irrigation water (0,135), agricultural area of PDO and/or PGI farms (0,119), organic agricultural area (0,107) and utilized agricultural area (0,09). Other ES indicators with a significant importance are volume of irrigation surface or underground water (0,069), irrigated area (0,06), arable land and wooded area (0,049). Lower importance have the irrigated area surface water (0,028), collective accommodation establishments (0,023), visitors arrivals and irrigated area underground water (0,022), foreigners visitors and number of agricultural holdings (0,021) and hotels and similar establishments (0,020). The ES indicators with the lower importance are active enterprises in accommodation and food services, holiday and other short-stay accommodation (0,017), active enterprises in agriculture (0,016), farms with other gainful activities (0,009) and Italian visitors (0,008). As observed, the ES indicators with lower importance are mainly representing cultural services.

Figure 9 Weights of ES Indicators



Source: own elaboration

6. Results

6.1 Baseline Scenario

In the Baseline scenario the performances of each municipality (alternatives) on each ES indicator (criteria) is based on the conditions of the area under pre-2013 CAP and specifically RDP 2007-2013. The performance of each alternative in relation to each criterion is presented in Table A1 (Appendix I). Table 16, Figures 10 and 11 present the evaluation of the study areas, as obtained from the net flows in the no weighting and weighting situations.

In the no weighted case, according to the value of the net flow, the 26 municipalities are divided into 5 groups. The first group of municipalities, characterised by positive net flows higher than +1, consists of: Comacchio, Goro, Argenta and Jolanda di Savoia, all located in the western area of the province. Comacchio and Argenta have the highest values in the indicators that represent cultural services, such as foreign visitors, hotels and similar establishments, the number of active enterprises providing accommodation and food service activities and the number of farms with other gainful recreational activities. Goro has the highest rate in the number of active enterprises in agriculture (crop and animal production, support activities to agriculture) and the highest number of farms with other gainful agricultural activities. Moreover, Jolanda di Savoia has the highest rate in the agriculture area of PDO and/o PGI farms. These features are indeed connected to key features of the area. Since a large part of the territory is within the Po Delta Park, it contains important Natura2000 sites. Visits to the area increase considerably during the summer months. During this period, demand for beaches, areas of high naturalistic value and historical sites has resulted in the development of receptive structures, such as rental houses, hotels, camping areas, beaches with restaurants, etc. Summer tourism is also an important market for horticultural farms (mainly close to the seaside). The municipalities in this group are presented in the Figure 10 as the “green group”, having net flows more than +1. The second group of municipalities, with a positive net flow but lower than +1, are Migliaro, Codigoro, Vigarano Mainarda, Bondeno Massa Fiscaglia and Portomaggiore. Migliaro and Godigoro, located in the western area of the province, have high rates in the indicators that represent cultural services, such as Italian visitors, holiday and short-stay accommodation, camping grounds, recreational vehicle parks and trailer parks. Migliaro also has the highest rate in organic agricultural area. Moreover, Bondeno and Vigarano Mainarda, located in the eastern area of the province, have the highest rate in the irrigated area from natural and artificial

basins. The third group, with net flows around 0 (from -0,2 to +0,2), consists of Mesola, Poggio Renatico, Cento, Ro and Sant'Agostino. Small negative flows (down to -1) distinguish the fourth group including, Migliarino, Ostellato, Lagosanto and Mirabello. These groups of municipalities are in the middle of this evaluation, since the rates are neither extremely high nor particularly low. Municipalities with negative net flows have low rates in more than one ecosystem system indicator, like agricultural farms with other gainful activities such as agritourism, recreational and social activities, initial processing of agricultural products or renewable energy production and the agricultural area of PDO and/or PGI farms. These municipalities have high rates in the ES indicators that represent provisioning services, like the municipalities ranked in higher positions, but their rates are low in ES indicators that represent cultural services such as agricultural farms with other gainful activities such as agritourism, recreational and social activities, initial processing of agricultural products or renewable energy production and the agricultural area of PDO and/or PGI farms. These results are connected to the key features of the area, since main recreational services in the area are related to habitat restoration and conservation and species protection habitat (especially birds) and are not provided in all the municipalities. The municipalities with net flows that vary from +1 to -1 are presented in the Figure 10 as the “blue group”. The fifth and last group of municipalities, located in the central area of the province, (Masi Torello, Ferrara, Voghiera, Formignana, Copparo, Tresigallo and Berra) has negative net flows less than -1 and are presented in the Figure 10 as the “red group”. Berra has no organic agricultural area, hotels or similar accommodation services. Tresigallo has no wooded area. Formignana has no hotels or similar establishments. Other indicators with low rates in these municipalities are agricultural farms with other gainful activities such as agritourism, recreational and social activities, initial processing of agricultural products or renewable energy production and the agricultural area of PDO and/or PGI farms.

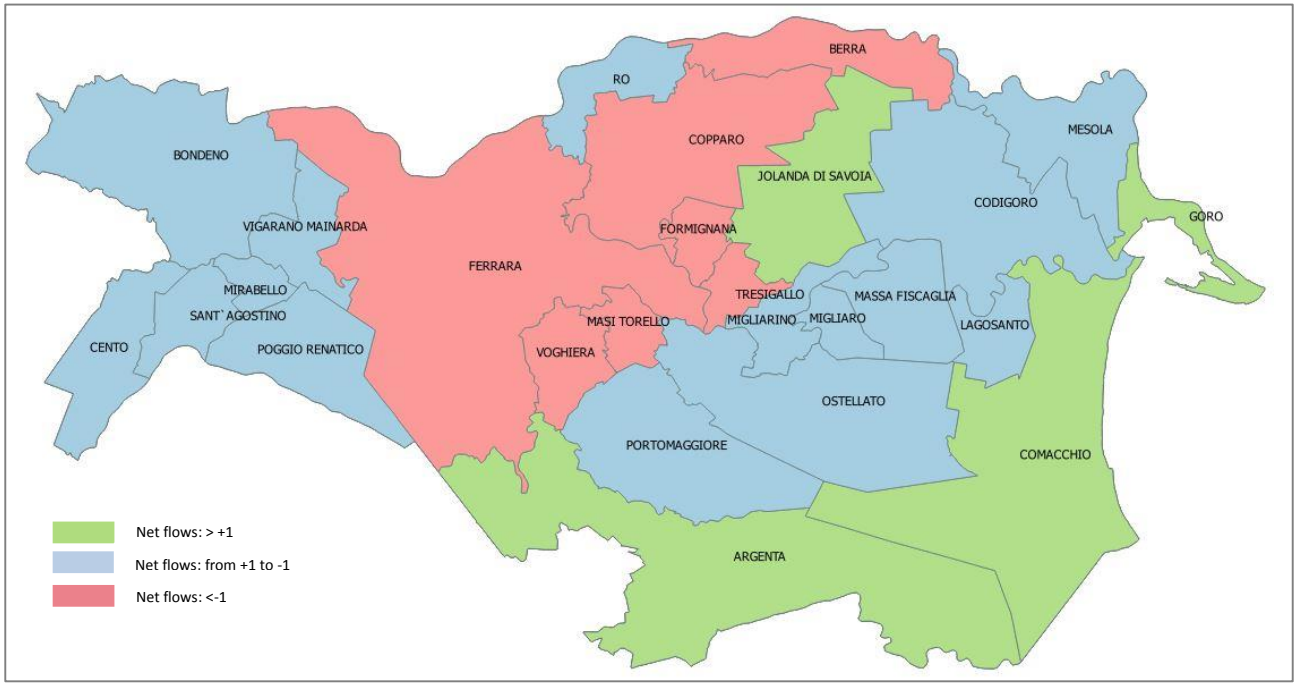
Table 16 Ranking of the Municipalities - Baseline Scenario

	No weighting approach		Weighting approach	
	Municipality	**Net Flow (Φ)**	**Municipality**	**Net Flow (Φ)**
1	Comacchio	2,888194373	Argenta	4,915419
2	Goro	2,543589598	Comacchio	4,372351
3	Argenta	1,997682356	Codigoro	4,136333
4	Jolanda di Savoia	1,190854183	Jolanda di Savoia	3,774961
5	Migliaro	0,720865791	Ferrara	2,45525
6	Codigoro	0,709070084	Ostellato	1,593052

7	Vigarano Mainarda	0,694387495	Migliaro	1,260627
8	Bondeno	0,614876652	Bondeno	0,718413
9	Massa Fiscaglia	0,402104543	Massa Fiscaglia	0,365578
10	Portomaggiore	0,257389617	Portomaggiore	0,001403
11	Mesola	0,194863948	Goro	-0,16183
12	Poggio Renatico	0,146803521	Mesola	-0,39481
13	Cento	0,008314139	Poggio Renatico	-0,57677
14	Ro	-0,14634547	Migliarino	-0,59769
15	Sant'Agostino	-0,21655112	Voghiera	-0,983
16	Migliarino	-0,27198083	Lagosanto	-1,01337
17	Ostellato	-0,28124392	Copparo	-1,03486
18	Lagosanto	-0,30769265	Cento	-1,19493
19	Mirabello	-0,68414923	Vigarano Mainarda	-1,54701
20	Masi Torello	-1,00385534	Berra	-1,64497
21	Ferrara	-1,14179801	Ro	-1,69578
22	Voghiera	-1,26554807	Sant'Agostino	-1,85619
23	Formignana	-1,32908587	Masi Torello	-1,87432
24	Copparo	-1,34379219	Formignana	-2,35824
25	Tresigallo	-2,09068952	Tresigallo	-2,99985
26	Berra	-2,28626409	Mirabello	-3,65975

Source: own elaboration

Figure 10 Classification of the Municipalities - No weighting approach

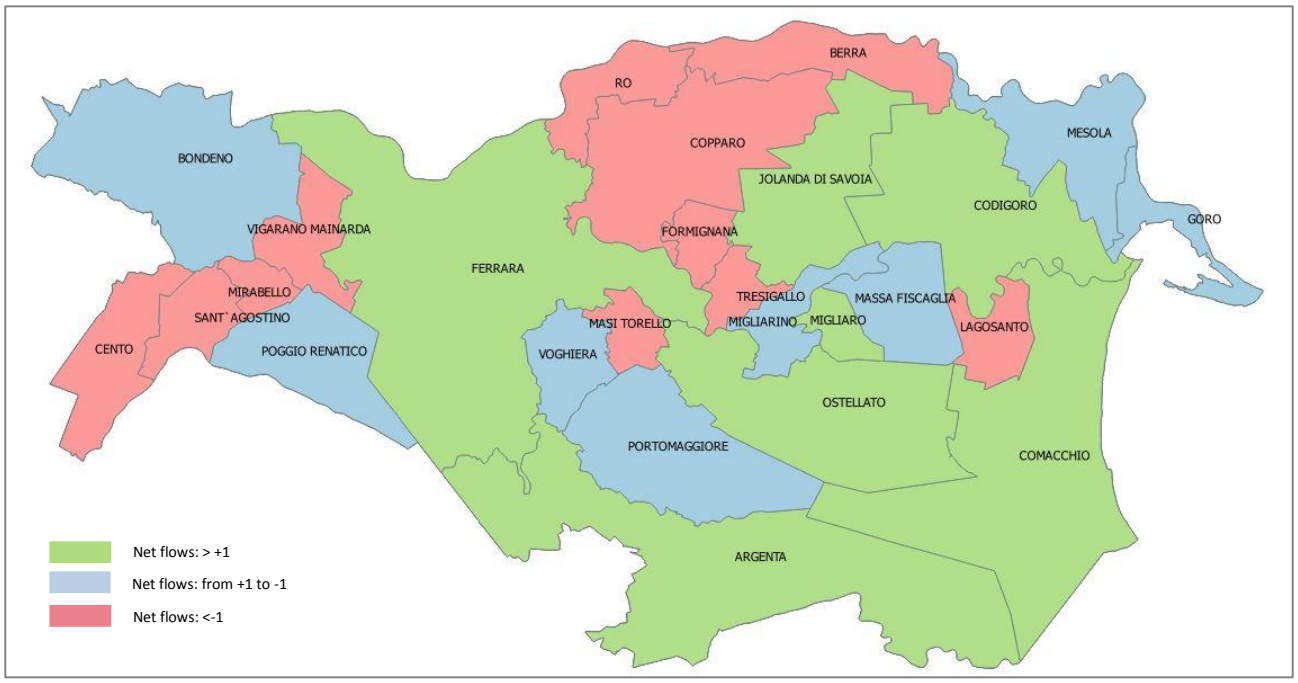


Source: own elaboration

Table 16 and Figure 11 present the evaluation of the study areas, as obtained from the integration of the weighting approach. Comparing the net flows of the municipalities, as obtained with and without the integration of the weights, there are differences in all the municipalities. In the ranking of the municipalities as obtained without the weighting approach, the highest net flow observed is 2,88 and the lowest is -2,28, with a variation of 5,16 among the 26 municipalities. That means that the preference of one municipality to the next is not very higher and so the net outranking flows do not vary among the municipalities. On the contrary, in the ranking of the municipalities with the integration of the weights the net flows vary from 4,9 to -3,6, with a variation of 8,55 among the 26 municipalities. The higher variation is a result of the integration of the weights. The net outranking flows of the municipalities vary according to the relevant importance of the weighted ES indicators, since they play an important role for measuring overall preferences of alternatives (municipalities). According to the results with the integration of the weights, the 26 municipalities are divided into 5 different groups. The first group of municipalities, characterised by the higher positive net flows, consists of Argenta, Comacchio, Codigoro and Jolanda di Savoia. These municipalities have high performances in all the ES indicators that represent provisioning services and also in more than one indicator that has high importance, such as and utilized agricultural area (W4), irrigated area (W7), arable land (W8) and wooded area (W9). Argenta and Comacchio have the highest values in indicators that represent cultural services, such as foreign visitors, hotels and similar establishments, the number of active enterprises providing accommodation and food service activities and the number of farms with other gainful recreational activities. Additionally, Jolanda di Savoia has the highest performance in PDO &PGI farms and organic farming, the second and third more important ES indicators respectively. The second group of municipalities, with a positive but lower net flow consists of Ferrara, Ostellato, Migliaro, Bondeno, Massa Fiscaglia and Portomaggiore. According to their performances and the importance of the weights, Migliaro has the highest rate in organic agricultural area which is the third more important ES indicator. Moreover, the municipalities of Massa Fiscaglia and Bondeno have the higher performances in irrigated area from natural and artificial basins (W10). The third group, with small negative net flows around 0 (from 0 to -1), consists of Goro, Mesola, Poggio Renatico, Migliarino and Voghiera. The municipalities that have net flows more +1 are presented in the Figure 11 as the green group. The municipalities with net flows that vary from +1 to -1 are presented in the Figure as the blue group. Negative flows from -1 to -2 distinguish the fourth group including Lagosanto, Copparo, Cento, Vigarano Mainarda, Berra, Ro, Sant'Agostino and Masi Torello. These municipalities are in the middle of this evaluation, since

the rates are neither extremely high nor particularly low. The fifth and last group of municipalities, Formignana, Tresigallo and Mirabello has negative net flows down to -2. These municipalities have very low performances in more than one indicator that represent provisioning services and others which are very important like the agricultural area of PDO and/or PGI farms. Other indicators with low rates are agricultural farms with other gainful activities such as agritourism, recreational and social activities, initial processing of agricultural products or renewable energy production. The group of municipalities with net flow lower than -1 is presented in the Figure 11 as the red group.

Figure 11 Classification of the municipalities - Weighting approach



Source: own elaboration

As regards the classification of the municipalities with and without the integration of the weighting approach, there are differences, in more than one case. Argenta, Comacchio and Jolanda di Savoia have high net flows in both cases, so they take the higher places in the two classifications. Goro on the other hand, is in the second place in the case of no weighting and in the eleventh with the integration of the weighting approach. This is because it has the highest rate in farms with other gainful activities, which is an indicator with very low importance (W21). Moreover, Goro has low performance in PDO &PGI farms and organic farming, the second and third more important ES indicators. Ostellato is another municipality that takes the sixth place with the weighting approach, and the seventeenth when no weights are integrated. This happens because Ostellato has high performance in volume of irrigation from underground water (W6) and in collective accommodation

establishments (W11). Another change that is observed is the municipality of Ferrara (twenty first without weights and fifth with weights). The reason of the low position in the classification without weights is the lowest rate in active enterprises in agriculture which is an indicator with very low importance (W20). The reason of the higher position in the weighted approach is also the high rate in organic farming, the third more important ES indicator. Additionally, Voghiera takes the twenty second place in the classification without weights and the fifteenth when weights are integrated. This is due to the second highest rate in PGI and PDO farms, the second more important indicator, and the low rate in active enterprises in food services which is less important (W17). In the case of Copparo, from the twenty fourth place (with no weights) takes the seventeenth (with weights) due to the low performance in indicators that have low importance such as holiday and short-stay accommodation (W18) and active enterprises in agriculture (W20). Moreover, Vigarano Mainarda takes the seventh place in the classification without weights and the nineteenth when weights are integrated. This happens because the municipality has low rates in PDO &PGI farms and organic farming, the second and third more important ES indicators respectively. The municipalities of Ro and Sant'Agostino take the fourteenth and fifteenth place in the classification without weights and lower places when the weights are integrated (twenty first and twenty second, respectively) due to the high performance in indicators that have low importance such as enterprises in accommodation and food services (W17), farms with other gainful activities (W21) and Italian visitors (W22). Finally, Berra, Mirabello, Masi Torello, Formigiana and Tresigallo have low net flows in both cases since they have low performances in more than one ES indicator, so they take lower positions in both classifications.

6.2 New CAP Scenario

The New CAP scenario is based on the RDP 2014-2020 and the methodology was implemented according to the new values of the ES indicators. The performances of the alternatives, regarding the New CAP, are presented in Table A3 (Appendix I). Table 17 presents the evaluation of the study areas, as obtained from the net flows in the no weighting and weighting situations. Initially, no weighting approach was integrated, so the model assumed that the criteria are equally important. According to the values of the net flows, the 26 municipalities have the same classification with the Baseline scenario with no weights. As described in previous section, the values for only some of the ES indicators are affected by the New CAP scenario. The most important change is observed about the organic farming, which is increased by 8,81% due to the implication of the measure 11.1 (convert

to organic farming). However, the effect of this increase is flattened when applied to the municipalities: Lagosanto, Mirabello, Goro and Berra do not have area under organic farming, so the implication of the operation 11.1 does not affect them. Moreover, in nine municipalities less than 1% of the area is under organic farming, in five municipalities is less than 5% and in two less than 10%. As a result, even with the implication of the operation 11.1, the rates in most of the municipalities continue to be very low and do not change their position in the final classification. Other changes are observed in the utilized agricultural area, which is decreased by 0,5% and the arable land which is decreased by 0,64%, due to the implication of the measure about setting aside arable land (10.1.10). Moreover, the wooded area is increase by 0,21% due to the implication of the measure for improving the resilience of forest ecosystems (8.5). Finally, the volume of irrigation water is decrease by 0,70% due to the implication of the measure about irrigation infrastructures. (4.3.02). These changes refer to the Region of Emilia-Romagna, and were calculated from the common context indicators of the Region and the expected value according to the RDP 2014-2020. In order to calculate the expected values at municipality level, these changes were applied proportionally to the municipalities and for each ES indicator. When these changes are proportionally applied in the municipalities flatten the effects of the New CAP scenario, and do not change their final classification.

As a further step, the methodology was applied with the integration of the weighting approach described above. The final classification of the municipalities, as obtained from the integration of the weighting approach, is presented in Table 17. As observed, the 26 municipalities have the same classification with the Baseline scenario with the integration of the weights. Since the values for only some of the ES indicators are affected by the New CAP scenario, and the weighting approach is the same, the municipalities have the same classification in the Baseline and the New CAP scenario.

Table 17 Classification of the Municipalities - New CAP Scenario

	No weighting approach		**Weighting approach**	
	Municipality	**Net Flow (Φ)**	**Municipality**	**Net Flow (Φ)**
1	Comacchio	2,888194373	Argenta	4,915419
2	Goro	2,543589598	Comacchio	4,372351
3	Argenta	1,997682356	Codigoro	4,136333
4	Jolanda di Savoia	1,190854183	Jolanda di Savoia	3,774961
5	Migliaro	0,720865791	Ferrara	2,45525
6	Codigoro	0,709070084	Ostellato	1,593052
7	Vigarano Mainarda	0,694387495	Migliaro	1,260627

8	Bondeno	0,614876652	Bondeno	0,718413
9	Massa Fiscaglia	0,402104543	Massa Fiscaglia	0,365578
10	Portomaggiore	0,257389617	Portomaggiore	0,001403
11	Mesola	0,194863948	Goro	-0,16183
12	Poggio Renatico	0,146803521	Mesola	-0,39481
13	Cento	0,008314139	Poggio Renatico	-0,57677
14	Ro	-0,14634547	Migliarino	-0,59769
15	Sant'Agostino	-0,21655112	Voghiera	-0,983
16	Migliarino	-0,27198083	Lagosanto	-1,01337
17	Ostellato	-0,28124392	Copparo	-1,03486
18	Lagosanto	-0,30769265	Cento	-1,19493
19	Mirabello	-0,68414923	Vigarano Mainarda	-1,54701
20	Masi Torello	-1,00385534	Berra	-1,64497
21	Ferrara	-1,14179801	Ro	-1,69578
22	Voghiera	-1,26554807	Sant'Agostino	-1,85619
23	Formignana	-1,32908587	Masi Torello	-1,87432
24	Copparo	-1,34379219	Formignana	-2,35824
25	Tresigallo	-2,09068952	Tresigallo	-2,99985
26	Berra	-2,28626409	Mirabello	-3,65975

Source: own elaboration

Comparing the classification of the municipalities with the simulation of different policy scenarios, there are no differences in the positions the municipalities take place. The New CAP scenario does not represent the new Common Agricultural Policy but is focused on the provision and the enhancement of the ES and how the Rural Development Policy might affect their provision at municipality level. Information on the contribution of each RDP measure on ES and on the identification of the changes observed in the area from the implication of these measures is not yet available. The New CAP scenario was based on common and specific context indicators of Emilia-Romagna Region and their expected value according to the RDP 2014-2020. These changes were applied proportionally to the municipalities for each ES indicator. The estimations made in order to build the New CAP scenario, do not lead to significant effects that change the ranking of the municipalities.

7. Discussion

A key challenge of ecosystem management is determining how to manage multiple ecosystem services across landscapes. One of the recent reports of TEEB (2013) was designed to map and assess the state of ecosystems and their services in the national territories of EU Member States by 2014, assess the economic value of such services, and promote the integration of these values into accounting and reporting systems at EU and national level by 2020. One of the main findings was that there does not exist one standard method or approach. There exists a wide variety of approaches in practice at different geographical scales, which are only partly related to ongoing efforts at European level to harmonize the classification of ecosystem services and their valuation. There are a number of choices to be made between classifications, methods and approaches. These choices involve firstly defining what the purpose of the ecosystem services valuation is; determine which ecosystem services are of highest relevance; defining the types of value information that are required; and finally select the relevant and appropriate valuation methods. Different studies have tried to classify, quantify, map and value ecosystem services in order to integrate the concept into decision making processes (e.g. Costanza et al., 1997; de Groot et al., 2010; Hermann et al., 2011). These efforts have suggested measures to better evaluate ecosystem services and to improve the knowledge base of the value of ecosystem services, as well as proposed measures that will mainstream the importance of biodiversity and the value of ecosystem services (SEPA, 2013). However, there are still open questions to fully integrate the ecosystem service concept in landscape research and decision making (Seppelt et al., 2012).

The value of ES has been estimated in various ways. In general, frameworks include three main parts: (i) measuring the provision of ecosystem services; (ii) determining the monetary value of ecosystem services; (iii) designing policy tools for managing ecosystem services (Polasky, 2008). This variety of methodological approaches is, on which ecosystem services to measure, which indicators to use and in which scale. Seppelt et al. (2011) provided a quantitative review of 153 ecosystem service studies that are using a set of indicators. More than 75% excluded scenario analysis and more than 60% of the studies did not involve stakeholders. Between 45% and 80% of the studies also did not give sufficient information, concerning the results' uncertainty and validation. Regarding data and where model descriptions are given respectively, 10% and 2% of the papers gave insufficient information. However, this does not mean that these studies were not reproducible. This variety of methodological approaches is, on the one hand, a creative scientific

process and typical of the development of new concepts, however on the other hand, it risks confusing the message to the community of the concept.

As assessing and mapping of services is mainly dependent on data availability and finding the appropriate indicators, most publications focused either on selected ES and/or only on one landscape scale. Ecosystems have the ability to produce multiple ES simultaneously, referred as multifunctionality. Efforts that focus on the provision of single services (e.g. production of a crop) can have a negative impact on other services; for example, water and often pollination are needed for agricultural crops. Enhancing important provisioning services, such as food and timber, often leads to trade-offs between regulating and cultural services, such as nutrient cycling, flood protection, and tourism. Van Zanten et al. (2016) tried to measure the relative importance of landscape features across agricultural landscapes in order to better understanding the cross-regional variation of aesthetic and recreational values and how these values relate to characteristics of the agricultural landscape. Moreover the study tried to assess the relative value of three different landscape scenarios of potential pathways of landscape management and policy. Additionally, Plieninger et al. (2013) performed a spatially explicit participatory mapping of ecosystem services at community level, but the analysis included cultural ecosystem services. Frank et al. (2012) introduced a conceptual approach for how to enhance the assessment of ecosystem services with regard to landscape structural aspects. The objective was to improve the understanding of how landscape structure contributes to the provision of ecosystem services. As a test case, the study simulated different afforestation scenarios based on the regional development in Germany. The approach adopted cannot be used to appraise all aspects (e.g. cultural) of the suitability of a landscape to provide ecosystem services. Moreover, Guo et al. (2016) proposed a modelling framework which considers land-competition across different land types and sectors (e.g. bioenergy vs. livestock sectors) and accounts for ecosystem service changes due to changes in land use transitions over multiple time periods without exploring options based on policy scenarios. They considered a number of quantitative and semi-quantitative indicators of ecosystem services, focusing on provisioning (e.g. bioenergy, livestock) and biodiversity.

Scientific progress is also being made in developing socio-economic scenarios and models of global change impacts on biodiversity and ecosystem services (Cheung et al., 2009; Rodriguez et al., 2006; Sitch et al., 2008; Thomas et al., 2004; Xenopoulos et al., 2005). Currently a major challenge in this field of research, is improving the relevance and value of these advances for decision makers at multiple scales (Donner et al., 2005). Scenarios are widely used in land use planning, climate change

analysis and conservation planning (Verburg et al., 2006; Xiang and Clarke, 2003), and, increasingly, in ecosystem service assessment (Castella et al., 2005; Duinker and Greig, 2007; Kirchner et al., 2015). Applying different policy scenarios is a key component of forward-looking decision making in some instances at local and national levels (e.g., climate change impacts on forests and protected areas, management of fisheries) but covers only a small range of sectors and cases (Jetz et al., 2007). The CAP has recently entered a new programming period and the new objectives are oriented towards the sustainable management of natural resources and climate action (Viaggi, 2015). The CAP 2014-2020 has presented policies centered on efficient provision of ecosystem services from agricultural land. However, only a few studies have tried to assess the value of changes in ecosystem services with the implementation of the reformed CAP measures that are addressed on ecosystems. Lupp et al. (2015) applied an ecosystem services approach as a framework to assess the impact of increasing energy crop production (with a focus on biogas production) on the quality and services of those ecosystems concerned, taking into account the European and national energy production targets and action plans about biomass and total energy consumption by 2020. Kirchner et al. (2016) tried to assess the impacts of alternative policy pathways on the supply of ecosystem services, considering the aggregate and spatial impacts of the latest CAP reform. The study presented the most important driving factors and processes that affect land use change and management choices in agriculture as well as forestry based only on a set of land use development and environmental indicators. Moreover, Bocci et al. (2016) applied an ecosystem approach for understanding the changes of Nador lagoon (Morocco), considering two scenarios, the past scenario (referring to 1980s), and the present scenario (referring to 2000-2013). The study provided a complete picture on present ecosystem functioning and on its changes, but during the last decades. Badgon et al. (2016) developed a quantitative model to better understand the effect of different management options on eight forest ecosystem services. The model simulated the effects of three management actions over a 45-year period, implementing optimal management scenarios. Albert et al. (2016) introduced an ES-in-Planning framework, which combined ES assessment and valuation indicators, considering two scenarios of potential landscape changes in terms of alterations in a set of ES indicators. The ES indicators examined were food production (provisioning), climate mitigation (regulation), landscape esthetics (cultural), and biodiversity. Finally, Fagerholm et al. (2016) based on literature review tried to identify and catalogue the knowledge field and provide the first systematic synthesis of ecosystem services research in relation to European agroforestry. According to their results, agroforestry assessments need to include a broader and relevant set of ecosystem

services at multiple spatial scales. Assessing the enhancement of EU policy and finance mechanisms was also a limitation. The capacity of agroforestry practices to enhance ecosystem service provision can be encouraged through public policies such as the EU Biodiversity Strategy to 2020, but the separation between agriculture and forestry in current EU thinking is a limitation to a supportive framework for agroforestry.

The present study faced different limitations and challenges, regarding data availability, and the structure of the methodological approach. An important challenge in the analysis was the lack of information with respect to the provision of ES at the municipality level. Particularly, the main issue concerned the number of gaps in the ES metrics and indicators available at municipality level, with respect to the number and quality of indicators needed to reflect the ES approach in a comprehensive way. The indicators available for most ES are not fully satisfactory in their ability to evaluate the quality and quantity of benefits provided. In addition, due to data paucity, it was not possible to consider the interactions between specific services. However, the evaluation focuses on all the categories of ecosystem services and applies a set of non-overlapping indicators assessing different aspects of ecosystem services. Although the number of indicators in each category varies significantly due to the different data availability and reliability, the selected indicators cover all the different categories of ecosystem services and from the available secondary data sources are those that can give sufficient estimation of the benefits that people derive from an ecosystem.

Another important limitation regarding the construction of the New CAP scenario was to identify and analyses the effects of the reformed CAP measures on the provision of ES in municipality level. The framework was applied based on different agricultural policy scenarios, the Baseline based on the RDP 2007-2013 and the New CAP based on the RDP 2014-2020. The New CAP scenario is based on the revised measures of the Rural Development Policy of the Region and the specific operations of the Priority 4 that are addressed on restoring, preserving and enhancing ecosystems. Information about the provision of ecosystem services at the local level is lacking; relevant information such as Mid-term evaluation reports are not yet available, in order to present compiled information on the RD performance, indicator values of output and result indicators. The changes of each specific measure on the provision of ecosystem services were obtained from the common context indicators of the Region of Emilia-Romagna and the expected values according to the RDP 2014-2010. These changes were proportionally applied in the municipalities for each indicator in order to obtain the new values of the ES indicators for our analysis. The estimations made, do not lead to significant effects of the New CAP scenario in the provision of ecosystem services.

Another limitation in the application of PROMETHEE is that it did not use any weighing approach to reflect the relative preferences of potential decision makers or society. According to Macharis et al. (2004), initially the model assumed that the criteria were equally important. As a further step the framework was integrated with an approach to elicit weights. The involvement of experts in ES indicators is a key aspect of the assessment and valuation of ecosystem services. As observed the indicators with higher importance in the area represent regulating services (the volume of irrigation water), supporting services (agricultural area of PDO and/or PGI farms and organic agricultural area) and provisioning services (utilized agricultural area, irrigated area, arable land and wooded area), while cultural services have received less attention. The area is characterised by intense agricultural production and protected areas of natural importance. Also water management and mechanization play an important role. In fact, local reclamation protects and increments the surface water resources for agricultural use; irrigation systems try to assure the stability and good hydraulic regime, a correct water drainage and good hydraulic conditions of the territory. On the contrary, main recreational activities are seen negatively because they influence the naturalistic value of the area. As an example, local tourism, the demand for beaches, hospitality structures, rental houses, hotels, camping areas, etc. have damaged the coastal line and threatened coastal habitats.

8. Conclusions

The objective of this study is to test a methodology for the classification of areas (in our case municipalities) according to the provision of ecosystem services and for the evaluation of the effects of different agricultural policy scenarios on such classification. The focus is on sustainable land use, in terms of valuation of ecosystem services and natural resource management, linking socio-economic requirements with landscape potentials and applying multicriteria methods as the tool for analysis. The framework is applied in the 26 municipalities of the province of Ferrara; an area characterised by historical-cultural sites, agricultural areas and protected areas of natural importance.

As a general remark, it is observed that the provision of ecosystem services varies greatly from one municipality to the next. All the municipalities offer a significant number of provisioning and cultural services, mainly connected to recreational opportunities. The territory is characterized by a typically plain structure and agriculture has traditionally played a significant role in the local economy. The tourism sector has been also developing gradually in recent decades, due to the territory within the Po Delta Park, other important Natura2000 sites and areas of high historical and naturalistic value. However, the province is generally recognized as an ecosystem in "continuous evolution". Land reclamation activities and drainage systems have influenced the area by contributing in the development of agriculture, fishing, tourism and forestry (Cencini, 1998). On the other hand, the concentration of population and some economic activities lead to a decrease in the standards of environmental quality, land subsidence and environment pollution. Some of the main recreational activities are seen negatively, because of the negative effects in the territory; e.g. the construction of buildings and infrastructure, and other activities associated with tourism, have negative impacts on the environment.

The classification of the case study municipalities was performed initially weighting equally the ES indicators. As a further step, the framework was integrated with a weighting approach, by eliciting weights for the ES indicators by experts' judgement. The involvement of experts in ES indicators is a key aspect of the assessment and valuation of ecosystem services. The conclusions regarding the weighting integration is that elicitation of weights to the ES indicators effects the evaluation of the provision of ES since it takes into account the different relevance of various indicators in the area. In this case, water regulation was the most important/sensitive indicator, due to the presence of an important wetland and coastal environment, in which protected areas of natural importance and

the natural wetlands need to be maintained as natural sites for biodiversity. Drainage systems need a continuous control and irrigation infrastructures need to be as efficient as possible. The ES indicators that represent provisioning services were also of high importance. Since agriculture activities play a significant role in the local economy, all the provisioning services need to be enhanced. Less attention is given in cultural services, probably because some recreational activities are seen negatively since they influence the environment and the naturalistic value of the area. As observed in the final ranking, municipalities with high performances in cultural services obtain high positions in the classification where the ES are equally weighted, while when the weights are applied, these municipalities take lower positions because the cultural services receive less attention by the experts.

The provision of ecosystem services was evaluated with the simulation of two scenarios, the Baseline, based on the RDP 2007-2013 and the New CAP scenario, based on the RDP 2014-2020 of Emilia-Romagna Region. PROMETHEE was not applied to compare the alternative policy scenarios directly, since the focus of the study was on the evaluation of ES and not on the comparison of different policy design options. According to the reformed CAP, the RDP 2014-2020 of the Region is built under the six Priorities with an almost equal emphasis on each one of the priorities. In the present study, the New CAP scenario is built considering only one of these (Priority 4), trying to measure how the Rural Development Policy might affect ecosystem services and their provision at municipality level. As expected, the values only for some ES indicators change, since all measures are designed to promote and enhance ecosystems but not only some of them provide straightforward measurable effects on the indicators selected. The New CAP scenario was based on common and specific context indicators of the Region of Emilia-Romagna and their expected value according to the RDP 2014-2020. These changes were applied proportionally to the municipalities for each ES indicator. The estimations made in order to build the New CAP scenario, do not lead to significant effects that change the classification of the municipalities. According to the results, the implementation of the New CAP will not change significantly the provision of ES in the area. All the provisioning services are given already much attention in all the municipalities and even with the small decrease of the UAA and the arable land due to the measure about setting aside (10.01.10), the provision of these services will remain high. On the contrary, regulating and supporting services are enhanced only in some municipalities, for example the organic production or the PGI and/or PDO farms are observed only in some municipalities. From the results we conclude that the situation will not change even with the support from the New CAP (11.1 organic farming). Finally regarding

cultural services, like recreational activities and the development of the tourism sector, as observed from the results, they are provided in municipalities with high naturalistic value or in municipalities with historical monuments or in the coastal area which provides accommodation establishments. Additionally, cultural services, as are not promoted by the New CAP and the specific measures the analysis took under consideration.

An integrative framework that takes a wide range of ecosystem services and small landscape scales into account is still under development. Such a framework should be comprehensible and able to be applied at small range of scales to different ecosystems or landscapes (Schleyer et al., 2015). The present study tried to meet some of these challenges by the development of a framework for the evaluation of the provision of multiple ecosystem services at municipality level. However, it experienced a variety of challenges and limitations. An important issue concerns the number of gaps in the ES metrics and indicators available at the regional level and for the municipality scale. In particular, ES indicators available at municipality level are insufficient to evaluate the quality and quantity of benefits provided. Finally, the number of ES indicators in each category varies significantly due to limitations in data availability and reliability. Another limitation was the construction of the New CAP scenario, and how to identify and analyses the effects of CAP measures on the provision of ES in municipality level. Finally, another challenge was the application of PROMETHEE in a context of too many potential indicators, in different number per issue addressed, which makes potentially difficult to maintain a clear view of the problem and to evaluate the potential biases in the results.

In the present case, the PROMETHEE considered different policy scenarios and different weights of the ES indicators in order to provide comparative classifications of municipalities; in this way it can be used as a support to the comparative evaluation of the ecosystem services of the ranked regions. This approach can also be extended to support policy design with respect to zoning/targeting. From the experience carried out in this study, we can conclude that the application of the PROMETHEE, in particular with the integration of the weights for the ES indicators, has shown the potential to support the characterisation of agricultural land in terms of the provision of multiple ecosystem services. The study presents MCDA as a suitable tool to illustrate the differences in the provision of ecosystem services in different case study areas. To some extent, in spite of the limitations of this work, this also applies to analyze the consequences of different agricultural policy scenarios in the provision of these services. If supported by stronger approaches to modelling policy effects, it could be a valuable tool for an evaluation of different regional/national policies, since it can help exploring

weak and strong points of policy options with respect to the provision of ES; also the impacts on distributional effects over different regions can be included in PROMETHEE approach. Regarding the weighting process, it could be integrated with improved approaches compared to the one used here, according to the problem structure, the evaluation criteria and the access to stakeholders and decision makers.

Altogether, this framework can be seen as promising instrument to structure environmental or regional policy problems and support decisions. Its further exploration could contribute to improving valuation methods for ecosystem services provision, in an attempt to narrowing the gaps between the ecosystem service concept, practical regional planning and agricultural policies evaluation.

9. References

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10. Appendix I

Table A1 Ecosystem Services provision Baseline scenario

	number of agricultural holdings	utilized agricultural area	arable land	irrigated area	irrigated area surface (natural artificial basins)	irrigated area - underground water	wooded area	volume of irrigation water	volume of irrigation surface water (natural and artificial basins, lakes, rivers)	volume of irrigation water - underground water in or near the farm	organic agricultural area	agricultural area of PDO and/or PGI farms	visitors Arrivals	Italian Visitors, Arrivals	Foreighners Visitors, Arrivals	accommodation establishments	hotels and similar establishments	holiday and other short-stay accommodation	number of active enterprises	number of enterprises in agriculture	number of enterprises in accommodation and food	number of farms with other gainful activities
Argenta	777	23104,96	21202,5	7897	650,83	69,83	317,2	22219871,85	1842392,49	18277528,04	6542	3169	5409	4579	830	25	5	20	1347	16	89	80
Berra	241	5005,19	4662,83	1692	422,35	37,98	38,17	8888067,05	1295545,48	3634800,82	0	164	91	79	12	0	0	0	260	9	13	14
Bondeno	587	12818,7	12156,22	2864	1588,8	61	22,7	8721393,28	4753715,27	880400,95	100	563	898	735	163	9	2	7	748	16	50	19
Cento	459	4965,41	4561,23	503	256,98	32,85	4,34	1425067,73	785070,95	108623,73	18,3	56,5	11696	9101	2595	16	7	9	2154	17	131	15
Codigoro	327	10891,06	10769,79	6685	343,19	22,6	75,71	43698065,67	1058176,82	40023575,57	1389	426	3985	3244	741	14	5	9	837	56	60	22
Comacchio	293	10033,64	9694,82	6406	1260,9	44,07	114,77	18585945,8	3681841,57	13115943,65	1140	651	455142	365022	90120	107	27	80	2545	289	393	22
Copparo	677	11631,09	10465,28	2402	404,45	40,68	33,63	10260339,76	1248347,74	3813132,4	143	451	4889	4152	737	10	3	7	975	7	69	27
Ferrara	1604	27874,6	22799,17	7433	1744,5	591,27	86,82	22737104,04	6201258,36	6654913,52	2535	440	175549	126404	49145	172	34	138	10860	30	697	64
Formignana	103	1720,67	1470,55	382	78,18	7,5	2,09	1257376,39	290371,02	529924,59	5,2	18,7	88	78	10	1	0	1	139	3	8	6
Goro	24	638,48	635,48	174	22	0	3	514795,61	264000	236735,34	0	0	465	442	23	8	2	6	1197	1009	21	5
Jolanda di Savoia	199	8230,48	7991,19	3200	53,8	12	23,13	28055933,9	138237,82	27293092,73	25,6	3802	56	56	0	3	0	3	130	6	13	11
Lagosanto	68	2124,74	1981	1468	59,16	0	17,73	4133759,17	141047,59	2738931,48	0	16,3	358	303	55	3	1	2	343	25	19	4
Masi Torello	98	1527,95	1316,11	349	7,2	0	16,64	1019254,47	23917,94	83147,47	20,4	129	124	114	10	5	0	5	152	0	10	6
Massa Fiscaglia	102	3042,2	3000,49	1017	57,06	13,6	1,77	3653570,09	476962,64	2930395,31	552	0	88	78	10	1	0	1	194	7	15	3
Mesola	282	4698,31	4592,52	3375	32,58	0	11,7	8472806,43	60708,87	7768578,41	29,5	528	2944	2542	402	10	4	6	604	163	34	35
Migliarino	92	2831,47	2382,05	1121	55,52	0	5	3917812,87	94048,48	3562210,88	1126	88,7	1025	929	96	7	0	7	266	1	20	9
Migliaro	52	3111,55	3073,59	264	10,85	0	15,24	943095,47	28136,22	914959,25	2187	0	88	78	10	2	0	2	116	1	5	2
Mirabello	43	1293,97	1196,75	70,7	11,6	23,06	0	198455,23	35615,66	100623,67	0	0	88	78	10	1	0	1	185	2	11	4
Ostellato	349	11857,18	11206,6	5738	490,46	61,99	8,69	18812898,76	1416033,01	16451586,06	435	28,1	5668	4788	880	10	2	8	363	10	27	16
Poggio Renatico	244	5894,04	5233,23	1423	538,62	121,05	15,26	3957393,46	1420865,38	2017315,88	6,2	93,5	271	223	48	7	1	6	488	5	27	8
Portomaggiore	324	10036,12	9166,19	2901	254,48	70,35	59,04	8556809,49	843795,16	6507314,36	316	246	3328	2969	359	10	1	9	759	6	55	30
Ro	163	2756,83	2590,52	709	5,9	37,34	20,12	2460678,75	21073,95	667629,1	29,8	11,9	97	93	4	4	0	4	161	4	14	12
Sant'Agostino	168	2404,4	2134,56	414	196,09	23	0	1241949,89	557231,38	572812,61	18,1	14,3	792	633	159	4	3	1	386	1	28	5
Tresigallo	80	1436,99	1240,67	359	52,41	8,31	0	1326476,31	139231,6	171284,57	108	85,3	1066	807	259	3	2	1	268	2	18	4
Vigarano Mainarda	177	3182,31	2538,07	638	353	200,76	9,54	1858061,51	995519,79	228545,16	13,9	41,9	2471	1758	713	7	3	4	390	4	28	7
Voghiera	214	3763,29	2814,05	1301	348,72	20,62	11,61	4077942,32	866873,9	161755,34	1,62	863	258	206	52	3	0	3	273	5	15	13

Table A2 Ecosystem Services provision New CAP scenario

	number of agricultural holdings	utilized agricultural area	arable land	irrigated area	irrigated area surface (natural artificial basins)	irrigated area - underground water	wooded area	volume of irrigation water	volume of irrigation surface water (natural and artificial basins, lakes, rivers)	volume of irrigation water - underground water in or near the farm	organic agricultural area	agricultural area of PDO and/or PGI farms	visitors Arrivals	Italian Visitors, Arrivals	Foreighners Visitors, Arrivals	accommodation establishments	hotels and similar establishments	holiday and other short-stay accommodation	number of active enterprises	number of enterprises in agriculture	number of enterprises in accommodation and food	number of farms with other gainful activities
Argenta	777	22989,52	21066,69	7897	650,83	69,83	317,88	22059625,1	1828816,5	18142858,1	7118,34	3169	5409	4579	830	25	5	20	1347	16	89	80
Berra	241	4980,18	4632,96	1692	422,35	37,98	38,25	8823967,5	1285999,0	3608019,4	0,00	164	91	79	12	0	0	0	260	9	13	14
Bondeno	587	12754,66	12078,35	2864	1588,8	61	22,75	8658495,8	4718686,7	873914,1	108,81	563	898	735	163	9	2	7	748	16	50	19
Cento	459	4940,60	4532,01	503	256,98	32,85	4,35	1414790,3	779286,0	107823,4	19,91	56,5	11696	9101	2595	16	7	9	2154	17	131	15
Codigoro	327	10836,65	10700,81	6685	343,19	22,6	75,87	43382921,1	1050379,5	39728679,3	1511,37	426	3985	3244	741	14	5	9	837	56	60	22
Comacchio	293	9983,51	9632,72	6406	1260,9	44,07	115,02	18451906,5	3654711,3	13019304,6	1240,43	651	455142	365022	90120	107	27	80	2545	289	393	22
Copparo	677	11572,98	10398,25	2402	404,45	40,68	33,70	10186343,6	1239149,1	3785037,0	155,60	451	4889	4152	737	10	3	7	975	7	69	27
Ferrara	1604	27735,33	22653,13	7433	1744,5	591,27	87,01	22573127,1	6155563,3	6605879,7	2758,33	440	175549	126404	49145	172	34	138	10860	30	697	64
Formignana	103	1712,07	1461,13	382	78,18	7,5	2,09	1248308,4	288231,4	526020,1	5,66	18,7	88	78	10	1	0	1	139	3	8	6
Goro	24	635,29	631,41	174	22	0	3,01	511083,0	262054,7	234991,1	0,00	0	465	442	23	8	2	6	1197	1009	21	5
Jolanda di Savoia	199	8189,36	7940,00	3200	53,8	12	23,18	27853598,3	137219,2	27091995,5	27,86	3802	56	56	0	3	0	3	130	6	13	11
Lagosanto	68	2114,12	1968,31	1468	59,16	0	17,77	4103947,1	140008,3	2718750,9	0,00	16,3	358	303	55	3	1	2	343	25	19	4
Masi Torello	98	1520,32	1307,68	349	7,2	0	16,68	1011903,7	23741,7	82534,8	22,20	129	124	114	10	5	0	5	152	0	10	6
Massa Fiscaglia	102	3027,00	2981,27	1017	57,06	13,6	1,77	3627221,0	473448,1	2908804,0	600,63	0	88	78	10	1	0	1	194	7	15	3
Mesola	282	4674,84	4563,10	3375	32,58	0	11,73	8411701,7	60261,5	7711339,0	32,10	528	2944	2542	402	10	4	6	604	163	34	35
Migliarino	92	2817,32	2366,79	1121	55,52	0	5,01	3889558,1	93355,5	3535964,3	1225,20	88,7	1025	929	96	7	0	7	266	1	20	9
Migliaro	52	3096,00	3053,90	264	10,85	0	15,27	936294,0	27928,9	908217,8	2379,67	0	88	78	10	2	0	2	116	1	5	2
Mirabello	43	1287,51	1189,08	70,7	11,6	23,06	0,00	197024,0	35353,2	99882,3	0,00	0	88	78	10	1	0	1	185	2	11	4
Ostellato	349	11797,94	11134,82	5738	490,46	61,99	8,71	18677222,7	1405598,7	16330369,7	473,32	28,1	5668	4788	880	10	2	8	363	10	27	16
Poggio Renatico	244	5864,59	5199,71	1423	538,62	121,05	15,29	3928853,3	1410395,5	2002452,2	6,75	93,5	271	223	48	7	1	6	488	5	27	8
Portomaggiore	324	9985,98	9107,48	2901	254,48	70,35	59,17	8495098,9	837577,5	6459368,1	343,84	246	3328	2969	359	10	1	9	759	6	55	30
Ro	163	2743,06	2573,93	709	5,9	37,34	20,16	2442932,7	20918,7	662710,0	32,43	11,9	97	93	4	4	0	4	161	4	14	12
Sant'Agostino	168	2392,39	2120,89	414	196,09	23	0,00	1232993,1	553125,3	568592,1	19,69	14,3	792	633	159	4	3	1	386	1	28	5
Tresigallo	80	1429,81	1232,72	359	52,41	8,31	0,00	1316909,9	138205,6	170022,5	117,51	85,3	1066	807	259	3	2	1	268	2	18	4
Vigarano Mainarda	177	3166,41	2521,81	638	353	200,76	9,56	1844661,4	988184,1	226861,2	15,12	41,9	2471	1758	713	7	3	4	390	4	28	7
Voghiera	214	3744,49	2796,02	1301	348,72	20,62	11,63	4048532,7	860486,2	160563,5	1,76	863	258	206	52	3	0	3	273	5	15	13

Table A3 Evaluation matrix Baseline scenario

	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10	K11	K12	K13	K14	K15	K16	K17	K18	K19	K20	K21	K22
X1	10,03%	91,20%	91,77%	12,99%	8,24%	0,88%	1,37%	9,62%	8,29%	82,26%	28,31%	13,72%	0,80%	84,66%	15,34%	5,66%	20,0%	80,0%	5,15%	1,19%	6,61%	10,30%
X2	3,11%	90,02%	93,16%	2,78%	24,95%	2,24%	0,76%	3,85%	14,58%	40,90%	0,0%	3,28%	0,01%	86,81%	13,19%	0,00%	0,0%	0,0%	0,99%	3,46%	5,0%	5,81%
X3	7,58%	92,72%	94,83%	4,71%	55,48%	2,13%	0,18%	3,78%	54,51%	10,09%	0,78%	4,39%	0,13%	81,85%	18,15%	2,04%	22,22%	77,78%	2,86%	2,14%	6,68%	3,24%
X4	5,92%	91,54%	91,86%	0,83%	51,07%	6,53%	0,09%	0,62%	55,09%	7,62%	0,37%	1,14%	1,73%	77,81%	22,19%	3,62%	43,75%	56,25%	8,24%	0,79%	6,08%	3,27%
X5	4,22%	91,36%	98,89%	11,00%	5,13%	0,34%	0,70%	18,92%	2,42%	91,59%	12,76%	3,91%	0,59%	81,41%	18,59%	3,17%	35,71%	64,29%	3,20%	6,69%	7,17%	6,73%
X6	3,78%	91,09%	96,62%	10,54%	19,68%	0,69%	1,14%	8,05%	19,81%	70,57%	11,36%	6,49%	67,24%	80,20%	19,80%	24,21%	25,23%	74,77%	9,74%	11,36%	15,44%	7,51%
X7	8,74%	91,06%	89,98%	3,95%	16,84%	1,69%	0,29%	4,44%	12,17%	37,16%	1,23%	3,88%	0,72%	84,93%	15,07%	2,26%	30,0%	70,0%	3,73%	0,72%	7,08%	3,99%
X8	20,70%	91,12%	81,79%	12,23%	23,47%	7,96%	0,31%	9,84%	27,27%	29,27%	9,09%	1,58%	25,93%	72,0%	28,0%	38,91%	19,77%	80,23%	41,55%	0,28%	6,42%	3,99%
X9	1,33%	92,18%	85,46%	0,63%	20,48%	1,96%	0,12%	0,54%	23,09%	42,15%	0,30%	1,09%	0,01%	88,64%	11,36%	0,23%	0,0%	100%	0,53%	2,16%	5,76%	5,83%
X10	0,31%	92,06%	99,53%	0,29%	12,63%	0,0%	0,47%	0,22%	51,28%	45,99%	0,0%	0,0%	0,07%	95,05%	4,95%	1,81%	25,0%	75,0%	4,58%	84,29%	1,75%	20,83%
X11	2,57%	90,57%	97,09%	5,26%	1,68%	0,37%	0,28%	12,15%	0,49%	97,28%	0,31%	46,19%	0,01%	100%	0,0%	0,68%	0,0%	100%	0,50%	4,62%	10,0%	5,53%
X12	0,88%	92,51%	93,23%	2,42%	4,03%	0,0%	0,83%	1,79%	3,41%	66,26%	0,0%	0,76%	0,05%	84,64%	15,36%	0,68%	33,33%	66,67%	1,31%	7,29%	5,54%	5,88%
X13	1,27%	92,73%	86,14%	0,57%	2,07%	0,0%	1,09%	0,44%	2,35%	8,16%	1,33%	8,43%	0,02%	91,94%	8,06%	1,13%	0,0%	100%	0,58%	0,9%	6,58%	6,12%
X14	1,32%	94,61%	98,63%	1,67%	5,61%	1,34%	0,06%	1,58%	13,05%	80,21%	18,15%	0,0%	0,01%	88,64%	11,36%	0,23%	0,0%	100%	0,74%	3,61%	7,73%	2,94%
X15	3,64%	88,17%	97,75%	5,55%	0,97%	0,0%	0,25%	3,67%	0,72%	91,69%	0,63%	11,23%	0,43%	86,35%	13,65%	2,26%	40,0%	60,0%	2,31%	26,99%	5,63%	12,41%
X16	1,19%	90,54%	84,13%	1,84%	4,95%	0,0%	0,18%	1,70%	2,40%	90,92%	39,77%	3,13%	0,15%	90,63%	9,37%	1,58%	0,0%	100%	1,02%	0,38%	7,52%	9,78%
X17	0,67%	92,68%	98,78%	0,43%	4,11%	0,0%	0,49%	0,41%	2,98%	97,02%	70,27%	0,0%	0,01%	88,64%	11,36%	0,45%	0,0%	100%	0,44%	0,86%	4,31%	3,85%
X18	0,56%	86,05%	92,49%	0,12%	16,42%	32,64%	0,0%	0,09%	17,95%	50,70%	0,0%	0,0%	0,01%	88,64%	11,36%	0,23%	0,0%	100%	0,71%	1,08%	5,95%	9,30%
X19	4,50%	93,54%	94,51%	9,44%	8,55%	1,08%	0,07%	8,14%	7,53%	87,45%	3,67%	0,24%	0,84%	84,47%	15,53%	2,26%	20,0%	80,0%	1,39%	2,75%	7,44%	4,58%
X20	3,15%	92,84%	88,79%	2,34%	37,85%	8,51%	0,26%	1,71%	35,90%	50,98%	0,11%	1,59%	0,04%	82,29%	17,71%	1,58%	14,29%	85,71%	1,87%	1,02%	5,53%	3,28%
X21	4,18%	92,09%	91,33%	4,77%	8,77%	2,42%	0,59%	3,70%	9,86%	76,05%	3,15%	2,45%	0,49%	89,21%	10,79%	2,26%	10,0%	90,0%	2,90%	0,79%	7,25%	9,26%
X22	2,10%	92,93%	93,97%	1,17%	0,83%	5,27%	0,73%	1,07%	0,86%	27,13%	1,08%	0,43%	0,01%	95,88%	4,12%	0,90%	0,0%	100%	0,625	2,48%	8,70%	7,36%
X23	2,17%	90,23%	88,78%	0,68%	47,32%	5,55%	0,0%	0,54%	44,87%	46,12%	0,75%	0,60%	0,12%	79,92%	20,08%	0,90%	75,0%	25,0%	1,48%	0,66%	7,25%	2,98%
X24	1,03%	90,48%	86,34%	0,59%	14,58%	2,31%	0,0%	0,57%	10,50%	12,91%	7,49%	5,93%	0,16%	75,70%	24,30%	0,68%	66,67%	33,33%	1,03%	0,75%	6,72%	5,0%
X25	2,28%	90,62%	79,76%	1,05%	55,31%	31,46%	0,30%	0,80%	53,58%	12,30%	0,44%	1,32%	0,37%	71,15%	28,85%	1,58%	42,86%	57,14%	1,49%	1,03%	7,18%	3,95%
X26	2,76%	92,05%	74,78%	2,14%	26,81%	1,59%	0,31%	1,77%	21,26%	3,97%	0,04%	22,94%	0,04%	79,84%	20,16%	0,68%	0,0%	100%	1,045%	1,83%	5,49%	6,07%

Table A4 Evaluation matrix New CAP scenario

	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10	K11	K12	K13	K14	K15	K16	K17	K18	K19	K20	K21	K22
X1	10,03%	90,74%	91,64%	12,99%	8,24%	0,88%	1,38%	9,55%	8,23%	81,65%	30,96%	13,72%	0,80%	84,66%	15,34%	5,66%	20,0%	80,0%	5,15%	1,19%	6,61%	10,30%
X2	3,11%	89,57%	93,03%	2,78%	24,95%	2,24%	0,77%	3,82%	14,47%	40,59%	0,00%	3,28%	0,01%	86,81%	13,19%	0,00%	0,0%	0,0%	0,99%	3,46%	5,0%	5,81%
X3	7,58%	92,26%	94,70%	4,71%	55,48%	2,13%	0,18%	3,75%	54,10%	10,02%	0,85%	4,39%	0,13%	81,85%	18,15%	2,04%	22,22%	77,78%	2,86%	2,14%	6,68%	3,24%
X4	5,92%	91,08%	91,73%	0,83%	51,07%	6,53%	0,09%	0,61%	54,68%	7,57%	0,40%	1,14%	1,73%	77,81%	22,19%	3,62%	43,75%	56,25%	8,24%	0,79%	6,08%	3,27%
X5	4,22%	90,90%	98,75%	11,00%	5,13%	0,34%	0,70%	18,78%	2,40%	90,91%	13,95%	3,91%	0,59%	81,41%	18,59%	3,17%	35,71%	64,29%	3,20%	6,69%	7,17%	6,73%
X6	3,78%	90,64%	96,49%	10,54%	19,68%	0,69%	1,15%	7,99%	19,66%	70,05%	12,42%	6,49%	67,24%	80,20%	19,80%	24,21%	25,23%	74,77%	9,74%	11,36%	15,44%	7,51%
X7	8,74%	90,61%	89,85%	3,95%	16,84%	1,69%	0,29%	4,41%	12,08%	36,89%	1,34%	3,88%	0,72%	84,93%	15,07%	2,26%	30,0%	70,0%	3,73%	0,72%	7,08%	3,99%
X8	20,70%	90,67%	81,68%	12,23%	23,47%	7,96%	0,31%	9,77%	27,07%	29,05%	9,95%	1,58%	25,93%	72,0%	28,0%	38,91%	19,77%	80,23%	41,55%	0,28%	6,42%	3,99%
X9	1,33%	91,72%	85,34%	0,63%	20,48%	1,96%	0,12%	0,54%	22,92%	41,83%	0,33%	1,09%	0,01%	88,64%	11,36%	0,23%	0,0%	100%	0,53%	2,16%	5,76%	5,83%
X10	0,31%	91,60%	99,39%	0,29%	12,63%	0,0%	0,47%	0,22%	50,90%	45,64%	0,00%	0,0%	0,07%	95,05%	4,95%	1,81%	25,0%	75,0%	4,58%	84,29%	1,75%	20,83%
X11	2,57%	90,12%	96,96%	5,26%	1,68%	0,37%	0,28%	12,06%	0,49%	96,56%	0,34%	46,19%	0,01%	100%	0,0%	0,68%	0,0%	100%	0,50%	4,62%	10,0%	5,53%
X12	0,88%	92,05%	93,10%	2,42%	4,03%	0,0%	0,84%	1,78%	3,39%	65,77%	0,00%	0,76%	0,05%	84,64%	15,36%	0,68%	33,33%	66,67%	1,31%	7,29%	5,54%	5,88%
X13	1,27%	92,27%	86,01%	0,57%	2,07%	0,0%	1,10%	0,44%	2,33%	8,10%	1,46%	8,43%	0,02%	91,94%	8,06%	1,13%	0,0%	100%	0,58%	0,9%	6,58%	6,12%
X14	1,32%	94,14%	98,49%	1,67%	5,61%	1,34%	0,06%	1,57%	12,96%	79,61%	19,84%	0,0%	0,01%	88,64%	11,36%	0,23%	0,0%	100%	0,74%	3,61%	7,73%	2,94%
X15	3,64%	87,73%	97,61%	5,55%	0,97%	0,0%	0,25%	3,64%	0,71%	91,01%	0,69%	11,23%	0,43%	86,35%	13,65%	2,26%	40,0%	60,0%	2,31%	26,99%	5,63%	12,41%
X16	1,19%	90,09%	84,01%	1,84%	4,95%	0,0%	0,18%	1,68%	2,38%	90,25%	43,49%	3,13%	0,15%	90,63%	9,37%	1,58%	0,0%	100%	1,02%	0,38%	7,52%	9,78%
X17	0,67%	92,22%	98,64%	0,43%	4,11%	0,0%	0,49%	0,41%	2,96%	96,30%	76,86%	0,0%	0,01%	88,64%	11,36%	0,45%	0,0%	100%	0,44%	0,86%	4,31%	3,85%
X18	0,56%	85,62%	92,36%	0,12%	16,42%	32,64%	0,00%	0,09%	17,81%	50,33%	0,00%	0,0%	0,01%	88,64%	11,36%	0,23%	0,0%	100%	0,71%	1,08%	5,95%	9,30%
X19	4,50%	93,07%	94,38%	9,44%	8,55%	1,08%	0,07%	8,09%	7,47%	86,80%	4,01%	0,24%	0,84%	84,47%	15,53%	2,26%	20,0%	80,0%	1,39%	2,75%	7,44%	4,58%
X20	3,15%	92,37%	88,66%	2,34%	37,85%	8,51%	0,26%	1,70%	35,64%	50,60%	0,12%	1,59%	0,04%	82,29%	17,71%	1,58%	14,29%	85,71%	1,87%	1,02%	5,53%	3,28%
X21	4,18%	91,63%	91,20%	4,77%	8,77%	2,42%	0,59%	3,68%	9,79%	75,48%	3,44%	2,45%	0,49%	89,21%	10,79%	2,26%	10,0%	90,0%	2,90%	0,79%	7,25%	9,26%
X22	2,10%	92,47%	93,83%	1,17%	0,83%	5,27%	0,74%	1,06%	0,85%	26,93%	1,18%	0,43%	0,01%	95,88%	4,12%	0,90%	0,0%	100%	0,625	2,48%	8,70%	7,36%
X23	2,17%	89,78%	88,65%	0,68%	47,32%	5,55%	0,00%	0,53%	44,53%	45,78%	0,82%	0,60%	0,12%	79,92%	20,08%	0,90%	75,0%	25,0%	1,48%	0,66%	7,25%	2,98%
X24	1,03%	90,03%	86,22%	0,59%	14,58%	2,31%	0,00%	0,57%	10,42%	12,82%	8,22%	5,93%	0,16%	75,70%	24,30%	0,68%	66,67%	33,33%	1,03%	0,75%	6,72%	5,0%
X25	2,28%	90,16%	79,64%	1,05%	55,31%	31,46%	0,30%	0,80%	53,18%	12,21%	0,48%	1,32%	0,37%	71,15%	28,85%	1,58%	42,86%	57,14%	1,49%	1,03%	7,18%	3,95%
X26	2,76%	91,59%	74,67%	2,14%	26,81%	1,59%	0,31%	1,75%	21,10%	3,94%	0,05%	22,94%	0,04%	79,84%	20,16%	0,68%	0,0%	100%	1,045%	1,83%	5,49%	6,07%

11. Appendix II

Questionario sulla valutazione dei servizi ecosistemici

Gent.simo Sign./Sig.ra,

Le siamo grati per avere accettato di partecipare a questa ricerca.

Gli ecosistemi forniscono all'umanità numerosi beni e servizi ecosistemici. I beni prodotti dagli ecosistemi comprendono, ad esempio, il cibo, l'acqua, i carburanti e il legname; i servizi, invece, comprendono l'approvvigionamento idrico e la purificazione dell'aria, il riciclo naturale dei rifiuti, la formazione del suolo, l'impollinazione e molti altri meccanismi regolatori naturali.

Il Millennium Ecosystem Assessment (MA, Valutazione del Millennio degli Ecosistemi) distingue quattro categorie di servizi ecosistemici:

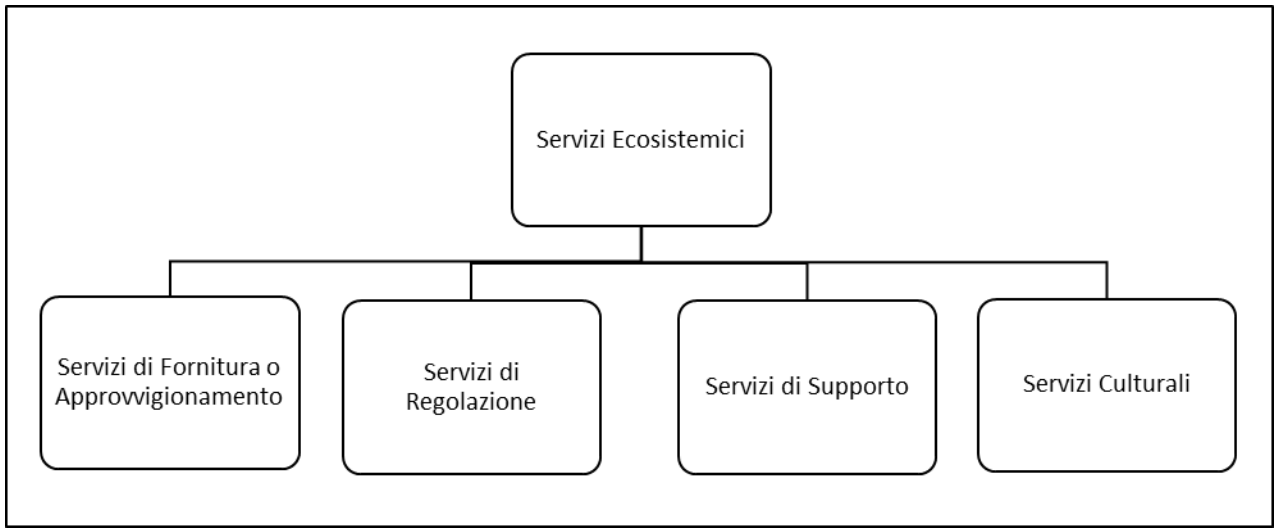
- i servizi di **fornitura o approvvigionamento**: forniscono i beni veri e propri, quali cibo, acqua, legname, fibre, combustibile e altre materie prime, ma anche materiali genetici e specie ornamentali
- i servizi di **regolazione**: regolano il clima, la qualità dell'aria e le acque, la formazione del suolo, l'impollinazione, l'assimilazione dei rifiuti, e mitigano i rischi naturali quali erosione, infestanti ecc.
- i servizi **culturali**: includono benefici non materiali quali l'eredità e l'identità culturale, l'arricchimento spirituale e intellettuale e i valori estetici e ricreativi
- i servizi di **supporto**: comprendono la creazione di habitat e la conservazione della biodiversità genetica.

Questa ricerca si propone di ottenere informazioni sull'importanza dei diversi servizi ecosistemici in provincia di Ferrara. Le domande saranno relative alle categorie, ai gruppi e agli indicatori di servizi ecosistemici, al fine di stabilire una classificazione per ordine di importanza delle varie categorie e sottocategorie.

Informazioni sull'intervistato

Nome	
Cognome	
Organizzazione	
Ruolo/posizione	
Contatto – Email	
Data dell'intervista	

Figura 1: Categorie di Servizi Ecosistemici

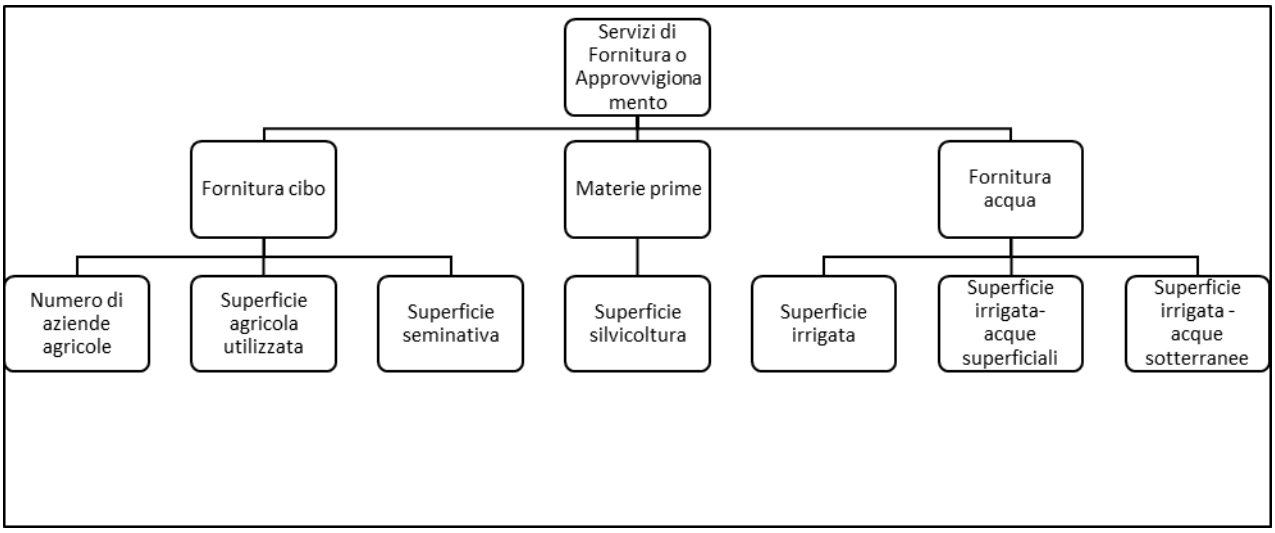


1: Come qualificherebbe l'importanza di ciascun gruppo di indicatori in relazione ai servizi ecosistemici?

Servizi Ecosistemici	Quantificare l'importanza (X)
Servizi di Fornitura o Approvvigionamento	0 1 2 3 4 5 6 7 8 9 ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
Servizi di Regolazione	0 1 2 3 4 5 6 7 8 9 ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Servizi di Supporto	0 1 2 3 4 5 6 7 8 9 ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
Servizi Culturali	0 1 2 3 4 5 6 7 8 9 ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Figura 2: Servizi di fornitura o approvvigionamento



2: Come qualificherebbe l'importanza di ciascun gruppo di indicatori in relazione alla categoria dei servizi di fornitura o approvvigionamento?

Servizi di fornitura o approvvigionamento	Quantificare l'importanza (X)
Fornitura cibo	0 1 2 3 4 5 6 7 8 9 ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
Fornitura acqua	0 1 2 3 4 5 6 7 8 9 ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
Materie Prime	0 1 2 3 4 5 6 7 8 9 ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

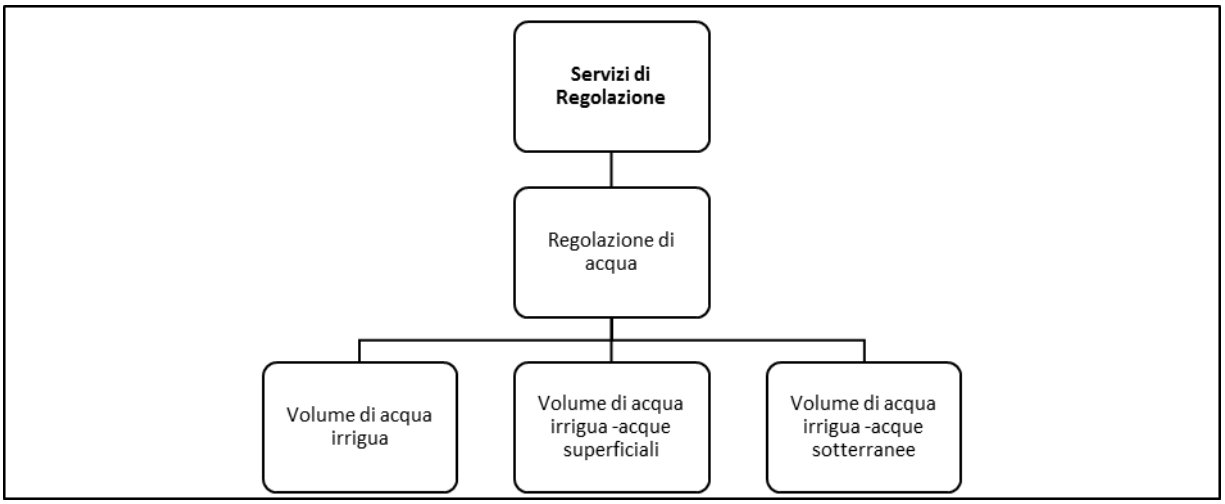
3: Come qualificherebbe l'importanza di ciascun indicatore in relazione al gruppo fornitura cibo

Fornitura cibo	Quantificare l'importanza (X)
Numero di aziende agricole	0 1 2 3 4 5 6 7 8 9 ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
Superficie agricola utilizzata	0 1 2 3 4 5 6 7 8 9 ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
Superficie seminativa	0 1 2 3 4 5 6 7 8 9 ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

4: Come qualificherebbe l'importanza di ciascun indicatore in relazione al gruppo fornitura acqua

Fornitura acqua	Quantificare l'importanza (X)
Superficie irrigata	0 1 2 3 4 5 6 7 8 9 ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
Superficie irrigata ettari - acque superficiali all'interno dell'azienda (bacini naturali ed artificiali, laghi, fiumi o corsi d'acqua)	0 1 2 3 4 5 6 7 8 9 ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
Superficie irrigata ettari - acque sotterranee all'interno o nelle vicinanze dell'azienda	0 1 2 3 4 5 6 7 8 9 ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

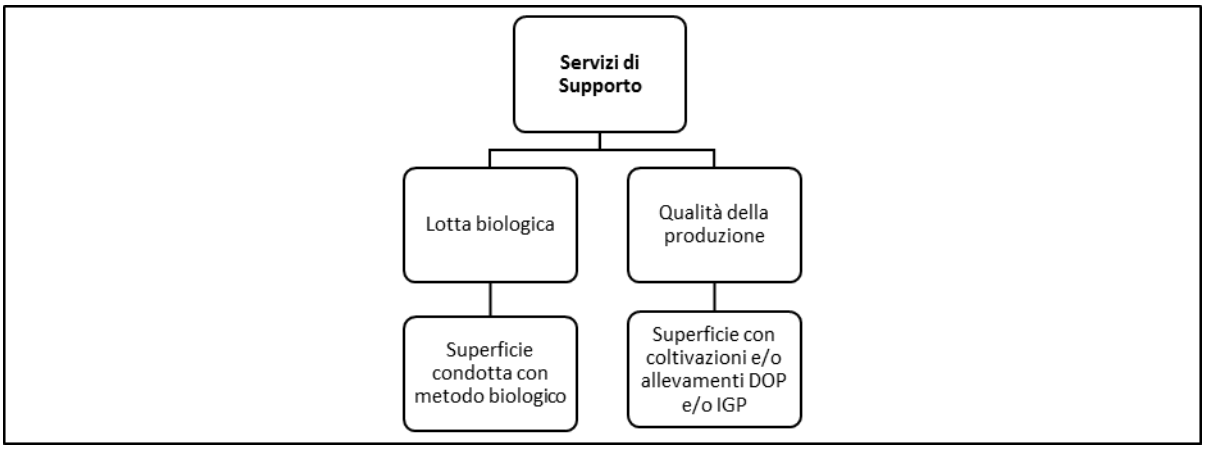
Figura 3: Servizi di regolazione



5: Come qualificherebbe l'importanza di ciascun indicatore in relazione al gruppo regolazione acqua e la categoria dei servizi di regolazione?

Servizi di regolazione	Quantificare l'importanza (X)
Volume di acqua irrigua	0 1 2 3 4 5 6 7 8 9 ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
Volume di acqua irrigua -acque superficiali all'interno dell'azienda (bacini naturali ed artificiali, laghi, fiumi	0 1 2 3 4 5 6 7 8 9 ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
Volume di acqua irrigua - acque sotterranee acquedotto, consorzio di irrigazione e bonifica o altro ente irriguo	0 1 2 3 4 5 6 7 8 9 ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

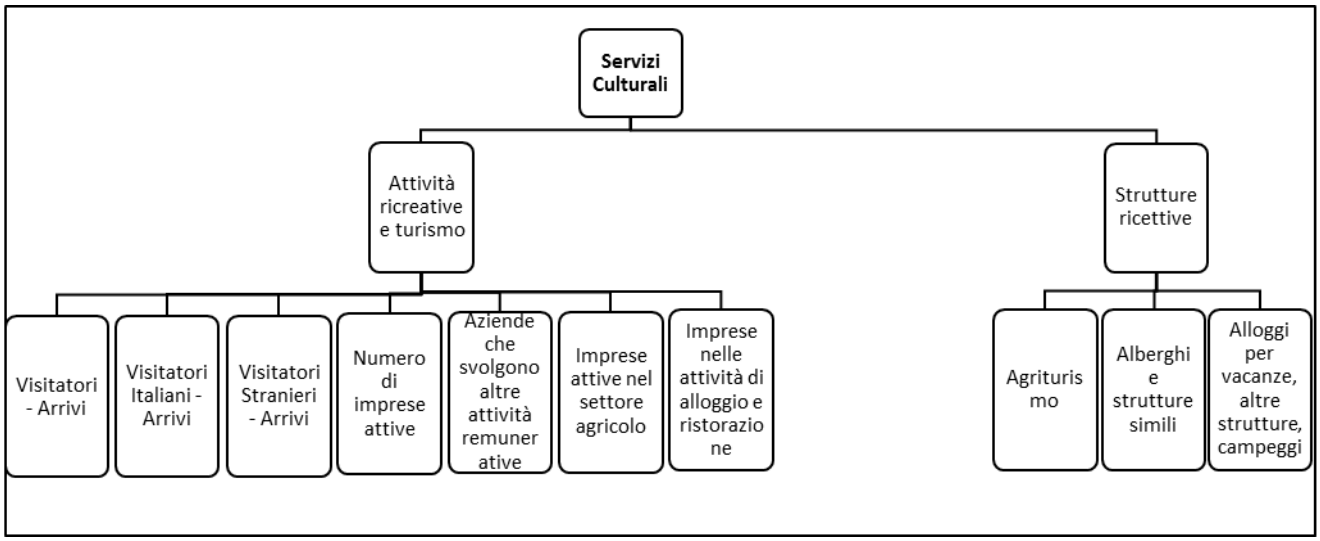
Figura 4: Servizi di supporto



6: Come qualificherebbe l'importanza di ciascun gruppo di indicatori in relazione alla categoria dei servizi di supporto?

Indicatori	Quantificare l'importanza (X)
Lotta biologica	0 1 2 3 4 5 6 7 8 9 ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
Qualità della produzione	0 1 2 3 4 5 6 7 8 9 ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Figura 5: Servizi Culturali



7: Come qualificherebbe l'importanza di ciascun gruppo di indicatori in relazione alla categoria dei servizi culturali?

Servizi di regolazione	Quantificare l'importanza (X)
Attività ricreative e turismo	0 1 2 3 4 5 6 7 8 9 ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
Strutture ricettive	0 1 2 3 4 5 6 7 8 9 ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

8: Come qualificherebbe l'importanza di ciascun indicatore in relazione al gruppo attività ricreative e turismo?

Servizi di regolazione	Quantificare l'importanza (X)
Visitatori - Arrivi	0 1 2 3 4 5 6 7 8 9 ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
Visitatori Italiani - Arrivi	0 1 2 3 4 5 6 7 8 9 ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Visitatori Stranieri - Arrivi	0 1 2 3 4 5 6 7 8 9 ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
Numero di imprese attive	0 1 2 3 4 5 6 7 8 9 ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
Numero di imprese attive nel settore agricolo (produzione vegetale e animale, attività di supporto all'agricoltura)	0 1 2 3 4 5 6 7 8 9 ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
Numero di imprese attive nelle attività di alloggio e servizi di ristorazione	0 1 2 3 4 5 6 7 8 9 ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
Numero di aziende che svolge altre attività remunerative (agriturismo, attività ricreative e sociali, prima lavorazione dei prodotti agricoli	0 1 2 3 4 5 6 7 8 9 ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

9: Come qualificherebbe l'importanza di ciascun indicatore in relazione al gruppo strutture ricettive?

Servizi di regolazione	Quantificare l'importanza (X)
Agriturismo	0 1 2 3 4 5 6 7 8 9 ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
Alberghi e strutture simili	0 1 2 3 4 5 6 7 8 9 ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
Alloggi per vacanze, altre strutture per brevi soggiorni, campeggi	0 1 2 3 4 5 6 7 8 9 ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Tabella 1: Lista degli indicatori

ES Categoria	ES Gruppo	ES Indicatori
Fornitura o approvvigionamento	Fornitura cibo	Numero di aziende agricole
	Fornitura cibo	Superficie agricola utilizzata
	Fornitura cibo	Superficie seminativa
	Fornitura acqua	Superficie irrigata
	Fornitura acqua	Superficie irrigata ettari - acque superficiali all'interno dell'azienda (bacini naturali ed artificiali, laghi, fiumi o corsi d'acqua)
	Fornitura acqua	Superficie irrigata ettari - acque sotterranee all'interno o nelle vicinanze dell'azienda
	Materie prime	Superficie silvicoltura
Regolazione	Regolazione di acqua	Volume di acqua irrigua
	Regolazione di acqua	Volume di acqua irrigua -acque superficiali all'interno dell'azienda (bacini naturali ed artificiali, laghi, fiumi)
	Regolazione di acqua	Volume di acqua irrigua - acque sotterranee acquedotto, consorzio di irrigazione e bonifica o altro ente irriguo
Supporto	Lotta biologica	Superficie agricola condotta con metodo biologico
	Qualità della produzione	Superficie agricola utilizzata con coltivazioni e/o allevamenti DOP e/o IGP
Culturali	Attività ricreative e turismo	Visitatori - Arrivi
	Attività ricreative e turismo	Visitatori Italiani - Arrivi
	Attività ricreative e turismo	Visitatori Stranieri - Arrivi
	Strutture ricettive	Agriturismo
	Strutture ricettive	Alberghi e strutture simili
	Strutture ricettive	Alloggi per vacanze, altre strutture per brevi soggiorni, campeggi
	Attività ricreative e turismo	Numero di imprese attive
	Attività ricreative e turismo	Numero di imprese attive nel settore agricolo (produzione vegetale e animale, attività di supporto all'agricoltura)
	Attività ricreative e turismo	Numero di imprese attive nelle attività di alloggio e servizi di ristorazione
	Attività ricreative e turismo	Numero di aziende che svolge altre attività remunerative (agriturismo, attività ricreative e sociali, prima lavorazione dei prodotti agricoli