PROVIDE
PROVIding smart DElivery of public goods by EU agriculture and forestry

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Draft paper analysing the issues and hot-spots identified by mapping public good demand and supply at multiple scales in Europe

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PU	Public	X
PP	Restricted to other programme participants (Including the Commission Services)	
RE	Restricted to a group specified by the consortium (Including the Commission Services)	
CO	Confidential, only for members of the consortium (Including the Commission Services)	

Content

Sommario

Introduction

This document represents D3.3 entitled "Paper (draft version for submitting to scientific journal) analysing the issues and hot-spots identified by mapping public good demand and supply at multiple scales in Europe." According to the description of the deliverable by DoA, this document focuses on most promising issues identified in D3.2 and suitable for an article-type outcome.

In particular, in view of the variety of mapping results from D3.2, and taking into account the difficulties in separating demand and supply on large scale analysis and secondary mapping data, the focus here has been on using stakeholders and experts views on public goods in order to build typologies of areas suitable to link thematic mapping with functional decision making about policy instruments.

1. Introduction and objectives

The provision of public goods by agriculture and forestry has been one of the major topics of the agricultural policy debate in recent decades. Currently the EU Common Agricultural Policy incorporates a number of instruments related to public good-type issues, ranging from greening and cross-compliance in the first pillar to agro-climate measures in the second pillar.

From an economic point of view, public intervention related to pubic goods is justified by the fact that, due to their nature, markets do not provide prices for public goods and, as a consequence, do not allow to reach an optimal level of provision. Research has tried to deal with this topic in different ways. One pathway tries to attach a value to public goods provision to support related decision-making, either using monetary or non-monetary techniques (e.g. as an utility/relevance score).

One difficulty of these exercises is that public goods values are rather site- and context-specific, so that value generated for a specific issue/decision may be hardly generalised/transferred. In addition, a problem arises due to the fact that demand and supply are difficult to observe separately from each other. In practice, the relevance of the public goods tends to mix up with the size of the discrepancy between desired level of public good and the actual supply. In addition, effects of agriculture on several public good dimensions (e.g. water) are seen as either public goods or bads depending on thresholds of agricultural practices or ecosystem status (e.g. nutrient use or water status). Hereafter public goods and bads are denoted by PGs and PBs, respectively; Public gods and bads by PGBs.

Another stream of literature tend to quantify public goods through physical measures, possibly made spatially explicit. The results of this mapping activities, as also evident from Marconi et al., 2016, is is often characterised by a lot of very specific information, which is however difficult to interpret on the aggregate, especially lacking the ability of combining insights from multiple PGs in the same area.

In this paper we try to add to the literature partially overcoming these limitations through a stakeholder based exercise. According to the scientific literature, stakeholders' involvement in environmental management has recently increased being a practical and cost-saving instrument of evaluating alternative policy prescriptions and/or management options (Targetti et al., 2016; Rutgers et al., 2012; Kuhnert et al., 2010; Reed, 2008) when ad hoc technical studies are not neither available nor affordable due to low budget and time limitations

In this paper we address the issues above through the identification of typologies of public good provision based on stakeholders' importance weights assigned to a set of public goods and bads, and try to establish a link with policy prescriptions, in terms of most relevant/suitable policy instrument, to each profile of public goods concern.

More specifically, the objectives of the paper are the following:

a) to identify perceived typologies of rural areas within Europe based on the relevance of different bundles of public goods and bads;

b) to disentagle the role of agriculture and forestry as providers of combinations of PGs and/or PBs;

c) to identify suitable policy instruments as a function of the specific combinations of public goods in each area (type).

The paper is structured as follows. In the next section (section 2) the methodology is illustrated, followed by the overview on the considered Case Study Regions (section 3). Section 4 illustrates the results, followed by a discussion section (section 5) and by concluding remarks (section 6).

2. Methods

Stakeholder survey

A survey was carried out to collect information from the stakeholders in order to estimate and map social demand for public good provision from agriculture and forestry across Europe. To provide a structure to the survey, public goods considered as connected in pairs to underlying Socia-Ecosystem Capital (SEC) items. Rural landscape, rural biodiversity, water, air, soil, climate change, geohazards, rural communities, rural products, livestock are the 10 elements of the SEC to which the definitions of PGs and PBs are referred to. In this framework, PGs and PBs provided by agriculture and forestry can be considered two opposite sides of the same issue. In particular, PGs include both the existence itself of certain goods (e.g. clean water) and the processes aiming at preserving or enhancing those goods (e.g. adoption of low input farming techniques). On the opposite, PBs are the processes that endanger the existence of public good, ranging from environmental, as clean water/air, to social, as the vibrant rural communities (e.g. the misuse of pesticides, the degradation that follows land abandonment). In stakeholders' perceptions, a correlation appears to exist between some public good and bads in the context of the same issues. The PGs provided by agriculture and forestry are selected integrating the lists identified by Cooper (2009) and ENRD (2010). A further result of the survey is the identification of the most relevant PGBs and the most useful policy instrument from the point of view of local stakeholders.

The stakeholders of the 9 case study regions were approached with a request to fill in a multiple choice questionnaire. The stakeholder survey aimed at gathering their views on several issues concerning PGBs in the context of agriculture and forestry: definition of PGs, local relevance of PGBs, preferential locations, governance mechanisms usable for improving the provision of PGs and reducing the provision of PBs. The questionnaire used in the survey consists of two main sections: the first including 7 questions on PGs and the second including a restricted number (5 out of 7) of the same questions but referred to PBs. The respondents of the stakeholder questionnaire were first asked to give a 0-9 score to the single PGs (section 1 of the questionnaire), then they were asked to give a 0-9 score to the single PBs (section 2 of the questionnaire). A total number of 101 stakeholders answered to the survey, however there was a considerable attrition rate and not all the respondents completed the questionnaire. The total number of the respondents answered to the question for PGs, while only 70% of respondents also answered to the same question for PBs. The composition of the sample of respondents is described in the results section.

Stakeholders were asked to score the relevance of the given set of PGs and PBs in their regions. The opinions of stakeholders on the most suitable governance mechanisms (GMs) for the management of PGBs were elicited through dedicated questions. Stakeholders were asked to select the most usable GMs among the same given list for each of the considered PGs and PBs, in two separate questions. The list of GMs is composed by the answers given by a reduced number of stakeholders (1-2 per CSRs) to the same questions during face-to-face interviews. Those answers were reworked trying to identify general categories of GMs among the options described by the respondents. Finally, those general categories were integrated with other categories of GMs described in the scientific literature when missing in the stakeholders' answers. The answers collected through the multiple choice questionnaire were used to rank the GMs indicated as useful for the PGBs based on the frequency of selection.

Identification of typologies of rural areas based on the relevance of different bundles of public goods through cluster analysis

The identification of typologies of rural areas within Europe was accomplished performing a clustering exercise based on the outcomes of the stakeholder survey. Then, the clusters identified has been characterized according to the provenance of the stakeholders composing each cluster.

The scores attributed to the total number of PGBs by each respondent were successively converted into weights expressed in the 0-1 range by conputing a ratio between the individuals core and the some of the scores given to all the PGs. Those weights expressing the relevance of 10 PGs and 10 PBs provided by agriculture and forestry were used as variables for the clustering exercises.

The cluster analysis aims at the identification of typologies of rural areas within Europe and consists of a two-stages analysis: first, a clustering exercise was performed focusing only on the relevance attributed to the PGs, then a second analysis was performed including the total number of PGBs scored by the respondents. Two analysis with different cluster variables were performed due to the fact that only 70% of the respondents answered to the second part of the questionnaire focused on the PBs. Thus, performing only one analysis would lead to the loss of the information concerning the relevance of PBs or to the loss of 30% of the observations if considering only the respondents answering to both sections. Besides the difference in the number and nature of the cluster variables, both the cluster analysis followed the same methodology, which can be described as follows. A hierarchical clustering analysis was performed as an explorative tool, in order to obtain a dendrogram showing the sequence and structure of cluster aggregations. This preliminary clustering exercise followed the Ward's method with Gower distance (this algorithm was used because of the discrete nature of the cluster variables). The analysis of the dendrogram supported the selection of the number of clusters. The most distinct solution identified was used to fix the number of clusters when computing a second, non-hierarchical cluster analysis. This second cluster analysis, following the k-means method (Gower distance), was performed in order to obtain the centres and the sizes of the clusters and improve the distinction between clusters. Finally, the identification of typologies of rural areas within Europe was accomplished matching the relevance attributed to bundles of PGBs with the country of provenance of the stakeholders composing each cluster.

Disentanglement of the role of agriculture and forestry as providers of PGs and/or PBs (correlation analysis, estimation of the net effect on each topic)

The role of agriculture and forestry as providers of PGBs was estimated by linking the weights assigned by stakeholders to the PGs and the PBs to the same element of the SEC (e.g. air or landscape). Those links were analysed by means of a pairwise correlation analysis at first. This analysis was done in order to identify statistically significant relations, and the sign of the correlation coefficient in significant relations. Then, a second pairwise analysis was performed by computing the difference between the weights attributed to PGs and the PBs related to the same SEC. The results of this computation are displayed trough a boxplot chart, which easily allows the identification of positive and negative median values for each SEC. Roughly speaking, positive median values indicate positive net effects of agriculture and forestry on the given SEC (e.g. soil or rural vitality), while the negative hints at the opposite. For example, if the median value of the difference of the scores attributed to the PGs and the PBs of the same element of the SEC (e.g. farmland biodiversity) is -0.01, this suggest that stakeholders consider agriculture and forestry to have an overall negative effect on this given element.

Identification of suitable policy instruments as a function of the most relevant public goods through ranking of the selected governance mechanisms for each PGBs

The Governance Mechanisms indicated as the most useful for improving the provision of PGs from agriculture and forestry have been identified for each PG by ranking the GMs proposed in the questionnaire according to the number of selections received. Similarly, the GMs considered to be the most useful to reduce the provision of PBs were ranked with the same criteria for each given PB.

The relation between the outcomes of the cluster analysis and the GMs was estimated as the sum of the products obtained by multiplying a score associated to the ranking of each GM for each PG, by the weight of the PG in each cluster. The score associated to each GM for each PG is obtained through the inverse ranking method. On detail, a score was attributed to each GMs based on the position of the GM in the ranking of the policy instruments indicated as usable for improving the provision of a given PG by the stakeholders. The assigned score was calculated in two steps: first the inverse of the positions in the raking were computed, for instance the GM ranked as the second most mentioned usable instrument for improving the provision of water quality has been attributed a 0.5 preliminary score. Then, the preliminary scores attributed to all the GMs have been converted into shares of their total sum for each PG. Finally they were multiplied by the weight (center of the cluster) of the given PG in each cluster.

3. Case study regions

This exercise is based on the involvement of Local stakeholders from nine Case Study Regions (CSR) each located in a different European country namemy: Italy, Germany, Spain, Finland, Estonia, Romania, Bulgaria, Poland, Czech Republic. In this section we provide a short description of each CSR.

The Finnish case study region is North Ostrobothnia, which is a sub-national administrative region in Northern Finland (NUTS3 FI1D6). Area of the region is some 44,000 km2 and population 405,000. It contains 29 municipalities and 11 cities with Oulu as the capital. Share of forest land in the region is 88%, and typical elements of landscape contain hill areas in northeastern part, rivers and river valleys in the western part, and flat peatland areas in the middle.

The Spanish CSR is Andalusia. Andalusia is located in southern Spain. It has 87,268 km2 and 8.4 million people. There is a wide variety of agroforestry landscapes, especially including olive groves (with more than 1.5 million ha), 'dehesa' agroforestry and livestock system (around 1 million ha), winter rainfed cereal systems (0.6 million ha) and different types of irrigated agricultural systems (0.5 million ha).

The Italian CSR is Emilia-Romagna region, located in the north-eastern side of the country. Agricultural areas cover the 60% of the regional land. Intensive arable crops covers the 42% of the regional UAA. Agricultural systems in Emilia-Romagna are mostly oriented towards high-quality traditional and local production and has been recently characterized by a process of abandonment of small and marginal farms in favour of an increase in farm size (+36%). Environmental concerns, are water quality degradation, flood risk and soil erosion.

The German CSR is located in the Federal State of Brandenburg (NUTS2), County of Märkisch-Oderland (NUTS3). The CSR is a Nature Park where forested areas are under nature conservation measures and which are surrounded by agricultural areas. Environmental issues are water scarcity, soil functionality (water retention, wind erosion), loss of biodiversity habitats and carbon stocks due to water management. The most important PGs in the region are cultural landscape, biodiversity, scenery, local recreation, soil functions and soil conservation, as well as water quality and water quantity.

The Estonian CSR is the Harju County. Harju County is one of the largest of Estonia and includes the capital city of Tallinn. More than 25% of the total rural population of Estonia lives in this area, however quite few of them are employed in farming. 51% of the regional is covered by forests representing the nearest recreation area for urban population. The county physical planning documents define 33 valuable landscapes and 30 valuable traditional landscapes: nature parks, and the Rebala Heritage Reserve.

The Romanian CSR is the North-East Region. In the CSR is located around 15% of the agricultural national area and 26,7% of wood production. Low productivity for most crops is due to: fragmentation of farmland ownership, aging workforce accompanied by a migration of young people to urban areas, high degree of poverty for small farmers, soil erosion and landslides. The main environmental problems are linked to deforesting, with implications in amplifying the land slips; soil erosion which affect, mainly, the east side of the region; local or zone pollution.

The Bulgarian CSR is the South Central region. The general structure of regional land use is: 48.1% agricultural areas (mainly arable and grassland) and 45.1% forest areas. The region has well developed livestock. There is a wide range of PGs associated with agriculture, many of which are highly valued in the region: agricultural landscapes, farmland biodiversity, water quality and availability, food security, rural vitality and farm animal welfare and health. PBs are soil erosion (about 80% of agricultural land), soil contamination from heavy metals and air pollution

The Poland CSR is represented by the Podlasie region. Agricultural areas constitute 53% of the region and forests constitute 31%. The region is predominantly rural and a significant number of municipalities fall within the Nature 2000 areas. The number of farms recently declined by 14%. The farms are, on average, small and oriented towards high quality production (the average certified ecological farm is larger than the regional average. The region has a potential to become a popular tourist destination. Environmental issues are water quality pollution and biodiversity losses due to the recent intensification of agriculture and urban expansion.

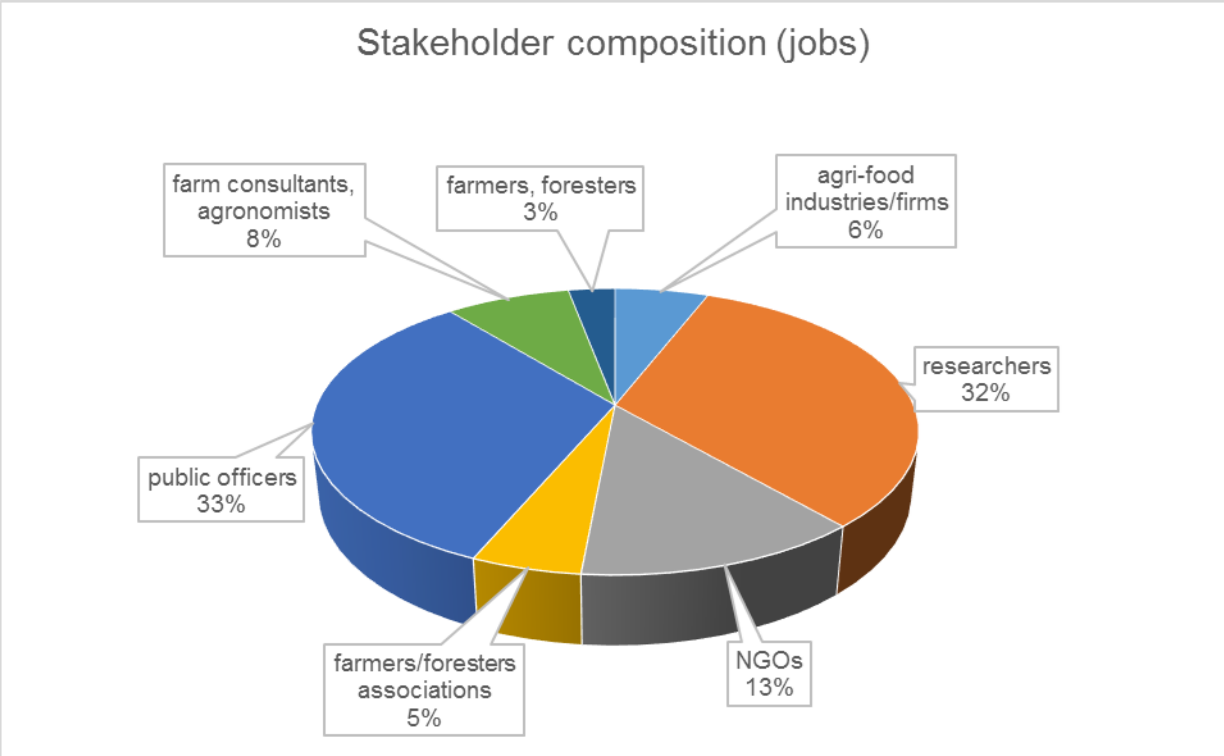
The first part of the case study area of the Czech republic, 'Česká Lípa', is situated in northern Bohemia. The second part of the case study area 'Děčín' is situated in the Northeast of the district Ústecký kraj. About. 450 km² of its surface are forests and approx. 365 km² are used for agricultural purposes. Both parts of the CSR are especially attractive to tourists due to its large amount of culturally rich sites such as nature reserves and nature monuments. Environmental issues are water scarcity due to climate change and soil pollution in the former military base.

4. Results

Description of the sample of respondents

The survey was filled in by a total number of 101 respondents, 65 out of which indicated 'agriculture' as their area of expertise, whereas 36 indicated 'forestry'. The respondents belong to the local stakeholders and expert platform (CS-SP) of 9 out 13 CSRs of the PROVIDE project. The composition of the sample according to the professional categories represented by the respondents is synthetized in the chart of figure 1, showing that stakeholders are mostly public officers working on regional or national institutes (33% of the total sample) or researchers in the field of agriculture and forestry or related (32%). Other less represented professional categories are the following, in order of decreasing share of the respondents sample: members of NGOs (13%), mainly in the field of nature conservation or local development); farm consultants and agronomists (8%); employees in agri-food firm and industries (6%); representatives of farmers/foresters associations (5%); farmers and foresters (3%).

Figure 1 – Composition of the surveyed sample of stakeholders: % shares of job categories represented



Concerning the composition of the sample according to the EU country, the Italian CSR, Emilia-Romagna region, is the most represented region (21.78 % of the total sample), followed by the Romanian, and the polish, CSRs (14.85% and 12.87%, respectively). All the remaining countries holds a share lower than 10% of the total sample.

Identitication of typologies of areas based on the relevance of bundles of public goods

The number of respondents and statistical descriptives of the stakeholders' weights, such as mean, standard deviation (S.D.), minimum (min) and maximum (max) values, median (p50) and variance, are synthetized in Table 1 for all of the 20 PGBs analysed. On the whole, the greatest mean relevance (0.11) has been attributed to 'Landscape and scenery' and 'Water quality and availability', the latest also shows the greatest median value (0.11) among PGs. Concerning PBs, the greatest mean (0.12) and median (0.11) relevance was attributed to 'Soil erosion' and to 'Biodiversity losses', followed by 'Water quality and availability' which achieved a mean and median relevance of 0.11. Thus, 'Water quality and availability' is the only issue indicated as either a most relevant PG and a very relevant PBs provided by agriculture and forestry. A much greater internal variability characterizes the scores attributed to PBs with respect to those attributed to PGs, as it is proven by the resulting standard deviations which are in the 0.2-0.3 range for all of the PGs and in the 0.3-0.5 range for the majority of PBs, with the exception of 'Soil erosion' showing the greatest variability of attributed scores (standard deviation equals 0.6).

Table 1 – Descriptives of the variables "relevance of PGs in the considered country" and "relevance of PBs in the considered country"

Variable	**Mean**	**S. D.**	**Min**	**Max**	**p50**
PGs (101 respondents)					
Landscape and scenery	**0.11**	0.02	0.02	0.16	0.10
Farmland biodiversity	0.10	0.03	0.04	0.19	0.10
Water Quality and availability	**0.11**	0.03	0.01	0.23	**0.11**
Air quality	0.09	0.02	0.02	0.14	0.10
Soil functionality	0.10	0.03	0.02	0.19	0.10
Climate stability	0.10	0.03	0.00	0.20	0.10
Resilience to Flooding, Landslides and Fire	0.09	0.03	0.00	0.17	0.10
Rural viability and vitality	0.10	0.03	0.04	0.20	0.10
Quality and security of products	0.10	0.02	0.02	0.17	0.10
Farm animal health and welfare	0.10	0.03	0.00	0.22	0.10
PBs (69 respondents)					
Landscape degradation	0.10	0.04	0.00	0.24	0.10
Biodiversity losses	**0.12**	0.05	0.00	0.40	**0.11**
Water resources pollution and depletion	0.11	0.04	0.00	0.28	**0.11**

Air pollution	0.09	0.03	0.00	0.25	0.09
Soil erosion	**0.12**	**0.06**	0.03	0.47	**0.11**
Climate degradation	0.10	0.03	0.00	0.17	0.10
Increase of flood and wild fire risk	0.11	0.05	0.00	0.36	0.10
Degradation of abandoned land	0.08	0.04	0.00	0.15	0.09
Poor quality and security of products	0.08	0.04	0.00	0.18	0.09
Degradation of animal health and welfare	0.09	0.03	0.00	0.14	0.09

As stated before, two different clustering exercises were performed in order to identify different typologies of (judgement on) rural areas in Europe. The first analysis (named Clu_PGs hereafter) was made on the basis of the weighted relevance attributed by stakeholders to the PGs only (10 cluster variables). Differently, the second (named Clu_PGBs hereafter) was based on the total range of PGBs provided by agriculture and forestry considered in this study (20 cluster variables). Both the cluster analyses indicate the number of 4 clusters as the most distinctive solution. The size of the total samples analysed and the name and the numerosity of the clusters are synthetized in Table 2.

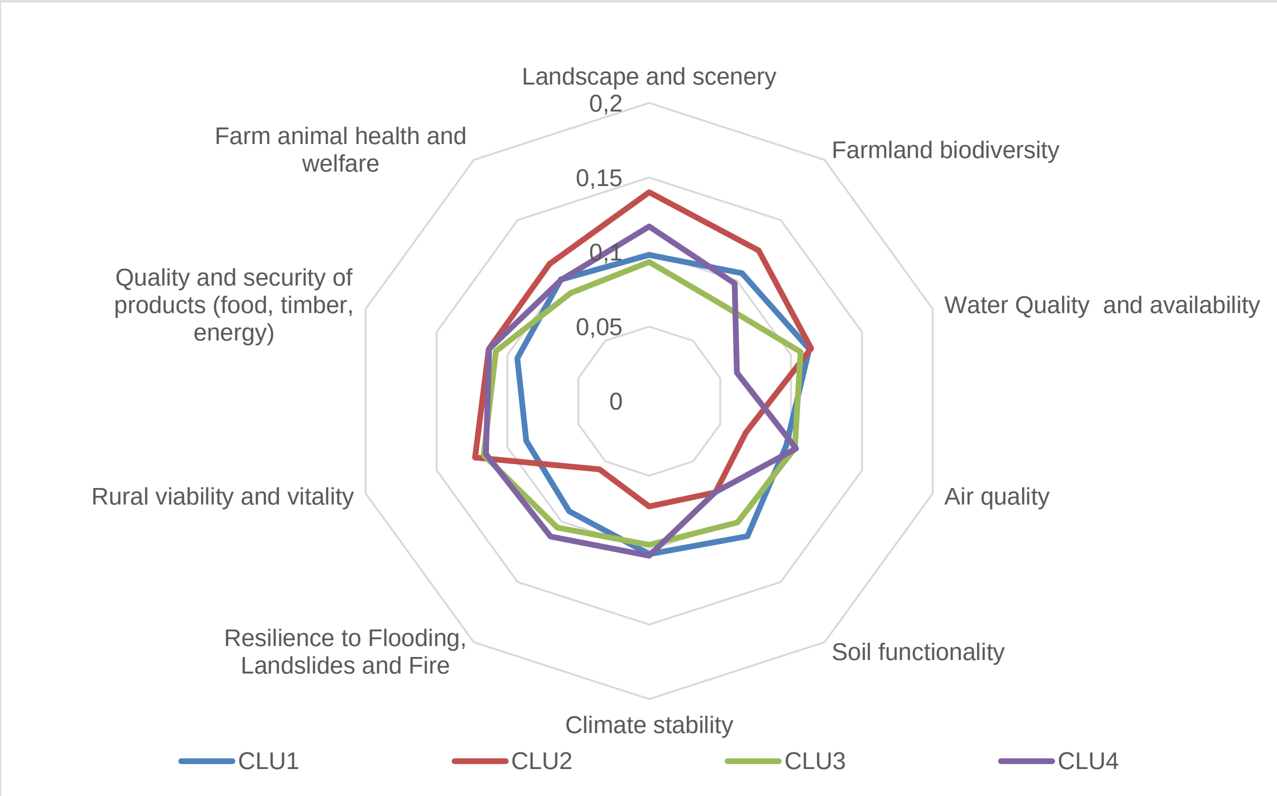
A large cluster including half or more of the surveyed stakeholders was identified in both of the analyses (Clu_1 in Clu_PGs and in Clu_PGBs). The largest clusters are composed by the stakeholders assigning a homogeneous level of relevance to the PGs (almost equal to 0.1) in both the clustering exercises. This outcome is clearly displayed by the blue lines in the spider graphs of Figure 3 and it is expressed by the centers of those clusters (Clu_1), which ranges from 0.09 to 0.11 for all of the cluster variables in both the cluster analysis (Table 3 and 4).

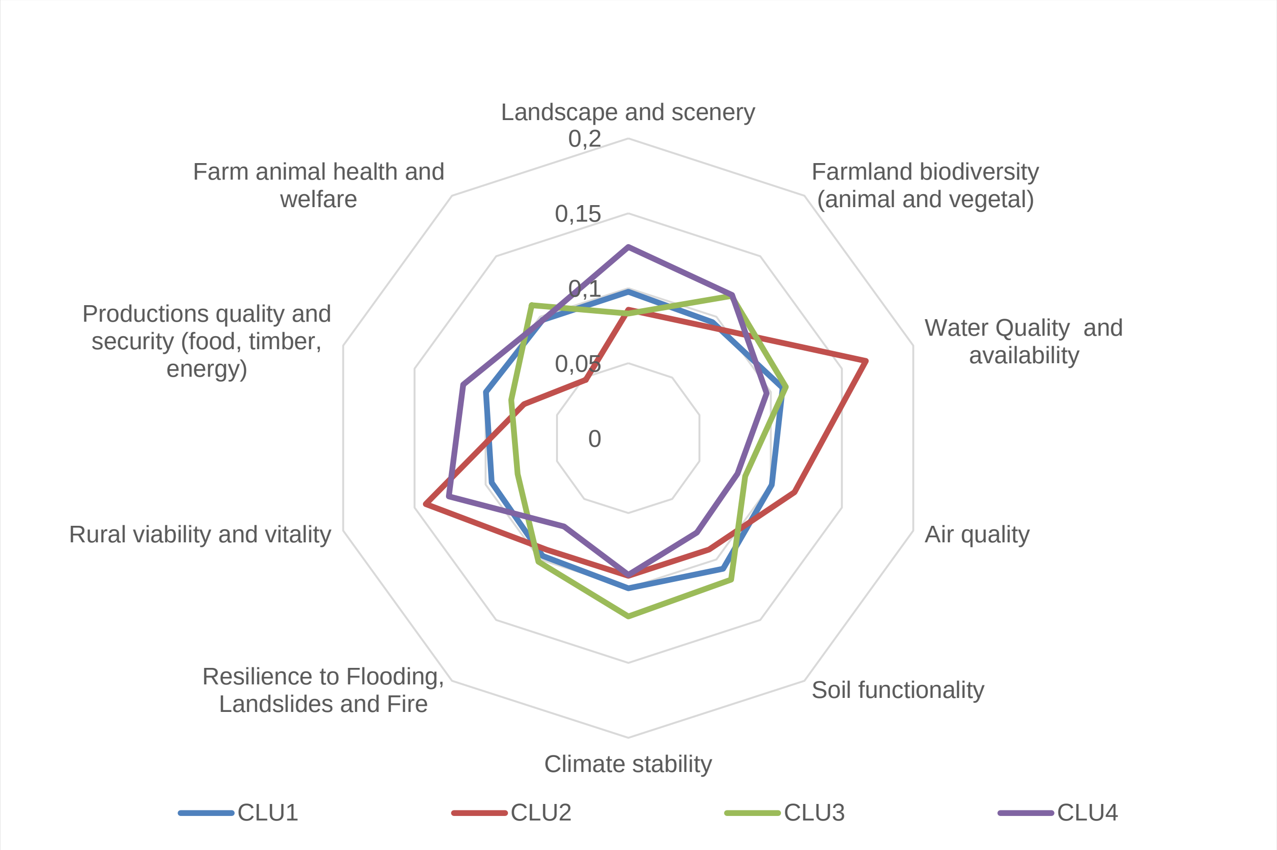
Table 2 – Cluster numerosity in the two performed cluster analysis

Clu_PGs			**Clu_PGBs**		
Cluster name	Frequency	Percent	Cluster name	Frequency	Percent
Clu_1	48	47.5	Clu_1	46	66.7
Clu_2	17	16.8	Clu_2	2	2.9
Clu_3	25	24.8	Clu_3	6	8.7
Clu_4	11	10.9	Clu_4	15	21.7

Total	101	100.0	Total	69	100.0

Figure 3 – Spider graphs showing the cluster variables (PGs) in the cluster analysis considering only PGs (clu_PGs, above) and in the cluster including also the PBs (clu_PGBs, below)





In Clu_PGs, the secondmost larger cluster includes one out of four of the stakeholders (Clu_3, Table 2). The centers of this cluster indicates that it is composed by the respondents attributing a slightly greater relevance to the PG 'rural viability and vitality' (0.12) and slightly lower relevance to 'farmland biodiversity' (0.08), while all of the remaining PGs have received almost homogeneous scores (0.1-0.11, Table 3). Those features characterising Clu_3 are also displayed through the green line in the spider graph of Figure 3. The thirdmost larger cluster (Clu_2, table 2) is composed by stakeholders considering more relevant the PGs that have more prononced local and social dimension ('rural viability and vitality' and 'landscape and scenery', see Table 3) with respect to the more environmental PGs (with the exception of 'water quality and quantity' and 'farmalnd biodiversity'). The smallest cluster (Clu_4, Table 2) represents 10% of the total sample of respondents, and in particular those indicating the more 'rural viability and vitality' and 'landscape and scenery'as the most relevant PGs, with especially low values for water and soil PGs (see table 3).

Table 3 – Centers of the cluster variables: cluster analysis Clu_PGs

PGs	Clu_1	Clu_2	Clu_3	Clu_4

Landscape and scenery	0.10	**0.14**	0.09	**0.12**
Farmland biodiversity	0.11	0.12	**0.08**	0.10
Water Quality and availability	0.11	0.11	0.11	0.06
Air quality	0.10	0.07	0.10	0.10
Soil functionality	0.11	0.08	0.10	0.08
Climate stability	0.10	0.07	0.10	0.10
Resilience to Flooding, Landslides and Fire	0.09	0.06	0.10	0.11
Rural viability and vitality	0.09	**0.12**	**0.12**	**0.12**
Quality and security of products (food, timber, energy)	0.09	0.11	0.11	0.11
Farm animal health and welfare	0.10	0.11	0.09	0.10

In Clu_PGBs, the secondmost large clusters includes one fifth of the stakeholders (Clu_4, Table 2). The centers of this cluster indicates that it is composed by the respondents attributing a greater relevance to the PGs that have more prononced social dimension ('rural viability and vitality', 'landscape and scenery', 'quality and security of products', see Table 4) with respect to the more environmental PGs (with the exception of 'farmland biodiversity'). This trend is comparable to that observed for Clu_3 of the previous clustering exercise, but this second exercise also allows the analysis of the relevance attributed to the PBs (Table 4). The stakeholders grouped in Clu_4 assigned a greater importance to a few environmental PBs provided by agriculture and forestry: 'Biodiversity losses', 'Water resources pollution and depletion'and 'Soil erosion'. Thus, those respondents indicated that agriculture and forestry deliver PGs useful for the socio-economic development of the rural areas where they operate, but simultaneously provide damages to natural resources such as water, soil and biodiversity. Limiting to the PGs, those features characterizing Clu_4 are also displayed through the purple line in the spider graph of Figure 3 (right). The thirdmost large cluster (Clu_3, Table 2) is composed by stakeholders considering the PGs characterized by a more environmental (and global) dimension as slightly more relevant than the others ('farmland biodiversity', 'climate stability' and 'soil functionality', Table 4). Among PBs the same respondents indicated that the 'Increase of flood and wild fire risk' is by far the most relevant environmental issue associated with agriculture and forestry, while 'Poor quality and security of products' and 'Degradation of animal health and welfare' are the most relevant socio-economics aspects (Table 4). The smallest cluster (Clu_2, Table 2) is composed by only 2 respondents, who attributed a greatest relevance to 'rural viability and vitality' and ‘water quality and quantity’ among PGs (see red line in Figure 3, right), and to ‘Biodiversity losses’, ‘Soil erosion’ and Increase of flood and wild fire risk’ among PBs (Table 4).

Table 4 - Centers of the cluster variables: cluster analysis Clu_PGBs

PGBs	**Clu_1**	**Clu_2**	**Clu_3**	**Clu_4**
Landscape and scenery	0.09	0.09	0.08	**0.13**
Farmland biodiversity (animal and vegetal)	0.09	0.09	**0.12**	**0.12**
Water Quality and availability	0.11	**0.17**	0.11	0.10
Air quality	0.10	0.12	0.08	0.08
Soil functionality	0.11	0.09	**0.12**	0.08
Climate stability	0.10	0.09	**0.12**	0.09
Resilience to Flooding, Landslides and Fire	0.10	0.09	0.10	0.07
Rural viability and vitality	0.10	**0.14**	0.08	**0.13**
Productions quality and security (food, timber, energy)	0.10	0.07	0.08	**0.12**
Farm animal health and welfare	0.10	0.05	0.11	0.10
Landscape degradation	0.10	0.03	0.05	0.11
Biodiversity losses	0.11	**0.20**	0.10	**0.16**
Water resources pollution and depletion	0.11	0.13	0.10	**0.14**
Air pollution	0.10	0.13	0.07	0.06
Soil erosion	0.11	**0.23**	0.11	**0.16**
Climate degradation	0.10	0.03	0.08	0.10
Increase of flood and wild fire risk	0.10	**0.25**	**0.18**	0.08
Degradation of abandoned land	0.09	0.00	0.05	0.06
Poor quality and security of products (food, timber, energy)	0.09	0.03	**0.15**	0.06
Degradation of animal health and welfare	0.09	0.00	**0.12**	0.07

The clusters so identified, have been characterised based on different background features. First of all they have been analysed based on the composition per CSR of the stakeholders grouped in each of them. Concerning the first clustering exercice, Clu_PGs, the countries more represented in the largest cluster (clu_1) are: Italy (33%), Romania (21%) and Poland (17%), see Table 5. The secondomost large cluster (clu_3) is mainly composed by stakeholders operating in Italy, Romania and Bulgaria (20% each). Germany (35%) and Finland (18%) are the most represented in clu_2, while clu_4 is largely dominated by Spanish stakeholders and subordinately by Estonian respondents (Table 5).

Table 5 – Cluster composition by country of the respondents (cluster analysis Clu_PGs)

Cluster	IT	DE	ES	FI	EE	RO	BG	PL	CZ	Total
1	**33**%	2%	2%	4%	6%	**21**%	10%	**17**%	4%	100%
2	6%	**35**%	12%	**18**%	12%	0%	0%	12%	6%	100%
3	**20**%	0%	4%	12%	8%	**20**%	**20**%	8%	8%	100%
4	0%	0%	**55**%	9%	**18**%	0%	0%	9%	**9**%	100%
Total	**22%**	**7%**	**10%**	**9%**	**9%**	**15%**	**10%**	**13%**	**6%**	**100%**

As previously explained, the second clustering exercise, Clu_PGBs, includes only the 70% of the respondents, operating in 7 countries (Table 6). Thus 2 countries are no more represented by any respondents in this second exercise (Czech Republic and Estonia). The countries more represented in the largest cluster (clu_1) are: Romania (37%), Bulgaria (28%) and Poland (17%). The secondomost large cluster (clu_4) is mainly composed by stakeholders operating in Spain (37%) and Finland (39%). Romania, and subordinately Bulgaria, dominate Clu_3 (59% and 32%, respectively). Clu_2 is composed by 2 italian stakeholders.

Table 6 - Cluster composition by country of the respondents (cluster analysis Clu_PGBs)

Cluster	IT	DE	ES	FI	RO	BG	PL	Total
1	3%	1%	3%	7%	**37%**	**28%**	**21%**	100%
2	**100%**	0%	0%	0%	0%	0%	0%	100%
3	9%	0%	0%	0%	**59%**	**32%**	0%	100%

4	0%	**10%**	**37%**	**39%**	0%	0%	**15%**	100%
Total	**3%**	**3%**	**9%**	**12%**	**32%**	**24%**	**18%**	**100%**

In addition to the country of provenance of the stakeholders, the elements of the landscape indicated as preferential location for the provision of PGs and PBs in their CSRs could be considered as another determinant of the clusters structure. When considering only the elements of the landscape indicated as preferential locations for the provision of PGs, it is possible to observe many similarities but also some differences among the clusters obtained through Clu_PGs (Table 7). In particular, 'riverside and valleys', 'forest and woodlands' and 'almost homogeneously widespread' were indicated among the preferential locations for the provision of PGs by the stakeholders of all of the clusters. Differently, 'hilly areas' and 'mountain areas' were given more importance with respect to the other elements of the landscape mainly by the stakeholders belonging to Clu_1. In addition to those most common to all the cluster, the stakeholders of Clu_2 and Clu_4 indicated as preferential locations also 'meadow and pastures', while those belonging to Clu_3 indicated also 'plain areas'. 'Specific production areas' were indicated as relatively relevant areas for the provision of PGs only by the stakeholders of Clu_4.

When considering the elements of the landscape indicated as preferential location for the provision of both PGs and PBs and the clusters of Clu_PGBs, relevant differences can be observed among clusters as well (Table 8).

Table 7 - Cluster composition by selection of landscape elements as providers of PGs

Cluster PGs	**Clu_1**	**Clu_2**	**Clu_3**	**Clu_4**	**Total (sample)**
On the riversides and river valleys	13%	**17%**	14%	11%	14%
Hilly areas	12%	8%	7%	6%	10%
Mountain areas	**13%**	2%	11%	9%	10%
Plain areas	10%	12%	**15%**	9%	11%
Specific production areas	9%	3%	8%	**11%**	8%
Meadow and pasture areas	10%	**20%**	11%	14%	12%
Areas with cultural and historical values	8%	6%	4%	8%	7%
Almost homogeneously widespread	**13%**	13%	12%	**14%**	13%
Forest and woodland	**13%**	**19%**	**18%**	**18%**	15%
Total (cluster)	**100%**	**100%**	**100%**	**100%**	**100%**

Table 8 - Cluster composition by selection of landscape elements as providers of PBs

Cluster PGBs	Clu_1	Clu_2	Clu_3	Clu_4	Total (sample)
On the riversides and river valleys	15%	15%	13%	19%	16%
Hilly areas	13%	13%	13%	10%	12%
Mountain areas	13%	25%	14%	6%	12%
Plain areas	16%	13%	18%	19%	17%
Specific production areas	11%	8%	12%	13%	11%
Meadow and pasture areas	11%	13%	4%	16%	12%
Areas with cultural and historical values	7%	8%	7%	9%	7%
Almost homogeneously widespread	14%	8%	19%	8%	13%
Forest and woodland	14%	10%	14%	20%	15%
Total (cluster)	100%	100%	100%	100%	100%

Disentanglement of the role of agriculture and forestry as providers of PGs and/or PBs

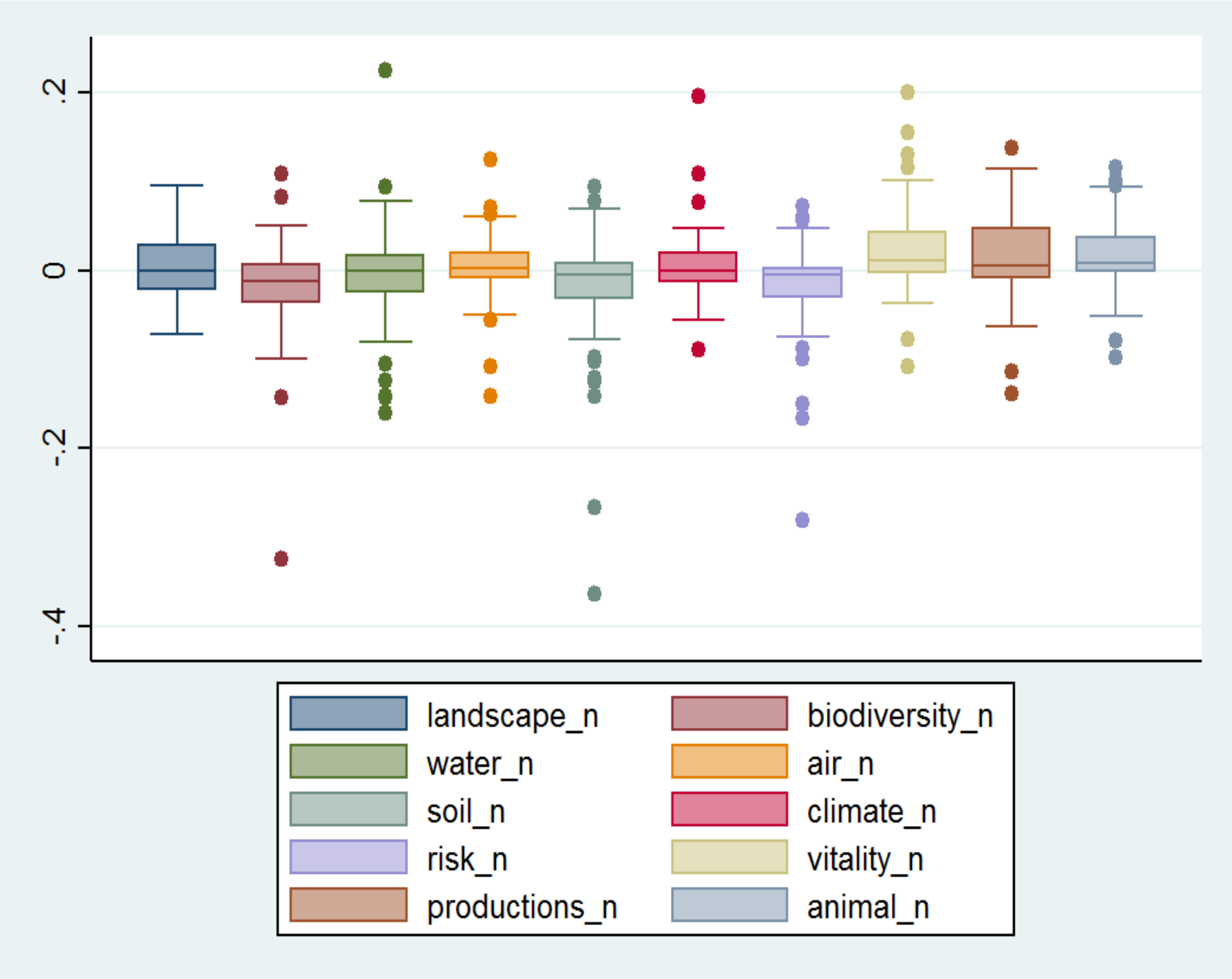
The results of the correlation analysis indicate that there are statistically significant relations for the following elements of SEC: rural landscape, air, geohazards (floodings, landslides, wildfire), rural communities and rural products (see bold lines in Table 9). According to the (weighted) relevance assigned by stakeholders to both the PGs and PBs associated with each of those issues, a positive link exists between the PGs and the PBs related to rural landscape, air, and geohazards. This means that the relevance attributed to the provision of the public goods related to those issues in their CSRs increases accordingly to that of the associated provision of public bads. On the contrary, a negative relation characterizes the relevance of PGs and PBs associated with the issues of rural communities and rural products (see negative correlation coefficients in table 8). This hints at the fact that in the CSRs where the PGs related to rural vitality and/or rural products are relevant, the associated PBs are not and viceversa. The differences in the relations found among associated PGBs lead to the identification of different roles attributed to agriculture and forestry by the stakeholders.

In details, the results of the joint analysis of the (weighted relevance) attributed to associated PGBs (see method section for details), if the relevance on the positive side is assumed to compensate for the relevance on the negative side, indicate that an overall neutral effect of agriculture and forestry is acknowledged for many of the issues, as it expressed by the boxplot diagrams of Figure 4 showing median values equal to zero. In the chart, the median value (expressed by the central line of the boxplots) is negative if the net effect of agriculture and forestry on a given issue is considered to be negative (e.g. soil and biodiversity), and positive if the net effect is considered to be positive (e.g. rural communities, rural products, livestock conditions).

Table 8 – Pairwise correlation among the relative relevance attributed to PGs and PBs related to the same topic

Elements of SEC	Goods_n	Bads_n	Corr. Coefficient	Significance
Rural landscape	Landscape and scenery	Landscape degradation	**0.412**	**0.000**
Rural biodiversity	Farmland biodiversity	Biodiversity losses	0.084	0.493
Water	Water Quality and availability	Water resources pollution and depletion	-0.072	0.557
Air	Air quality	Air pollution	**0.233**	**0.054**
Soil	Soil functionality	Soil erosion	-0.090	0.462
Climate change	Climate stability	Climate degradation	0.073	0.552
Geohazards	Resilience to Flooding, Landslides and Fire	Increase of flood and wild fire risk	**0.329**	**0.006**
Rural communities	Rural viability and vitality	Degradation of abandoned land	**-0.206**	**0.089**
Rural products	Quality and security of products (food, timber, energy)	Poor productions quality and distribution	**-0.348**	**0.003**
Livestock	Farm animal health and welfare	Degradation of animal health and welfare	0.132	0.279

Figure 4 - Boxplot representing the net effect of agriculture and forestry on the considered topics



Identification of suitable policy instruments as a function of the most relevant public goods

As explained in the Method section, stakeholders answered to two questions concerning the mechanisms that could be used to improve the provision of PGs and reduce the provision of PBs. According to the answers, the most cited mechanisms "usable to improve the provision of PGs" are subsidies (namely 'increased financial support to farmers and foresters' and 'PES'), followed by market incentives (specifically 'new market incentives') and education (specifically 'farmers and foresters education to sustainability'). Mechanisms related to regulations are the least cited.

Those results are only partially confirmed by the answers to the same question referred to PBs. In fact, education was the most cited mechanism indicated as usable for the reduction of PBs, while PES is the secondmost. Moreover, mechanisms related to regulation such as pioneering cross compliance in all public subsidies were most frequently selected for the reduction of PBs than those related to the market, which were not considered as usable by the stakeholders. More in detail, environmental PGs with global dimension, such as 'Farmland biodiversity' and 'Climate stability', are seen as potentially benefiting most from increased financial support to farmers (Table 9), which was also the most mentioned mechanism in association with 'water quality and availability' and 'landscape and scenery'. PES were the most cited mechanisms (first and second highest number of selections) in association with all the social PGS (Table 9), and with a number of environmental PGS ('soil functionality', 'resilience to floodings, landslide and fire', 'Water quality and availability', 'air quality' and 'climate stability'). Similarly, PES are the most cited mechanism (highest number of selections) in association with all of the environmental PBs, both local and global, followed by education and fostered cross-compliance in public subsidies (see Table 10). Finally, the mechanisms indicated as the most usable for reducing social PBs is increased financial support to farmers, followed by new market based incentives and education (Table 10).

When combining the relative relevance of the PGs in each cluster of Clu_PGs, expressed in the form of weights by the centers of the clusters, with that of the GMs, also expressed as weights on the basis of the ordering based on the frequency of selection of each mechanisms (see methods), it is clear that there are no significant differences among clusters: PES, increased financial support to farmers and farmers'education are considered to be the most useful mechanisms by the respondents of each clusters (Table 11). A very similar result can be observed combining the relative relevance of all of the PGBs in each cluster of Clu_PGBs with that of the GMs (Table 11): there are no significant differences among clusters, even if some change can be detected in the relative relevance of GMs accordingly to what observed in

Table 10. Partially contrary to what could be expected, PES increase even their relevance, especially in Cluster 2.

Table 9 - Top three mechanisms usable for the improvement of the provision of specific PGs

		Mechanisms		
Attributes of PGs	**PGs**	**1st**	**2nd**	**3rd**
Environmental and local	**Water Quality and availability**	Increase financial support to farmers and foresters	Implement payments for environmental services (PES)	Implement new market-based incentives
	Air quality	Implement new market-based incentives	Implement payments for environmental services (PES)	Increase financial support to farmers and foresters
	Soil functionality	Implement payments for environmental services (PES)	Increase financial support to farmers and foresters	Adapt compensation schemes and regulations to the global market
	Resilience to Flooding, Landslides and Fire	Implement payments for environmental services (PES)	Implement new market-based incentives	Increase financial support to farmers and foresters
Environmental and global	**Farmland biodiversity (animal and vegetal)**	Increase financial support to farmers and foresters	Promote farmers' and foresters' education to sustainability	Implement new market-based incentives
	Climate stability	Increase financial support to farmers and foresters	Implement payments for environmental services (PES)	Implement new market-based incentives
Social and local	**Landscape and scenery**	Increase financial support to farmers and foresters	Implement payments for environmental services (PES)	Promote farmers' and foresters' education to sustainability
	Rural viability and vitality	Promote farmers' and foresters' education to sustainability	Implement payments for environmental services (PES)	Adapt compensation schemes and regulations to the global market

Social with both local and global implications	**Productions quality and security (food, timber, energy)**	Adopt more efficient land use plans and restrictions	Implement payments for environmental services (PES)	Promote farmers' and foresters' education to sustainability
	Farm animal health and welfare	Implement payments for environmental services (PES)	Adopt more efficient land use plans and restrictions	Promote farmers' and foresters' education to sustainability

Table 10 - Top three mechanisms usable for the improvement of the provision of specific PBs

		Mechanisms		
Attributes of PBs	**PBs**	**1st**	**2nd**	**3rd**
Environmental and local	**Water resources pollution and depletion**	Implement payments for environmental services (PES)	Promote farmers' and foresters' education to sustainability	Pioneer/foster cross-compliance in all public subsidies
	Air pollution	Implement payments for environmental services (PES)	Promote farmers' and foresters' education to sustainability	Pioneer/foster cross-compliance in all public subsidies
	Soil erosion	Implement payments for environmental services (PES)	Promote farmers' and foresters' education to sustainability	Pioneer/foster cross-compliance in all public subsidies
	Increase of flood and wild fire risk	Implement payments for environmental services (PES)	Promote farmers' and foresters' education to sustainability	Pioneer/foster cross-compliance in all public subsidies
Environmental and global	**Biodiversity losses**	Implement payments for environmental services (PES)	Promote farmers' and foresters' education to sustainability	Pioneer/foster cross-compliance in all public subsidies
	Climate degradation	Implement payments for environmental services (PES)	Promote farmers' and foresters' education to sustainability	Pioneer/foster cross-compliance in all public subsidies
Social and local	**Landscape degradation**	Increase financial support to farmers and foresters	Implement payments for environmental services (PES)	Promote farmers' and foresters' education to sustainability
	Degradation of abandoned land	Increase financial support to farmers and foresters	Promote farmers' and foresters' education to sustainability	Adopt more efficient land use plans
Social with both local and global implications	**Poor productions quality and distribution**	Increase financial support to farmers and foresters	Implement new market-based incentives	Promote farmers' and foresters' education to sustainability
	Degradation of animal health and welfare	Implement new market-based incentives	Promote farmers' and foresters' education to sustainability	Pioneer cross-compliance in all public subsidies

Table 11 - Relative weights of the GMs in each cluster in relation with PGs (clu_PGs) and PGBs (Clu_PGBs)

PGs	Implement payments for environmental services (PES)	Increase financial support to farmers and foresters	Promote farmers' and foresters' education to sustainability	Implement new market-based incentives	Adopt more efficient land use plans and restrictions	Adapt compensation schemes and regulations to the global market	Pioneer/ foster cross-compliance in all public subsidies
CLUSTER 1	**0.33**	0.29	0.13	0.14	0.08	0.04	0.00
CLUSTER 2	**0.31**	0.29	0.17	0.11	0.09	0.04	0.00
CLUSTER 3	**0.33**	0.27	0.14	0.14	0.08	0.04	0.00
CLUSTER 4	**0.32**	0.27	0.15	0.13	0.09	0.03	0.00
PGBs	**Implement payments for environmental services (PES)**	**Increase financial support to farmers and foresters**	**Promote farmers' and foresters' education to sustainability**	**Implement new market-based incentives**	**Pioneer/ foster cross-compliance in all public subsidies**	**Adopt more efficient land use plans and restrictions**	**Adapt compensation schemes and regulations to the global market**
CLUSTER 1	**0.35**	0.22	0.19	0.10	0.07	0.05	0.02
CLUSTER 2	**0.42**	0.17	0.21	0.08	0.09	0.03	0.02
CLUSTER 3	**0.35**	0.22	0.19	0.12	0.07	0.04	0.02
CLUSTER 4	**0.35**	0.22	0.19	0.10	0.07	0.05	0.02

5. Discussion

Identification of different typologies of rural areas

An understanding of the heterogeneity of rural areas in terms of local relevance of different PGBs is essential to thinking about public good provision from agriculture and forestry, future land use planning and stewardship of public lands. In this paper, the PGBs provided by agriculture and forestry that stakeholders scored the highest are considered to be a proxy of society demand for those PGBs (or, more realistically of the relevance of discrepancy between demand and supply of goods). The cluster analysis identified some typologies of rural areas within Europe.

Results are difficult to compare with others in the literature, as there are no really comparable studies available. The results seem consistent with Ahtiainen et al. (2015) that found a substantial distribution of relevance across different objectives of agriculture (though not explicitly identified as public goods type). Also, our results confirm the outcome of Ahtiainen et al. (2015) that resources-based public goods (e.g. water) tend to receive a higher weight. On the other hand, we confirm different relevance of public goods across regions, consistent with most of the studies addressing this issue and with well-known evidence about the variety of different local conditions in the EU (Bartolini et al., 2011).

The main limitations associated to the approach followed in this study are linked to the coverage of the sample: in spite of the good number of stakeholders interviewed compared to many stakeholder-based studies, the sample is still far from guaranteeing a totally satisfactory coverage of EU territories and different stakeholders background. In particular, biases are due to the partly unbalanced distribution of expertise among stakeholders of different countries (e.g. a majority of public officers compose the Italian group, while all the Spanish stakeholders are researchers). This does not allow a complete distinction between regional and expertise effect.

In addition, the intermediate (regional) scale does not allow to incorporate the heterogeneity of very local problems.

Other limitations concern the methodological choices, and especially the calculation of weights which followed a score-based approach. This is widely used in the area of multicriteria approaches and general survey. While according to the literature, there is not a preferential approach for the elicitation of weights, the one used here can be considered less robust in identifying the relative importance of different public goods, at least because of the likelyhood of allineation around central values, compared with methods such as pairwise comparison. The use of this method was however not possible here due to the number of indicators.

Other limitations come from the fact of using of stakeholders. Studies pursuing similar objectives adopt indeed a very wide methodologies, ranging from the computation of spatial explicit indicators to the monetary valuation, that can indeed be seen as complementary to this study. While our choice is motivated by the attempt to use stekeholders to get insights on issues that are difficult to manage with alternative methods, we acknowledge that this approach can oversimplify or miss some points, e.g. the precise spatial distribution of phenomena or the precise monetary value of public goods. Indeed these would be very suitable to be analysed in follow-ups of this study.

Management Implications

The complicated issues surrounding agri-environmental policies today require integrating technical knowledge with public values in risk-based decisions (Assmuth and Hildén, 2008; Garmendia and Stagl, 2010; ELO-BirdLife, 2010). While technical analysis is the responsibility of scientists and engineers, among others, understanding public values requires integration among a variety of views, including those of the scientists, policy-makers and citizens. This is not an easy task, but it appears to be crucial to the formulation of (improved) policy design usable for publicly funded initiatives (Zahrnt, 2009; Hart et al., 2011; Kenter, 2016). A necessary first step is to understand how stakeholders conceptualize rural land management issues, such as public good/bad provision from private lands and/or activities, the implications of such provisions for the local and global society. Secondly, it is important to understand how they associate a certain PGBs with a given GM.

Our study showed that the identification of most suitable instruments is rather straightforward and largely focuses on PES. Also support to agriculture and forestry remains a key instrument to ensure the provision of public goods, which may be linked both the fact that public goods are jointly produced by agricultural activities.

On the other hand, the distinction between PGs and PBs in terms of policy instruments has been identified in a rather straightforward way in the second level instruments, with higher attention to education to sustainability and cross-compliance. This result may also have been affected by the fact that many experts are closely connected to the farming sector, but are consistent with the general recognition of the role of agriculture and forestry in producing public goods.

6. Conclusions

Several conclusions can be drawn from this exercise based on a survey of stakeholders operating in the field of agriculture and forestry in different European countries and identification of typologies of views on regional relevance of public goods and bads. First, water-related issues are the most relevant environmental concerns in the context of agriculture and forestry; however on average of respondents and at regional scale, the relevance of the different public goods identified is rather homogeneously distributed. On the contrary, there is a relevant heterogeneity across areas and individuals views. This supports the identification of different typologies of rural areas in terms of relevance of different bundles of PGBs. Specific issues linked to different types of PGBs can be handled through specific governance mechanisms; however the large majority of PGs tend to be associated to similar instruments, namely PES. The results show that positive and negative public goods are in the majority of cases linked to specific components of Socio-Ecological Capital (e.g. water), so that the perception of positive and negative public goods and services as (threshold-related) levels or direction of effect of such flow is a major qualifier of the PGBs detection.

The findings in this study have implications for land management in general. First in spite of the huge difference across different types of areas as for the endowment of public goods, a few typologies seems to well represent this variety. This can probably be of relevance for zoning and targeting at least at the intermediate scale of analysis. In terms of policy instruments, a few instruments remains constantly in the hotspot, particularly linked to financial support to farmers and, in perspective, PES (most frequently advocated as the most suitable instruments). However, it is likely that the real issue to promote the production of public goods it is not the instrument per se, but rather the detailed implementation solution in each context. Also, the combination of instruments is certainly important and should be in the focus, rather than considering only individual instruments.

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Appendix

Table A1 - Cluster descriptives

cluster		Landscape and scenery	Farmland biodiversity (animal and vegetal)	Water Quality and availability	Air quality	Soil functionality	Climate stability	Resilience to Flooding, Landslides and Fire	Rural viability and vitality	Productions quality and security (food, timber, energy)	Farm animal health and welfare
1	min,	0.02	0.07	0.07	0.02	0.09	0.04	0.03	0.04	0.04	0.00
	mean,	0.10	0.11	0.11	0.10	0.11	0.10	0.09	0.09	0.09	0.10
	p50,	0.10	0.10	0.11	0.10	0.11	0.10	0.10	0.09	0.10	0.10
	max,	0.14	0.17	0.19	0.12	0.19	0.20	0.17	0.11	0.14	0.20
	sd,	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03
	variance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	min,	0.11	0.08	0.03	0.02	0.02	0.00	0.00	0.07	0.02	0.07
	mean,	0.14	0.12	0.11	0.07	0.08	0.07	0.06	0.12	0.11	0.11
	p50,	0.14	0.12	0.12	0.07	0.08	0.08	0.05	0.12	0.12	0.11
	max,	0.16	0.19	0.16	0.11	0.16	0.14	0.13	0.19	0.17	0.22
	sd,	0.02	0.03	0.03	0.02	0.04	0.04	0.03	0.03	0.04	0.03
	variance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0011
3	min,	0.08	0.04	0.05	0.04	0.04	0.06	0.08	0.08	0.05	0.00
	mean,	0.09	0.08	0.11	0.10	0.10	0.10	0.10	0.12	0.11	0.09
	p50,	0.09	0.08	0.10	0.10	0.10	0.10	0.11	0.11	0.11	0.09
	max,	0.12	0.11	0.23	0.13	0.13	0.13	0.14	0.20	0.14	0.13
	sd,	0.01	0.02	0.03	0.02	0.02	0.02	0.02	0.03	0.02	0.03
	variance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	min,	0.10	0.05	0.01	0.08	0.05	0.05	0.10	0.08	0.04	0.07

	mean,	0.12	0.10	0.06	0.10	0.08	0.10	0.11	0.12	0.11	0.10
	p50,	0.12	0.10	0.06	0.11	0.08	0.11	0.11	0.12	0.12	0.09
	max,	0.16	0.15	0.09	0.14	0.11	0.14	0.14	0.14	0.14	0.14
	sd,	0.02	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.03	0.02
	variance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00