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Building an empirically-based framework to value multiple public goods of agriculture at broad supranational scales

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ABSTRACT

Agricultural landscapes deliver multiple, highly valued goods such as cultural amenities, biodiversity conservation and climate stability. These goods are often delivered as side-effects of farmers' production decisions driven by broad-scale, supranational changes in agricultural, trade or other policies. Human well-being is thus affected in ways not taken into account in these macro-policy decisions. To avoid this policy failure, there is a growing demand for the valuation of broad-scale changes in public goods by the general public. For this purpose, context-rich valuation scenarios at this broad scale need to be developed which are empirically-based, policy-relevant and understandable by the general public. In this way, respondents are focused on actual trade-offs rather than invited to give symbolic reactions. This paper presents and discusses a valuation framework developed to fulfil these criteria. The approach is based on a typology of Macro-Regional Agri-Environmental Problems (MRAEP). Each MRAEP is defined by: (1) prevailing farming systems and agricultural landscapes; (2) current levels of public-good delivery; (3) expected direction of land-use change; and (4) expected effects of such change on public-good provision in each macro-region. Multivariate analysis of EU-wide data on agricultural landscapes and farming-systems led to identify thirteen macro-regions in the EU. Current public-good provision was described using public-good indicators. Only those public goods that are expected to change or could be improved by available policy options (core public goods) were used to generate choice alternatives for survey respondents. The paper ends by discussing innovative elements in the proposed approach, achievements, shortcomings and possible policy uses.

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1. Introduction

Cultural and environmental goods and services delivered by agriculture, such as biodiversity conservation or aesthetic amenity, are often provided as side-effects of production decisions made by farmers in response to market prices and diverse public policies. In addition, many of these goods and services exhibit different degrees of non-excludability (and also non-rivalry) in consumption. This side-effect, public-good character of cultural and environmental goods of agriculture makes them prone to significant market failure, which calls for policy interventions, such as agri-environmental schemes or input taxes, aimed at internalizing the values of those goods and services into farmers' production decisions. Environmental economists have advocated the use of nonmarket valuation techniques to value cultural and environmental benefits of environmentally sensitive farming as part of a full benefit-cost evaluation of agri-environmental policy schemes.

On the other hand, farming systems and the bundles of public goods (PG) they deliver are often driven, at broad supranational scales, by changes in agricultural and trade policies (e.g., Common Agricultural Policy reforms or World-Trade-Organization rounds) which change prices, policy payment schemes and other drivers of farmers' production decisions. PG-related human well-being is thus significantly affected by these macro-policies in ways which are largely not taken into account in policy decisions. The need to assess different policy options and to avoid these policy fail-

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ures, e.g., by considering non-trade concerns within trade policy or available opportunities to use agricultural policy reform to correct market failure in PG provision, led to an increasing demand for the economic valuation of changes in multiple PG of agriculture at broad, supranational scales, which has been acknowledged in the valuation literature (Santos, 2000; Randall, 2002, 2007; EFTEC, 2004; Hein et al., 2006; Madureira et al., 2007).

There are many challenges involved in developing a valuation framework to address this policy demand. Basically, this framework needs to be both empirically-based and policy-relevant, that is: focused on available policy options at broad macro-regional scales. It also needs to be understandable by the general public of the many involved countries whose preferences for the PGs at stake are to be gauged in valuation surveys. In addition, economic values are context-dependent and should be valued as such; providing context-rich scenarios is thus essential for people to engage in the assessment of the actual trade-offs (as required by valid valuation) instead of simply giving us their symbolic reactions to very abstract scenarios. An additional challenge for such a valuation framework is how to take into account substitution effects across goods and services to avoid large aggregation biases when dealing with changes in multiple PGs (Santos, 1998). These challenges might explain why, as far as the authors are aware of, no valuation frameworks have been developed for this purpose within the economic valuation literature in spite of an existing demand for such broad-scale valuation exercises.

This paper discusses the main issues involved in building a valuation framework for changes in multiple PGs of agriculture at broad, supranational scales by developing and discussing one such framework focused on empirically-based and policy-relevant trade-offs. This is supported by a EU-wide analysis of the supply-side of PG provision, using a macro-regional frame of reference to account for socio-ecological gradients across this vast spatial scale, and eventually leading to the identification of the core public goods to be valued in each macro-region. These issues, while crucial to ensure the policy-relevance of valuation exercises, in general, are unfortunately not always addressed with the required detail and rigour in many valuation studies, which prefer to focus instead on experimental design or econometric modelling details. In particular, the valuation of multiple PGs at a broad supra-national scale requires an even more careful consideration of empirical supply-side and policy-relevance issues, which calls for using and analysing complex, heterogeneous (across countries and PGs), incomplete and often limited-quality data.

A related goal of this paper is exploring and discussing the effort involved in the proposed valuation framework to convey context-rich scenarios that may enable respondents to engage in the economic trade-offs that are required to assess different policy options for the provision of multiple PG.

Section 2 discusses basic elements and the foundations of the overall approach used to develop the valuation framework. Section 3 discusses data and methods used in developing the framework. Section 4 presents the main results and assesses the framework's ability to frame the valuation of multiple PGs of EU agriculture at a broad, macro-regional scale. Section 5 concludes by underlining the most innovative elements in the proposed approach, as well as its achievements and shortcomings, and identifies possible applications in informing relevant policy debates.

2. The valuation framework: overall approach and concepts

The valuation framework developed in this article is grounded on three basic conceptual elements: first, the definition of the good(s) to be valued; second, the specification of the agricultural landscape and its role in valuation scenarios; and third, the way broad-scale socio-ecological heterogeneity across the EU was taken into account in the framework. This last element refers to a central concept within the framework: that of Macro-Regional Agri-Environmental Problems (MRAEPs). This section introduces these three basic elements of the framework.

Agricultural landscapes are specific combinations of farming systems with non-agricultural elements such as woodlands, semi-natural vegetation and other land covers. They have specific structures, functioning and processes which weave all of these components as a whole, or system, which delivers multiple, highly valued goods and services such as food, cultural amenities, biodiversity conservation, water quality, or climate stability.

The first step in any valuation framework is to clearly define the good to be valued. In our case, there were two alternative options: either valuing the broad-scale change in an agricultural landscape as a whole, or valuing changes in the provision levels of the many PGs that change in the context of that broad-scale landscape change.

As people are often more directly affected by changes in PG provision levels than by landscape change as a whole, the valuation framework was focused on directly valuing the former rather than the latter. So, the landscape was taken as the agro-ecological infrastructure delivering things people directly value, such as food, fibre and energy, plus multiple cultural and environmental PGs. As the focus here is on nonmarket outputs, the proposed valuation framework is thus specifically focused on the following PGs of EU agriculture: cultural amenities, farmland biodiversity, water quality and availability, air quality, soil quality, climate stability, resilience to fire and resilience to flooding.

Second, landscape can be specified as either general landscape types or specific landscape areas. Swanwick et al. (2007) identify these two options as: (1) landscape character types, which are generic and occur across different particular areas sharing similar combinations of geomorphology, land cover and historical land use; or (2) landscape character areas, which are unique, discrete geographical areas. The choice between the two was determined by our working scale. In fact, our main concern with policy-driven landscape changes occurring across broad geographical scales led us to adopt the first option. Of course, this ruled out valuing changes in unique landscape areas within the proposed valuation framework. Defining landscapes as landscape character types also underlines their ecological dimension as generic ecosystem mosaics supplying public-good ecosystem services and benefits, which, in the current framework, are the goods to be directly valued by the general public. Examples of this approach within landscape valuation studies are Catalini and Lizardo (2004), Vanslembrouck et al. (2005), Kallas et al. (2006), Scarpa et al. (2007), Chiueh and Chen (2008) and Borresch et al. (2009).

Opting for separating landscape as an agro-ecological infrastructure from both its ecosystem services (e.g., water quality or biodiversity) and its landscape cultural dimension (e.g., landscape cultural services) led us to exclude the landscape itself from the set of ecological and cultural goods and services to be valued; instead, it is considered as the overall ecological structure delivering all of these goods and providing the context for the valuation exercise.

Third, broad-scale changes in agricultural landscapes and the PGs they deliver, including the direction of change itself, are spatially differentiated across socio-ecological gradients within the EU. These gradients determine different regional responses to the same broad-scale (e.g., EU policy) drivers of change. Differentiated responses require the valuation framework to integrate a macro-regional frame of reference (or 'map of macro-regions') that controls for broad-scale socio-ecological heterogeneity. This is why changes in PG provision levels were framed within specific Macro-Regional Agri-Environmental Problems (MRAEPs).

Each MRAEP is defined by: (1) the typical farming-system and agricultural-landscape mixes characterizing a specific macro-region (MR), or its agro-ecological infrastructure; (2) the bundle of PGs currently delivered by that agro-ecological infrastructure; (3) a direction of expected future landscape change in that MR, e.g., farmland abandonment versus agricultural intensification; and (4) the expected effects of this change on PG provision in the MR.

MRAEPs also provide respondents with context-rich valuation scenarios, which, though specified at a broad, macro-regional scale, still keep in touch with concrete aspects – namely geographic location – of the valuation exercise. This enables the valuation exercise to focus on specific, contextualized trade-offs between geographically-sensitive PG provision changes rather than abstract trade-offs (e.g., food versus biodiversity anywhere), which tend to elicit symbolic responses or attitudes rather than economic values. Context definitely matters for valid economic valuation of PGs at broad macro-regional scales.

3. Developing the valuation framework: data and methods

A typology of MRAEPs within the EU-27 was developed and tested in six sequential steps. This section discusses the data and methods used in these steps. The first step, identifying and describing macro-regions (MRs), is presented in Section 3.1. The second, assessing current PG provision levels in each MR, is discussed in Section 3.2. The third, testing whether these MR types and PG provision levels were understandable by survey respondents, and making the required adjustments, is the focus of Section 3.3. The fourth, identifying land-use dynamic trends in each MR and, together with information from previous steps, arriving at the full typology of MRAEP in the EU-27, is discussed in Section 3.4. The fifth, selecting core PGs to be valued in each MRAEP, is discussed in Section 3.5. The sixth and final step, testing the performance of the MRAEP framework in a survey environment is the subject of Section 3.6.

3.1. Identifying and describing macro-regions (MRs)

MR are intended to depict types of agro-ecological landscape infrastructure delivering different PG provision levels. They were identified based on landscape and farming-system variables for which data was available at the NUTS3 level. These variables were hypothesized to be related to one or more PGs, but variables used as PG indicators in the next step were not used to identify MR in this step. This allowed for checking the degree of association between MR types and specific PG provision levels, to assess the consistency of the approach as a whole.

MR were described according to the variables used to identify them plus other variables that, for different reasons, were not used for identification but only for descriptive purposes. As regards the landscape dimension, three groups of variables were used for identification purposes (Table 1): land cover; agricultural land use, and core versus marginal areas. As regards the farming-system dimension, the following five groups of variables were used for identification or description purposes (Table 1): specialization pattern of farms; overall economic intensity of farming; relevance of irrigation (only for descriptive purposes); stocking rates, and distribution of farms per size class.

A factor analysis (PCA) was run on EU-wide data at the NUTS3 level including all variables in Table 1 except relevance of irrigation, for dimension reduction and to avoid overweighting dimensions for which more variables were available. A hierarchical cluster analysis (Ward's method, Squared Euclidean distance) was run on the first 9 factors from the PCA (the eigenvalue criterion was used to select these factors). All analyses were run in SPSS version 20. The resulting 13 clusters (macro-regions, or MR types) were profiled using the means of each variable for each cluster (centroids) and mapped using the ArcGis.

Table 1
Variables used to define Macro-regions (MR).

Variable	Description	Source
Landscape dimension		
Land cover	Per-cent shares of agriculture, forest, natural and artificial land-cover-class areas	EC (2011)
Agricultural land use	Per-cent shares of arable, permanent-crop and permanent-grassland areas in Utilized Agricultural Area (UAA)	EC (2011)
Core versus marginal areas	Percentage of UAA in 3 classes of Less Favoured Areas (LFA): Nordic LFA, mountain LFA and other LFA	EC (2011)[a]
Farming system dimension		
Specialization pattern of farms	Per-cent shares of farms classified as specialist field crops, specialist horticulture, specialist permanent crops, specialist grazing livestock, specialist granivores and mixed farms	Eurostat's FSS 2005, 2003 or 2000
Overall economic intensity of farming	Average Gross Margin in Euros per hectare (GM/ha)[b]	EC (2011)
Relevance of irrigation[c]	Percentage of irrigated area in the UAA	EC (2011)
Stocking rates	Average number of Livestock Standard Units per hectare of UAA (LSU/UAA)	Eurostat's FSS 2005, 2003 or 2000
Distribution of farms per size class	Percentage of farms with less than 5 ha (UAA), between 5 and 50 ha, and 50 or more ha	EC (2011)

[a] Adapted to separate Nordic LFA from mountain LFA, and to assess mountain LFA (from map interpretation) at NUTS3 level for Romania and Bulgaria, which had only available data at the national level.
[b] Logarithm transformation in the multivariate analysis, as it had a very different scale when compared to the other variables and extreme outlier values at the highest (intensive) side of the scale.
[c] Not used to identify the MR, as not available for all countries and as it was used as a PG indicator for Water Availability. Yet, used to describe the intensity of farming in the different MR.

3.2. Assessing current PG provision levels in each MR

Current levels of PG provision by the agro-ecological infrastructure of different MR were estimated using PG indicators computed at the NUTS3 level from available agri-environmental indicator systems, as well as from the results of on-going research that is being carrying out to increase the spatial resolution of such indicators (see acknowledgments section at the end of this article). PG indicators were computed from variables that are different (although not always fully independent in data terms) from landscape and farming-system variables used to identify MRs.

The final list of PG indicators and corresponding information sources are presented in Table 2. Ten of the 12 PG indicators were computed at the NUTS3 level; for two indicators – cultural heritage and flooding risk – NUTS2 level estimation was the only possibility and was used as an exception from the general rule. Some indicators (e.g., irrigated utilized agricultural area, and fire risk) have missing-data problems for many NUTS3 units or even for entire countries, which ruled out a full multivariate analysis of the statistical signif-

Table 2
Public-good (PG) indicators.

PG/PG indicator	Source
Cultural amenities	
Recreation potential index	Maes et al. (2011), data at NUTS 3 level provided by the study's authors
Cultural heritage	Paracchini (Unpublished), data at NUTS 2 level provided by the study's author
Biodiversity	
High Nature Value Farmland (HNVF)	Paracchini et al. (2008), data at NUTS 3 level provided by the study's author
Water quality and availability	
Infiltration (mm)	Maes et al. (2011), data at NUTS 3 level provided by the study's author
Irrigated Utilized Agricultural Area (% of total UAA)	EC (2011)
Total nitrogen input	Leip et al. (2011)
Soil quality	
Soil erosion	based on the PESERA model (Joint Research Centre), in EC (2011)
Soil carbon content	Maes et al. (2011) (low values indicate soil fertility problems)
Air quality	
Total NH_3 emissions	Leip et al. (2011)
Climate stability	
Soil carbon content	Maes et al. (2011) (high values indicate significant soil carbon stocks – climate change mitigation)
Total N_2O emissions	Leip et al. (2011)
Resilience to flooding	
Flooding risk (model LISFLOOD)	Data at NUTS 2 level provided by Florian Wimmer (Center for Environmental Systems Research University of Kassel)
Resilience to fire	
Fire risk (average yearly burnt area between 1997 and 2006)	European Forest Fire Information System (Joint Research Centre, JRC); data at NUTS3 level provided by JRC

icance of differences between current levels of PG provision across MRs. Thus, only the MR averages of all PG indicators were computed and compared for each PG across MRs.

3.3. Testing whether the MR typology was understandable by respondents

Following good-practice guidelines for stated-preference valuation studies (see e.g., SEPA, 2006; Söderqvist and Soutukorva, 2009; Riera et al., 2012), the focus group technique was used to assist in the implementation of the valuation framework. Two focus groups, held in Lisbon on the 18th and 22nd October 2012 and run by a leading market research company, allowed us to assess: (1) respondents' previous knowledge about agro-ecological diversity across the EU and (2) how well the MR typology developed in the previous steps matched this previous knowledge. Among other tasks, participants were requested to associate non-labelled photographs depicting typical views of different MRs with particular MR names, as presented in a map legend. Madureira et al. (2013a) provide a full account of these focus groups.

In general, there was a good level of matching between the MR typology and respondents' previous perceptions. Yet, some amendments of the valuation framework were judged appropriate as a follow up to the focus groups and their preparatory works, namely the reduction of our initial list of 13 MRs to only 8 simplified MRs. This ensured that each of the remaining eight simplified MR could be associated to a specific MRAEP that respondents clearly understand and locate. The particular amendments resulting from this step are detailed in the results section (Section 4.3).

3.4. Identifying core dynamic trends and setting the final list of MRAEPs

A MRAEP involves more than a MR and its current PG provision levels: it also involves a dynamic trend and its effect on future PG provision levels.

In fact, some of the identified MRs include more than a single core dynamic trend, which lead to split them into different MRAEPs, where different PG provision problems occur. This is usually related to lower-scale heterogeneity of soils, landforms or other factors within the MR. For example, in both MRs of Mediterranean Europe (MRs 1 and 2) identified below, there are valley areas, with irrigation infrastructure and flatter, better soils, with intensification problems (water-quality problems, intensification-related biodiversity loss), and hilly areas with poorer soils, where land abandonment (fires, farmland biodiversity loss and cultural amenity decline) is instead the major problem. Thus, each MR had to be checked to assess whether it includes a single, consistent MRAEP, with a single core dynamic trend (either farmland abandonment, farmland expansion or agricultural intensification) and a consistent set of related PG provision problems or if, for sake of coherence, this MR should be split into different MRAEPs with a different core dynamic trend associated to each.

This verification of whether there was need to split each MR according to different core dynamic trends was based on the available PG indicators, which suggested whether their values (e.g., HNVF, cultural landscape, water quality) point to problems related to intensive agriculture, extensive agriculture, or both. If different problems seem to be co-present, this is a first sign of heterogeneity, which may suggest splitting the MR. Expected future land-use trends from the literature were also checked to confirm these first suggestions. As regards future land-use trends, the Scenar 2020 study was consulted, in both of its successive versions (EC, 2007, 2009), about the expected changes in farmland abandonment, land use intensity, and specific land-use transitions (e.g., changes for arable, grassland, and total UAA) to identify expected land-use and intensity trends or, at least, the direction of expected change up to 2020.

This verification of whether it would be appropriate to split MR according to different core dynamic trends revealed a need to split a MR into different MRAEP only in the cases of the two Mediterranean MRs. In both cases, the original MR has been split into one MRAEP related to farmland abandonment and another MRAEP related to agricultural intensification.

It was not possible to rule out the hypothesis that other MRs would justify similar treatment. However, our PG indicators and the available information on land-use change scenarios did not support this need for other MR splits. More detailed information collection might, in the future, lead to further splits. With this important caveat in mind, this procedure of checking whether MRs need to be split into different MRAEPs led us to a list of ten MRAEPs (cf. Table 5).

3.5. Identifying core PGs to be valued in each MRAEP

Only those PGs that are expected to change and/or that could be improved by available policy options were selected for valuation in the context of each particular MRAEP.

To implement this criterion, for each particular MRAEP, available policy options (PG programmes) have been explored that could offset expected negative trends in PG provision, or improve the current negative status of a particular PG. MRAEPs and PG programmes are both crucial elements of the valuation scenarios

Table 3
Selection of core public goods (PG) to be valued in the "Farmland abandonment in Mediterranean hinterlands" MRAEP.

Public goods (PGs)	State of PG indicators	Expected effect of land use trend on the indicators	Available policy options exist to offset negative effects, or improve current bad condition?	Selected as core PG to be valued in this MRAEP:
Cultural amenities	• Very high recreation potential index • High cultural heritage	Decrease	Yes	X
Biodiversity	• Medium-high HNVF	Decrease	Yes	X
Water quality	• Medium-low total N input			
Water availability	• Low infiltration • Very high irrigated UAA	Decrease		
Soil quality	• High risk of soil erosion	Increase	Yes	X
Air quality	• Medium-low total NH_3 emissions			
Climate stability	• Very low soil carbon content	Increase		
Resilience to flooding	• Very low flooding risk			
Resilience to fire	• High fire risk	Increase	Yes	X

within the proposed framework. In fact, both provide the required setting for context-dependent (that is: valid) valuation of particular changes in PG provision. Coherence and plausibility of valuation scenarios (MRAEP + PG programmes) to respondents are essential for the validity and reliability of the valuation results. Achieving these goals requires selecting for valuation, in each MRAEP, only those PG that logically match the MRAEP context and that can be addressed through plausible policy options (PG programmes). These are thereafter called the core PGs in that MRAEP.

The following criteria were used to select core PGs to be valued in each MRAEP: (1) the current status of the PG in the corresponding MR according to its PG indicator(s); (2) the core dynamic trend of land use defining that MRAEP (according to the study Scenar 2020, considering three major trends in land use or farming practices: farmland abandonment, agricultural intensification and farmland expansion) and the expected effect of this trend on the relevant PG indicator(s); and (3) whether there are available policy options (PG programmes) to offset expected negative trends on PG status, or to improve its currently condition when this is bad.

When the current level of the PG indicator in the particular MR is medium-high to very high, or low to very-low (categories set for each PG indicator to cover the full range of MR averages of this indicator), it was considered for selection as core PG in that MRAEP when:

- the dynamic trend is expected to significantly worsen the condition of this PG, and there is a policy option able to offset this negative trend; or
- the current status is already negative, the dynamic trend is expected not to improve it, and there is a policy option able to improve this negative current status.

The example of the MRAEP "farmland abandonment in Mediterranean hinterlands" is used here to illustrate this procedure (Table 3). In this MRAEP, there is already a land abandonment problem, which is expected to worsen in the near future, especially in the absence of PG programmes. This dynamic trend is associated with the increase of fire risk, which will increase soil erosion problems. Both landscape cultural services (currently high) and farmland biodiversity (medium–high) would decline as a result of farmland abandonment. There are available policy options to offset these negative trends, such as PG incentive schemes, which would act in different ways to maintain critical parts of the farmland mosaic to preserve recreation potential, cultural heritage and biodiversity values, as well as to keep some resilience towards fire and soil-erosion risks. Climate stability was not selected as a core PG to be valued within this MRAEP because soil carbon content, although very low, would probably increase with farmland abandonment. In addition, many policy options to improve soil carbon content are not consistent with those required to prevent land abandonment and improve the status of the other four core PG. Including it as a core PG in that MRAEP would have introduced scenario inconsistencies and forced respondents to face unclear trade-offs and cognitive dissonances.

3.6. *Testing the performance of the MRAEP framework in a survey environment*

To test the performance of the proposed valuation framework at a pilot-survey scale, a choice-modelling questionnaire was developed for a single MRAEP: ("Farmland abandonment in the Mediterranean uplands"). Four core PG were to be valued in this MRAEP: cultural amenities, biodiversity, soil quality and resilience to fire. Questionnaire development for this MRAEP was supported by the second part of the focus groups mentioned in Section 3.3. This questionnaire was administered to 3 samples using 2 different survey models: a face-to-face survey of a random stratified sample of Lisbon residents (300 valid interviews); two on-line surveys of separate samples of the national Portuguese and German populations (300 valid questionnaires each). The comparison Portuguese vs German residents, both using the online mode, allows comparing residents and non-residents in the MR, who were expected to have different preferences e.g., for local (e.g., fire resilience) versus global (e.g., biodiversity) PGs. The online sample of the Portuguese, on the other hand, represents a significantly wealthier and better

Table 4
Description of the 13 Macro-regions (MR).

MR number	MR name	Land cover	Agricultural land use	Core vs marginal areas	Specialization pattern of farms	Overall economic intensity of farming	Relevance of irrigation	Stocking rates	Distribution of farms per size class
1	Mediterranean hinterlands	Dominated by farmland (53%) with significant natural (13%) and some forest (25%).	Dominated by arable (56%) with significant permanent crops (22%)	Dominated by non-LFA (54%) but with significant non-mountain LFA (32%) and some mountain LFA (14%).	Specialist permanent crops (50%), and specialist field crops (17%).	High (2500–3500€)	High (>15%)	Low (0,5–0,75)	Dominated by small farms (59%), with significant medium (33%) and a few large (8%).
2	Mediterranean uplands/permanent crops	Balanced mosaic of farmland (40%) and natural (39%).	Dominated by permanent crops (48%) with some grasslands (27%) and very scarce arable (25%).	Dominated by mountain LFA (54%), and mostly LFA (75%).	Specialist permanent crops (68%).	High (2500–3500€)	High (>15%)	Low (0,5–0,75)	Dominated by small farms (72%), with some medium (24%).
3	Eastern Europe/Southern mountains and valleys	Dominated by farmland (59%) with significant forest (29%).	Strongly dominated by arable (71%)	Largely non-LFA (60%) but with significant mountain LFA (29%).	Mixed farming (53%) and specialist granivores (14%).	Very low (<750€)	Very low (<2,5%)	Low (0,5–0,75)	Strongly dominated by small farms (90%)
4	Eastern Europe/Northern flatlands	Dominated by farmland (58%) with significant forest (33%).	Strongly dominated by arable (73%)	Dominated by non-LFA (52%) but with significant non-mountain LFA (44%).	Mixed farming (46%) and specialist field crops (28%).	Very low (<750€)	Very low (<2,5%)	Low (0,5–0,75)	Dominated by small farms (65%), with significant medium (32%).
5	Central lowlands/crops	Strongly dominated by farmland (68%).	Strongly dominated by arable (76%)	Mostly non-LFA (70%).	Specialist field crops (38%) and grazing livestock (29%).	Medium (1300–2500€)	Medium (7,5–15%)	Medium/low (0,75–1,00)	Dominated by medium (40%) and large (28%).
6	Central lowlands/crops and livestock (Eastern Germany)	Dominated by farmland (57%) with significant forest (27%) and some artificial (11%).	Strongly dominated by arable (78%)	Dominated by non-LFA (54%) but with significant non-mountain LFA (46%).	Specialist field crops (35%), grazing livestock (34%) and mixed farming (21%).	Low (750–1300€)	Very low (<2,5%)	Low (0,5–0,75)	Dominated by large (41%) with significant medium (35%).
7	Central low-lands/livestock	Strongly dominated by farmland (68%) with some artificial (16%)	Strongly dominated by arable (72%).	Mostly non-LFA (72%).	Specialist grazing livestock (39%), mixed farming (28%), granivores (11%) and horticulture (4%).	High (2500–3500€)	Medium (7,5–15%)	Very high (>4,00)	Dominated by medium (52%) with some large (18%).
8	Lowland-upland transitions in Central Europe	Balanced mosaic of farmland (43%) and forest (41%) with some artificial (12%).	Dominated by arable (65%) with significant grasslands (33%).	Clearly dominated by LFA (64%) but mostly non-mountain LFA (only 6% mountain).	Specialist grazing livestock (36%), field crops (27%), mixed farming (20%) and permanent crops (11%).	Low (750–1300€)	Some (2,5–7,5%)	Medium/low (0,75–1,00)	Dominated by medium (57%) with some large (19%).

Table 4 (*Continued*)

MR number	MR name	Land cover	Agricultural land use	Core vs marginal areas	Specialization pattern of farms	Overall economic intensity of farming	Relevance of irrigation	Stocking rates	Distribution of farms per size class
9	North-western fringes and continental uplands	Dominated by farmland (59%).	Dominated by grasslands (57%).	Slighlty dominated by LFA (52%) but mostly non-mountain LFA (only 10% mountain).	Specialist grazing livestock (63%).	Medium (1300–2500€)	Very low (<2,5%)	Medium/high (1,25–1,50)	Dominated by medium (50%) and large (24%).
10	The Alps, NW Iberian mountains and the Scottish Highlands	Balanced mosaic of forest (40%) and natural (31%) with scarce farmland (25%).	Strongly dominated by grasslands (68%).	Largely mountain LFA (70%).	Specialist grazing livestock (50%), mixed farming (23%) and permanent crops (12%).	Low (750–1300€)	Some (2,5–7,5%)	Medium (1,00–1,25)	Dominated by small (51%) and medium (37%) with a few large (12%).
11	Northern Scandinavia	Strongly dominated by forest (67%) with significant natural (24%) and very scarce farmland (8%).	Strongly dominated by arable (95%)	Mostly LFA North (94%).	Specialist field crops (44%) and grazing livestock (40%).	Low (750–1300€)	Very low (<2,5%)	Low (0,5–0,75)	Strongly dominated by medium (67%) with some large (12%).
12	Urban/grazing livestock	Strongly dominated by artificial (57%).	Mosaic of arable (58%) with grasslands (41%).	Mostly non-LFA (80%).	Specialist grazing livestock (37%), field crops (19%) and horticulture (5%).	Medium (1300–2500€)	Very low (<2,5%)	Medium (1,00–1,25)	Dominated by small (46%) and medium (34%) with a few large (19%).
13	Urban/horticulture	Dominated by artificial (48%) with some natural (13%).	Balanced mosaic of arable (47%) and grasslands (43%) with some permanent crops (9%).	Mostly non-LFA (69%).	Specialist horticulture (55%) and permanent crops (11%).	Extremely High (>15,000€)	Medium (7,5-15%)	Low (0,5–0,75)	Dominated by small farms (73%), with some medium (21%).

educated segment than the face-to-face sample, allowing a rough comparison of preferences across the income and education scales.

The results of each of these 3 surveys were modelled using the standard (multinomial logit and random-parameters) choice modelling approaches. We checked the signs of the parameters for each of the 4 valued PG, the corresponding comparisons across samples, and the degree of agreement of these results with previous expectations to test for theoretical validity of the results. The overall goodness-of-fit of the models and the confidence intervals built for WTP for each PG were used to assess reliability (sensu Santos, 1998) or absence of statistical noise. The methodological options used in these surveys are discussed in detail in Madureira et al. (2013a,b).

4. The valuation framework: results and discussion

4.1. Typology of macro-regions

Table 4 presents the 13 MRs that resulted from the cluster analysis. The interpretation of the MR clusters is carried out based on the MR averages of the diverse variables in the table columns.

The first two MRs (1 and 2) correspond to Mediterranean Europe. Their major fingerprints are the significance of permanent crops in both agricultural land use and specialization pattern of farms, the relevance of irrigation and small farms, and their low stocking rates and high economic intensity of farming. They include balanced landscape mosaics and tend to include significant shares of different types of less favoured areas (LFA). “Mediterranean uplands” differ from “Mediterranean hinterlands” by having more permanent crops, natural areas and small farms; they are also associated to mountain LFA, which dominate in this MR.

The next two MRs (3 and 4) correspond to Eastern Europe. They both have: landscape mosaics dominated by farmland, mostly arable; mixed farms as the dominant specialization type; insignificant irrigated areas; low economic intensity and stocking rates; many small farms and some importance of LFA. “Southern mountains and valleys” (3) differ from “Northern flatlands” (4) by having higher shares of mountain LFA, granivore specialization and small farms.

Next come two MRs (5 and 6) mostly located in the flatlands of Central Europe, which are characterized by a farmland-dominated, mostly arable landscape mosaics and non-LFA land; farms are medium to large-sized and many are specialized in field crops; economic intensity, relevance of irrigation and stocking rates are at the medium to low ranges of corresponding scales.

The four MRs that come next (7–10), while differing in many respects, have specialist grazing livestock as their top farm specialization category. With landscapes dominated by farmland, mostly arable, mostly in non-LFA land, the “Central lowlands/livestock” (MR 7) are characterized by medium to large farms, high economic intensity of farming, medium relevance of irrigation, and very high stocking rates. In the opposite extreme, with balanced land mosaics, including plenty of forest and natural areas, and scarce farmland, dominated by grasslands, mostly in mountain-LFA land, the “Alps, NW Iberian mountains and Scottish Highlands” (MR 10) are characterized by dominance of small farms, low economic intensity of farming, some relevance of irrigation, and medium stocking rates. The other two MRs in this group (8 and 9) are, in many respects, intermediate between these two extreme cases.

Next comes “Northern Scandinavia” (MR 11) with its strongly forested landscapes in Nordic-LFA land; scarce farming, mostly arable, with low intensity levels and stocking rates. It is followed by a group of two urban MRs (12 and 13), with their land mosaics dominated by artificial areas mostly in non-LFA land, where either specialist grazing livestock (12) or horticulture (13) are the top farm specialization categories.

Fig. 1 represents the mapping of these 13 MRs at the NUTS3 level over the whole of the EU-27. Taking into account the easy interpretation of MR above, their clear geographical meaning, as can be assessed in the map, as well as their good correspondence with many known socio-ecological gradients as inferred at this broad scale, this typology of macro-regions was taken as a sound analytical basis for the valuation framework developed in this article.

4.2. Levels of PG provision in each macro-region

The next check is assessing whether the geographical frame of reference provided by the MR typology helps to reveal clearly different levels of PG provision across MRs. These levels are evaluated through the PG indicators presented in Section 3.2, which, as noted in that section, were computed from variables different from those used to identify MRs. Fig. 2 presents the MR averages of each PG indicator by MR. This figure is discussed below to check the ability of our clusters of agricultural landscapes and farming systems (that is the MR types) to discriminate, as well, PG provision levels.

Note that both the recreation potential and the cultural heritage indicators are at their highest levels in the “Mediterranean uplands” (MR 2) and “Lowland-upland transitions in Central Europe” (8), with the “Alps, NW Iberian mountains and the Scottish Highlands” (10) following very close for the cultural heritage indicator. The “Alps, NW Iberian mountains and the Scottish Highlands” (10) and the “Mediterranean uplands” (2) also have the largest shares of UAA classified as High-Nature-Value (HNV) farmland. “Northern Scandinavia” (11), “Eastern Europe/Southern mountains and valleys” (3), and the “Mediterranean hinterlands” (1) also present moderately high shares of HNV farmland. Four of the abovementioned MRs (1, 2, 10 and 11) share some common characteristics of their agro-ecological infrastructures, such as having significant natural land covers; low intensity farming systems and significant LFA land. These characteristics of MR seem, therefore, to be associated to the PGs cultural amenities and biodiversity conservation.

On the other hand, the “Central lowlands/crops” (5) and “Central lowlands/livestock” (7) are at or close to the lowest levels of the recreation potential and HNV-farmland indicators. In these MRs, land cover is strongly dominated by farmland, mostly arable, in primarily non-LFA land, and their farming systems are moderately to highly intensive.

In MRs with landscapes strongly dominated by intensive arable uses, such as the “Central Lowlands/crops” (5) and “Central Lowlands/livestock” (7), the values of the total N input are very high, indicating likely water-pollution problems. Contrarily in “the Alps, NW Iberian mountains and the Scottish Highlands” (10), levels of water infiltration are the highest and total N input is low, which, together, indicate provision of good-quality water. A similar situation occurs in “Northern Scandinavia” (11), but not necessarily in the “North-western fringes and continental uplands” (9), where, although infiltration is high, total N input is also high.

The Alpine and the two Mediterranean MRs (10, 1 and 2) have the highest levels of soil erosion, which is likely related to their slope or climatic conditions and farming systems respectively.

NH3 emission levels have a clear maximum in the “Central lowlands/livestock” (7). Note this type of pollution is associated with intensive livestock, and this is the MR with the highest stocking rates. Other MRs with significant NH_3 emissions—“North-western fringes and Continental uplands” (9); “Urban/grazing livestock” (12); “Lowland-upland transitions in Central Europe” (8) and “Central lowlands/crops” (5)—also include specialized livestock farming systems although in different proportions.

For the PG climate stability, the carbon soil content is the highest in “Northern Scandinavia” (11), which is linked to the prevailing

Table 5
From Macro-regions (MR) to Macro-regional Agri-environmental Problems (MRAEP).

MR (13)		Simplified MR (8)	MRAEP (10)
1	Mediterranean hinterlands	Mediterranean hinterlands	- Farmland abandonment in Mediterranean hinterlands
2	Mediterranean uplands/permanent crops	Mediterranean uplands/permanent crops	- Agricultural intensification in Mediterranean hinterlands - Farmland abandonment in Mediterranean uplands/permanent crops
3 4	Eastern Europe/Southern mountains and valleys Eastern Europe/Northern flatlands	Eastern Europe	- Agricultural intensification in Mediterranean uplands/permanent crops Agricultural intensification in Eastern Europe
5 6	Central lowlands/crops Central lowlands/crops and livestock (Eastern Germany)	Central lowlands/crops and livestock	Maintenance of intensive agriculture in Central Lowlands/Crops
7	Central lowlands/livestock	Central lowlands/livestock	Maintenance of intensive agriculture/livestock in Central Lowlands/livestock
9	North-western fringes and continental uplands	North-western fringes and continental uplands	Maintenance of intensive agriculture/grazing in North-western fringes and continental uplands
10	The Alps, NW Iberian mountains and the Scottish Highlands	The Alps, NW Iberian mountains and the Scottish Highlands	Farmland abandonment or decline in The Alps, NW Iberian mountains and the Scottish Highlands
11	Northern Scandinavia	Northern Scandinavia	Declining agricultural area in Northern Scandinavia
8	Lowland–upland transitions in Central Europe	NUTS 3 in this transition MR were included in MR 9 or in MR 10 depending on location (closest MR), predominant land form (mountain versus plain) and agricultural intensity.	
12	Urban/grazing livestock	The "islands" of NUTS 3 in this MR were included in the surrounding or adjacent MR.	
13	Urban/horticulture	The "islands" of NUTS 3 in this MR were included in the surrounding or adjacent MR.	

type of Nordic climate, combined with extensive forest cover. Other three MRs (4, 9 and 10) with cool or wet climates also have significantly above the average levels of soil organic carbon. On the other extreme, the two Mediterranean MRs (1 and 2) have the lowest levels of soil carbon, and the "Central lowlands/crops" (5), probably due to intensive tillage, also has low values of soil carbon. Low values of soil carbon also indicate significant soil fertility problems.

Concluding, the analysis of the results in Fig. 2 strongly suggests a high degree of consistency between the map of MRs (that is: landscape and farming system clusters) and current patterns of PG provision.

4.3. Simplified MR set

As referred to in the methods section, the initial 13 MRs were reduced to eight simplified MRs, so as to keep only those MR types that is possible to associate to a MRAEP/narrative that respondents clearly understand and locate. The other five MR were merged with the remaining eight. The first and second columns in Table 5 identify these merges; the rest of this section discusses the main criteria and reasons for them.

MRs 3 and 4 were merged into a simplified Eastern European MR, given the difficulties in specifying two clearly different MRAEP scenarios for these two MRs. MRs 5 and 6 were also merged, because the main difference between these two MRs (larger farm size in the later) does not translate into significant differences in PG provision or the nature of the MRAEP. Focus groups participants seem to have recognized the mapping of these simplified MRs and the nature of the associated MRAEPs.

Given the difficulty in communicating transition types so that respondents understand them as well-defined problems, different areas within the MR8 (Lowland–upland transitions in Central Europe) were included into adjacent (or close) areas of two MRs: either 9 or 10, according to similarities as regards land form and agricultural intensity, in addition to distance.

MRs 12 and 13 are very small and scattered across the EU map, which makes them difficult to associate to MRAEPs that respondents across the EU would clearly understand and locate. So, they were integrated in the larger MR which surrounded them.

4.4. List of MRAEPs and core PGs to be valued in each MRAEP

Comparing the 2nd and 3rd columns in Table 5, it is also possible to check which simplified MRs were split according to the criteria and procedures introduced in Section 3.4. In fact, as said in that section, only the two Mediterranean MRs were split (into two MRAEPs each) depending on whether farmland abandonment versus intensification was the dominant trend. This leads us to the list of 10 MRAEP also named in this table.

Applying the procedures and criteria discussed in Section 3.5 led to the list of core public goods to be valued in each MRAEP type presented in Table 6. Also identified in this Table is the main dynamic trend in each MRAEP type.

Table 6 is the final outcome of the development of the proposed framework to value multiple PGs of agriculture at a broad, EU-27 scale. It organizes the available information to frame an empirically-based, policy-relevant and internally-consistent valuation scenario for each MRAEP (including the MRAEP narrative itself as well as the PG programmes referred to in Section 3.5). These valu-

Table 6
Typology of Macro-regional Agri-environmental Problems (MRAEPs), dynamic trends and core public goods (PGs) to be valued in each MRAEP.

MRAEP	Dynamic trend	Cultural amenities	Biodiversity	Water quality	Water availability	Soil quality	Air quality	Climate stability	Resilience to flooding	Resilience to fire
Farmland abandonment in Mediterranean hinterlands	Farmland abandonment	X	X			X				X
Agricultural intensification in Mediterranean hinterlands	Agricultural intensification				X	X		X		
Farmland abandonment in Mediterranean uplands/permanent crops	Farmland abandonment	X	X			X				X
Agricultural intensification in Mediterranean uplands/permanent crops	Agricultural intensification				X	X		X		
Agricultural intensification in Eastern Europe	Agricultural intensification	X	X	X				X		
Maintenance of intensive agriculture in Central Lowlands/Crops	Maintenance of intensive agriculture		X	X	X		X	X		
Maintenance of intensive agriculture/livestock in Central Lowlands/livestock	Maintenance of intensive agricul-ture/livestock		X	X			X		X	
Maintenance of intensive agriculture/grazing in North-western fringes and continental uplands	Maintenance of intensive agricul-ture/grazing	X	X	X			X		X	
Farmland abandonment or decline in the Alps, NW Iberian Mountains and the Scottish Highlands	Farmland abandonment or conversion to forest	X	X			X				X
Declining agricultural area in Northern Scandinavia	Farmland area decline/conversion to forest	X	X					X		

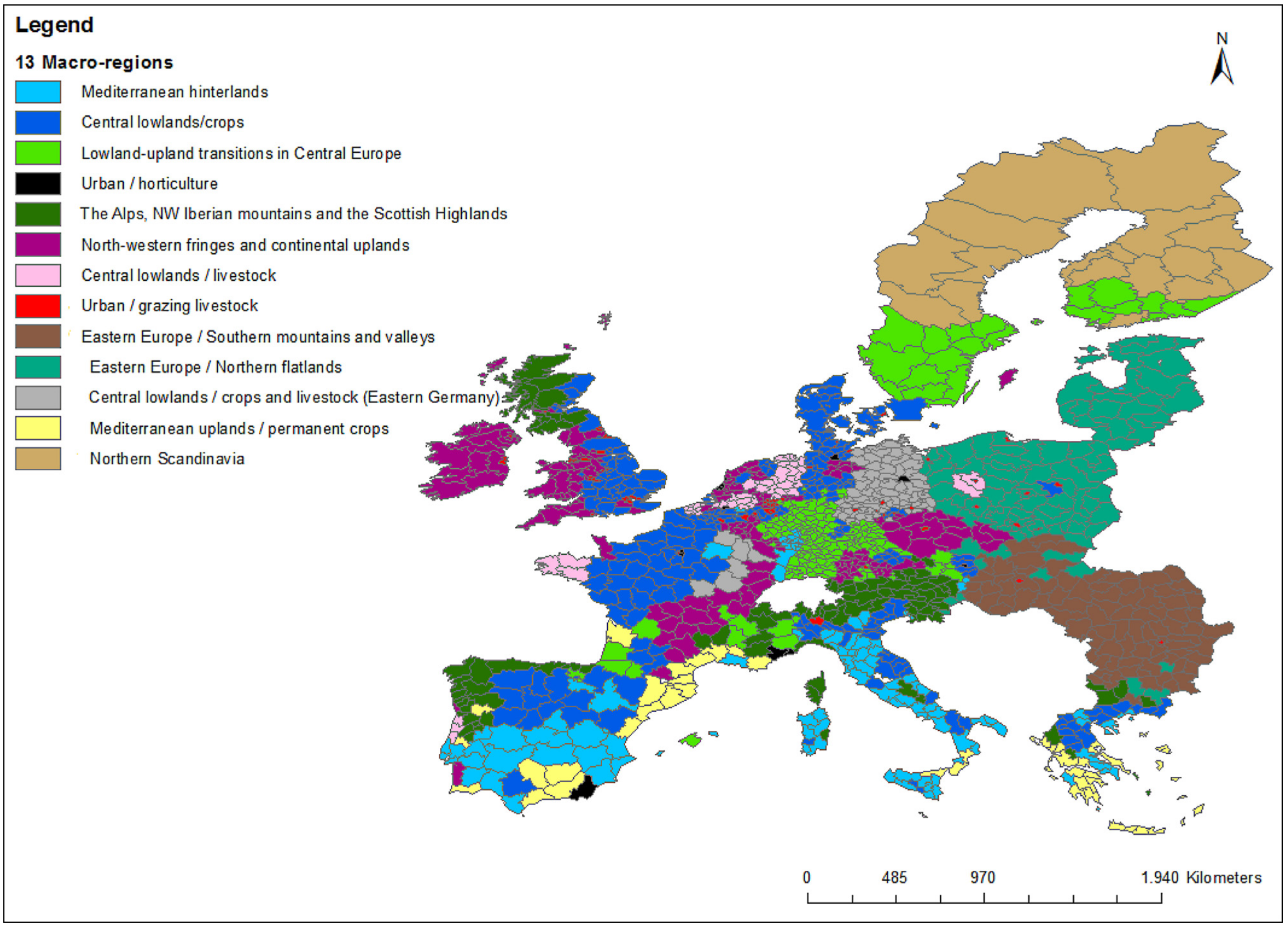


Fig. 1. Map of the 13 Macro-regions (MR) resulting from the cluster analysis.

ation scenarios provide sufficient information to focus respondents on actual trade-offs that are potentially relevant to decide upon alternative policy options. In addition, these valuation scenarios also provide context-rich opportunities for respondents to engage in assessing the required trade-offs, rather than giving us simply symbolic reactions to abstract notions such as e.g., biodiversity loss versus water quality problems anywhere.

The development of these scenarios to be applied in a valuation survey context (using e.g., choice-modelling techniques) will require further research, using focus groups and other qualitative techniques, to make sure respondents understand all of these MRAEP scenarios in the exact ways intended by the researchers. As mentioned in Section 3.6, this was already done to build a choice-modelling pilot application for a single MRAEP (summary report in next section). It still requires further research to complete this for the EU as a whole.

4.5. Performance assessment of the MRAEP framework in a survey environment

In this section, we summarize the main results of the preliminary analysis of the pilot surveys carried out for a single MRAEP ("Farmland abandonment in the Mediterranean uplands") to assess the performance of the proposed approach. Survey methods and results are discussed in detail elsewhere (Madureira et al., 2013b), and thus we focus here on some of the results that are particularly relevant to assess the validity and reliability (sensu Santos, 1998) of the approach.

Table 7 presents the estimated multinomial logit (MNL) and random parameters (RPL) models. Firstly, MNL models were estimated for all the three survey datasets—face-to-face (F2F) Portugal (PT), WEB Portugal and WEB Germany (DE)—with a high overall goodness-of-fit. These models yielded reasonably narrow 95% confidence intervals for WTP for most PGs in most surveys; e.g., 41–67 Euro.year^{-1} for Farmland Biodiversity in the WEB-DE sample, or 20–45 Euro.year^{-1} for Fire risk reduction in the F2F-PT sample. A smaller number of confidence intervals are slightly broader, but their lower limits are always well above zero (all figures referred to here are from the estimated MNL models). These results suggest that signal is apparently stronger than pure statistical noise in the estimated values, which is a good indication of the reliability of the approach. We also underline the significant convergence of the main results across different estimation (MNL and RPL) approaches, which reinforces this favourable reliability assessment.

Secondly, the signs of the estimated choice parameters for all four attributes (cultural amenities, biodiversity, soil quality and resilience to fire) were all significantly positive ($P < 0.01$) and the price parameter was significantly negative ($P < 0.001$); all of these signs being in accordance with theoretical expectations. The most valued PG was: (1) Fire risk reduction in the F2F-PT sample (lower income and education levels); (2) Biodiversity conservation and Fire risk reduction, very close to each other, in the WEB-PT sample (higher income and education levels); and (3) Biodiversity conservation in the WEB-DE sample. Estimated WTP for fire risk reduction – a typical local public good – was significantly higher in both PT samples (irrespective of education and income levels) than in the DE sample. WTP results also suggest that age had a negative effect on WTP for fire risk reduction among the Portuguese and on WTP for biodiversity conservation among the German. The role of familiarity with the good in increasing its value for people is well expressed by the higher WTP for fire prevention and for landscape amenities for those German respondents that had previously visited the Mediterranean Uplands. All of these results make a lot of sense, according to economic theory and basic rationality, and thus represent strong evidence in favour of the theoretical validity of this valuation exercise. Although preliminary, they also suggest interesting interactions between public good provision levels: for instance, a positive interaction between fire risk prevention and erosion control in the PT sample, and a negative one

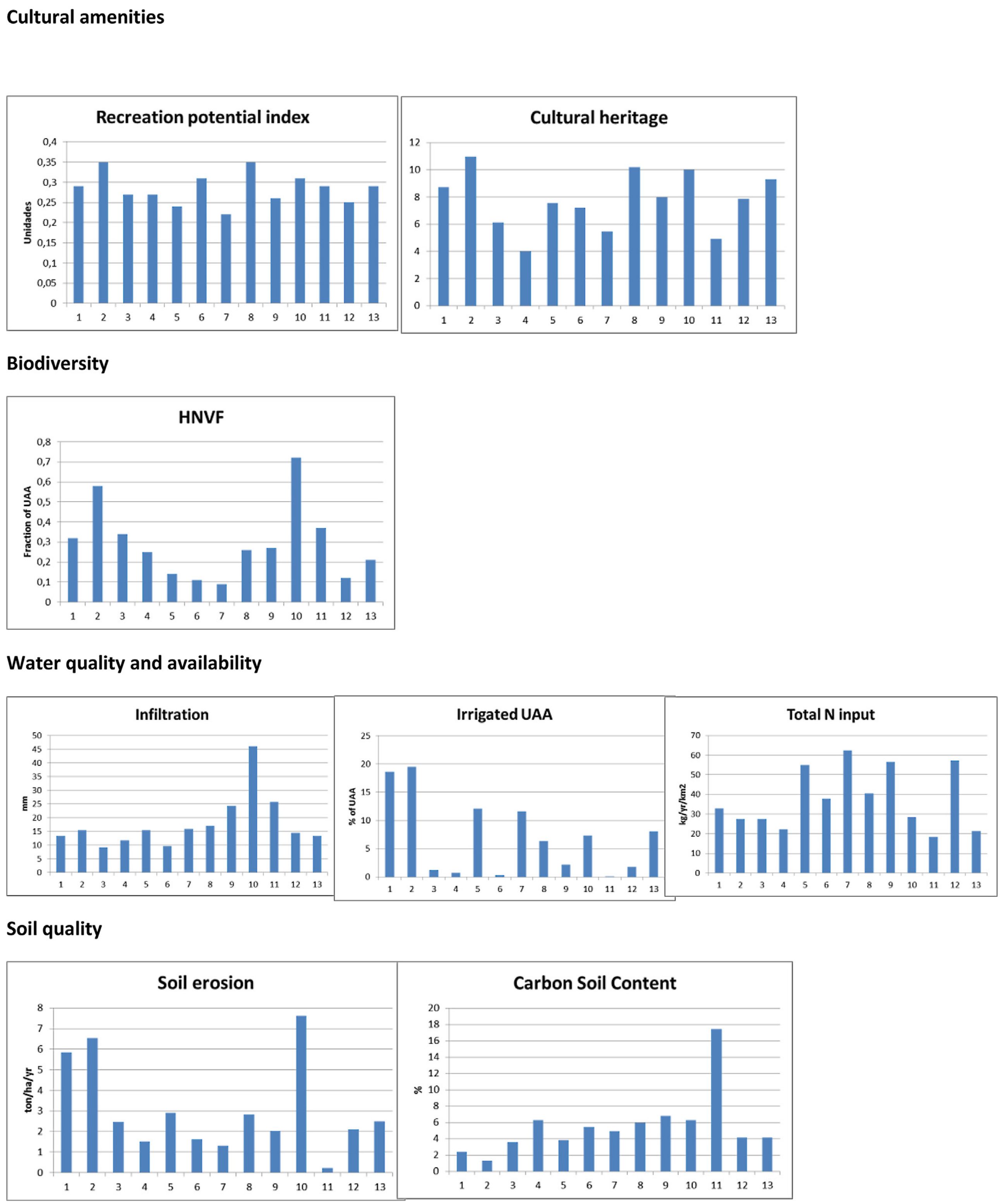
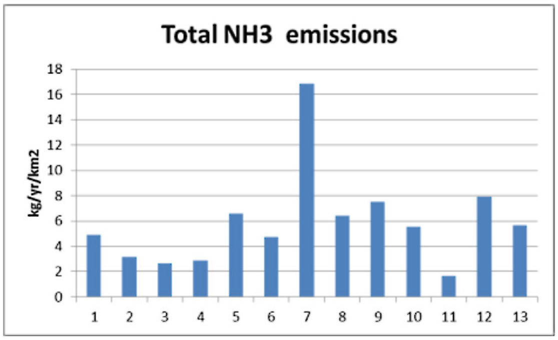
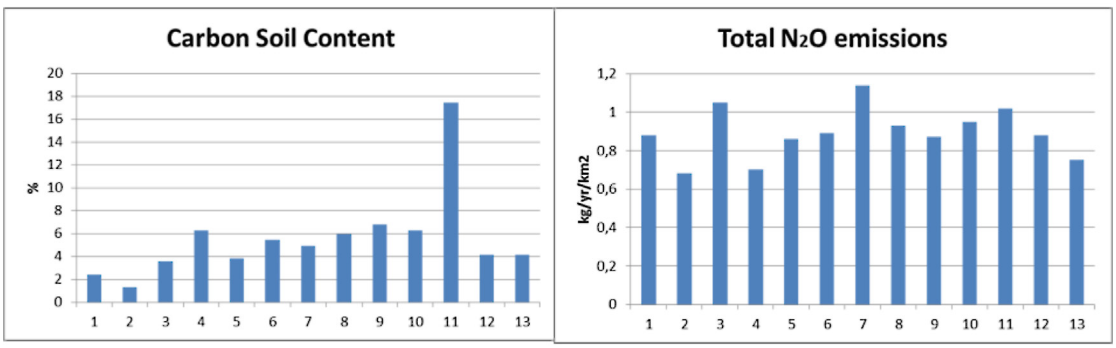


Fig. 2. Public Good (PG) provision levels in the 13 Macro-regions (MR).

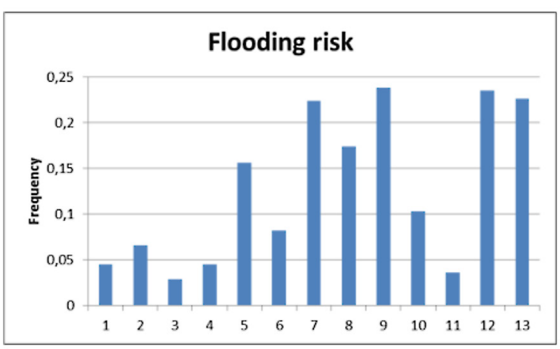
Air quality



Climate stability



Resilience to flooding



Resilience to fire

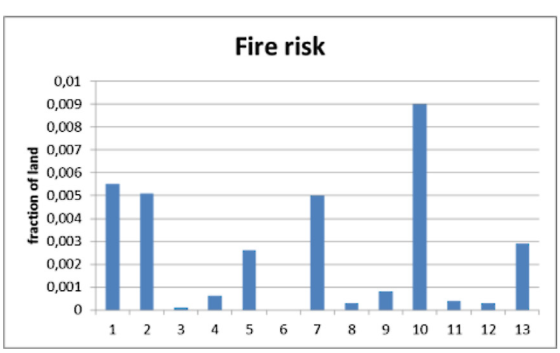


Fig. 2. (*Continued*)

Table 7
Estimated multinomial logit (MNL) and random parameters logit (RPL) models for the three samples.

Coefficients	F2F_PT		WEB_PT		WEB_DE	
	MNL	RPL	MNL	RPL	MNL	RPL
	Means					
Landscape (LAND)	0.836***	1.773***	0.501***	0.823***	0.867***	1.151***
Farmland biodiversity (BIOD)	0.818***	1.529***	0.724***	0.942**	1.820***	2.990***
Soil erosion prevention (EROS)	0.365**	0.523**	0.248**	0.269	0.262***	0.567***
Fire risk prevention (FIRE)	1.360***	2.400***	0.431**	0.896**	0.268***	0.607***
BID	−0.0258***	−0.0405***	−0.0237***	−0.0326***	−0.0245***	−0.0331***
FIRE*AGE	−0.0120**	−0.0208*				
BIOD*AGE					−0.0117**	−0.0222
LAND*HIGH EDUC.	−0.232*	−0.523*	0.298*	0.568		
EROS*HIGH EDUC			0.457**	0.763***		
BIOD*VISMEDIT.			0.469**	0.973*		
FIRE*VISMEDIT.			0.508**	0.891*		
LAND*VISMED_PT					0.636***	1.434**
FIRE*VISMED_PT					0.732***	1.541***
EROS*FIRE	0.777**	1.815***				
LAND*BIOD					−0.857***	−0.261
	Standard deviation					
PG-LAND		1.762***		2.324***		2.230***
PG-BIOD		2.428***		2.266***		3.260***
PG–EROS		2.052***		1.241***		1.850***
PG–FIRE		2.107***		1.939***		1.544***
Log-Likelihood	−1311.4	−1153.54	−1303.81	−1179.35	−1435.52	−1222.49
No. Individuals	300	300	300	300	300	300
No. Observations	1500	1500	1500	1500	1500	1500

Significance levels are shown as ***, **, * for 1%, 5% and 10% level respectively. The standard deviation (SD) is given for the four random parameters (LAND, BIOD, EROS, FIRE).

between landscape amenities and biodiversity conservation in the DE sample.

These results suggest that a large-scale survey at the EU level would bring great insights regarding the preferences of the Europeans towards environmental public goods of agriculture and the variables influencing these preferences. This information could significantly inform EU agricultural and agri-environmental policies, allowing them to better address the common citizen's expectations, and to demonstrate the benefits from tax-based public expenditure in agri-environmental policies.

5. Conclusion: assessment of the proposed valuation framework

This paper discusses a methodological framework to generate scenarios for the economic valuation of changes in multiple PGs of agriculture at broad, supranational scales. The MRAEP is the key concept in the proposed valuation framework. It allows for context-rich scenarios in broad-scale valuation exercises enabling survey respondents to make context-dependent choices on policy-relevant trade-offs. The detailed, evidence-based approach used in developing the valuation framework, though not often followed, is required to make sure that valuation scenarios are focused on empirically-grounded facts.

Major challenges that have so far hindered a wider use of value estimates produced by non-market valuation methods, namely when applied to the environment, were overcome by this methodological framework by:

- explicitly adopting an inter-disciplinary approach, which links knowledge and information from ecological and agricultural sciences (namely agri-environmental indicators) to economic and valuation concepts;
- incorporating policy relevance as a major criterion in the design of valuation scenarios, and thus explicitly addressing informational needs of end users (policy makers and policy analysts);
- designing context-rich valuation scenarios at broad scales, ensuring the content validity of the valuation exercise and hence the quality of the resulting value estimates.

The design of context-rich valuation scenarios is always a challenging aspect of the design and implementation of stated-preference valuation methods, but it is even more challenging when we move to a supra-national scale. A multi-country valuation framework for multiple PGs for an entire cross-country MR, such as the one discussed in this paper, has never been developed before, as far as we know.

The positive assessment of the reliability and theoretical validity of an application of the proposed approach at a single MRAEP pilot-survey scale, although not necessarily generalized to all MRAEPs, is quite encouraging.

Nonetheless, and probably due to the degree of innovation involved in this up-scaled non-market valuation framework, it has some limitations, which are mostly due to data constraints. Data constraints on PG provision significantly limited the possible descriptions of PG provision levels in each selected MRAEP, and thus the development of standardised descriptions of these PGs within the proposed valuation framework. Currently available agri-environmental indicator systems are still insufficient to ensure that PGs are described in their main dimensions, and/or at reasonable spatial scales, such as NUTS3. Often, information is only available at the NUTS2 or country level, which is inappropriate to develop consistent MRAEP.

Therefore, most of the information used in this article came from on-going research focusing on the downscaling of agri-environmental indicators. Eventually, it was possible to get at least one indicator for each PG with data disaggregated at the NUTS3 level.

The consolidation of this link of supply-side, policy-relevant information with demand-side valuation of PGs of agriculture depends on expected developments in agri-environmental indicator systems. Currently, there are PGs, namely cultural amenities, which are not yet sufficiently covered at the EU level. Lack of information might also have led to underestimating important PGs in some of the macro-regions (e.g., in Eastern Europe).

We finish by discussing possible uses for the proposed valuation framework. The main usefulness of this non-market valuation framework is its ability to deliver information on the value for the general public of changes in multiple PGs of agriculture at broad cross-country scales. This is useful for the design and evaluation of agricultural and agri-environmental policies, because it provides information on the people's (e.g., EU taxpayers) well-being variations in response to increases/decreases in the agriculture side-effects that can be influenced or controlled by these public policies. It could be particularly useful in supplying a broad-scale valuation frame that could provide for a better integration of environmental, cultural or social PG concerns into full cost-benefit assessments of broad policy reforms, such as those of Common Agricultural Policy (CAP reforms), or multi-lateral trade agreements by using explicit valuation of non-market environmental, cultural or social side-effects of these agreements.

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References

Borresch, R., Maas, S., Schmitz, K., Schmitz, P.M., 2009. Modeling the Value of a Multifunctional Landscape: A Discrete Choice Experiment. Paper presented at the International Association of Agricultural Economics Conference. Beijing, China.

Catalini, A.H., Lizardo, M., 2004. Agriculture: environmental services and agro-tourism in the Dominican Republic. J. Agric. Dev. Econ. 1, 87–116.

Chiueh, Y.-W., Chen, M.-C., 2008. Environmental multifunctionality of paddy fields in Taiwan: an application of contingent valuation method. Paddy Water Environ. 6, 229–236.

EC—European Commission, 2007. Scenar 2020—scenario study on agriculture and the rural world. Available on: http://ec.europa.eu/agriculture/agrista/2006/scenar2020/final_report/scenar2020final.pdf.

EC—European Commission, 2009. Scenar 2020-II—update of scenario study on agriculture and the rural world. Final report. Available on: http://ec.europa.eu/agriculture/analysis/external/scenar2020ii/index_en.htm.

EC—Directorate-General for Agriculture and Rural Development, 2011. Rural Development in the European Union. http://ec.europa.eu/agriculture/statistics/rural-development/2011/index_en.htm.

EFTEC, 2004. Framework for Environmental Accounts for Agriculture. EFTEC, London. http://www.statistics.defra.gov.uk/esg/reports/envacc/default.asp.

Hein, L., van Koppen, K., de Groot, R.S., van Ierland, E.C., 2006. Spatial scales, stakeholders and the valuation of ecosystem services. Ecol. Econ. 57, 209–228.

Leip, A., et al., 2011. Integrating nitrogen fluxes at the European scale. In: Sutton, M.A., Howard, C.M., Erisman, J.W., Billen, G., Bleeker, A., Grennfelt, P., van Grinsven, H., Grizzetti, B. (Eds.), The European Nitrogen Assessment. Cambridge University Press, pp. 345–376, http://afoludata.jrc.ec.europa.eu/index.php/dataset/files/237.

Madureira, L., Rambonilaza, T., Karpinski, I., 2007. Review of methods and evidence for economic valuation of agricultural non-commodity outputs and suggestions to facilitate its application to broader decisional contexts. Agric. Ecosyst. Environ. 120, 5–20.

Madureira, L., Santos, J. L., Ferreira, A., Guimarães, H., 2013a. Feasibility Study on the Valuation of Public Goods and Externalities in EU Agriculture. Study Commissioned by the European Commission, JOINT RESEARCH CENTRE, Institute for Prospective Technological Studies Agriculture and Life Sciences in the Economy. Final Report. 142 pp.

Madureira, L., Santos, J.L., Ferreira, A.C., Espinosa, M., Gomez y Paloma, S., 2013b. A Choice-modeling Approach to Value Public Goods and Externalities of EU Agriculture. In: Paper presented to the V Workshop on Valuation Methods in Agro-food and Environmental Economics, 37th EAAE Seminar, Castelldefels (Barcelona), June 27th–28th, 2013.

Maes J., Braat L., Jax K., Hutchins M., Furman E., Termansen M., Luque S., Paracchini M. L., Chauvin C., Williams R., Volk M., Lautenbach S. Kopperoinen L., Schelhaas M.-J., Weinert J., Goossen M., Dumont E., Strauch M., Görg C., Dormann C., Katwinkel M., Zulian G., Varjopuro R., Ratamäki O., Hauck J., Forsius M., Hengeveld G., Perez-Soba M., Bouraoui F., Scholz M., Schulz-Zunkel C., Lepistö A., Polishchuk Y. & Bidoglio, G., 2011. A spatial assessment of ecosystem services in Europe: methods, case studies and policy analysis - phase 1. PEER Report No 3. ISPRA: Partnership for European Environmental Research.

Paracchini, M.L., Petersen, J.-E., Hoogevee, Y., Bamps, C., Burfield, I., Swaay, C., 2008. High Nature Value Farmland in Europe—an estimate of the distribution patterns on the basis of land cover and biodiversity data. Joint Res. Centre.

Randall, A., 2002. Valuing the outputs of multifunctional agriculture. Eur. Rev. Agric. Econ. 29, 28–307.

Randall, A., 2007. A consistent valuation and pricing framework for non-commodity outputs: progress and prospects. Agric. Ecosyst. Environ. 120, 21–30.

Riera, P., Signorello, G., Thiene, M., Mahieu, P.-A., Navrud, S., Kaval, P., Rulleau, B., Mavsar, R., Madureira, L., Meyerhoff, J., Elsasser, P., Notaro, S., Salvo, M., Dragoi, S., 2012. Non-market valuation good practice guidelines proposal for forest goods and services. J. For. Econ. 18, 259–270.

Santos, J., 1998. The Economic Valuation of Landscape Change. Theory and Policies for Land Use and Conservation. Edward Elgar, Cheltenham.

Santos, J.L., 2000. Problems and Potential in Valuing Multiple Outputs: Externality and Public-good non-commodity Outputs from Agriculture. In: OCDE (Ed.), Towards Policies for Rural Amenities? Valuing Public Goods and Externalities. OECD, Paris, pp. 41–79.

Scarpa, R., Campbell, D., Hutchinson, G., 2007. Benefit estimates for landscape improvements: sequential bayesian design and respondents' rationality in a choice experiment. Land Econ. 83, 617–634.

SEPA, 2006. An instrument for assessing quality of environmental valuation studies. In S. E. P. Agency (Ed.). Bromma.

Söderqvist, T., Soutukorva, Å., 2009. On how to assess the quality of environmental valuation studies. J. For. Econ. 15, 15–36.

Swanwick, C., Hanley, N. and Termansen, M., 2007. Scoping study on agricultural landscape valuation. Final Report to DEFRA.

Vanslembrouck, I., Huylenbroeck, G.V., Meensel, J.V., 2005. Impact of agriculture on rural tourism: a hedonic pricing approach. J. Agric. Econ. 56, 17–30.