PROVIding smart DElivery of public goods by EU agriculture and forestry

Contract no. **633838**

PROVIDE

PROVIding smart DElivery of public goods by EU agriculture and forestry

Call identifier: H2020-ISIB-2014-2; Topic: ISIB-01-2014

Funding scheme: Research and Innovation Action (RIA)

Deliverable D5.2

Report on comparative evaluation results

01 June 2018

Organisation name of lead beneficiary for this deliverable:

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Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (Including the Commission Services)	
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Contents

List of abbreviations

AES: Agri-environmental schemes

AT: Austria

BAU: Business as usual

BG: Bulgaria

CZ: Czech Republic

CAP: Common agricultural policy

CSR: Case Study region

DCE: Discrete choice experiment

DE: Germany

EE: Estonia

ES: Spain

FCM: Fuzzy cognitive mapping

FI: Finland

EU: European Union

FR: France

IT: Italy

LRVT: Landscape and Recreational Values Trading

MAPP: Method for Impact Assessment of Programmes and Projects

MCA: Multicriteria Analysis

NL: Netherlands

PES: Payment for ecosystem services

PB: Public bad

PG: Public good

PL: Poland

PAM: Principal Agent Model

RDP: Rural development program

RO: Romania

UK: United Kingdom

WP: Work Package

WTP: Willingness to pay

WTA: Willingness to accept

Introduction

This document represents deliverable D5.2 "*Report on comparative evaluation results*" within Workpackage WP5 "*Formulating and evaluating governance mechanisms for delivery of public goods*" of the EU Horizon 2020 project PROVIDE (PROVIding smart DElivery of public goods by EU agriculture and forestry). PROVIDE WP5 targets at designing and evaluating improved and applicable governance mechanisms for the smart delivery of Public Goods (PG) and the avoidance of Public Bads (PB). The objectives of WP5 are:

(1) to identify private and public governance mechanisms for the smart delivery of Public goods (PG)/avoidance of Public bads (PB),
(2) to design evaluation approaches to integrated and innovative governance strategies,
(3) to comparatively evaluate the potential success or trade-offs of the most promising governance strategies at case study level,
(4) to analyse the practicability and transferability of these governance strategies at programming and EU level, and
(5) to formulate guidelines for practical implementation of governance instruments for PG delivery.

While deliverable D5.1 reported on the achievements in respect to objective (1) and (2), deliverable D5.2 "*Report on comparative evaluation results*" reports on the achievements in respect to objective (3) of WP5. It synthesizes the findings of Task 5.3 "*Practical, case study based evaluation of governance strategies*". Task 5.3 comprises 2 sub-tasks, namely

1. *Task 5.3.1: "Definition of case study targets on public good provision and the formulation of an appropriate mix of governance instruments*" and
2. *Task 5.3.2: "Evaluation of potential effects on public good provision"*

Deliverable 5.2 reports on the outcomes of the formulation of an appropriate mix of governance mechanisms *(Chapter 1)* and the definition of target levels *(Chapter 2)*. Also, it summarises the evaluation studies, which have been conducted in the single PROVIDE CSRs in order to assess the mechanisms' effects in respect to public good provision *(Chapter 3)*. At the end, it provides short summaries of the individual studies *(Chapter 4)*, which are then presented in detail in *ANNEX 1* to this Deliverable. It concludes with final remarks *(Chapter 5).*

1 Formulation of an appropriate mix of governance instruments

The formulation of an appropriate mix of governance instruments and the definition of case study targets on public good provision have been carried out in form of a strong stakeholder participation approach as part of the co-design process in PROVIDE (see figure 1).

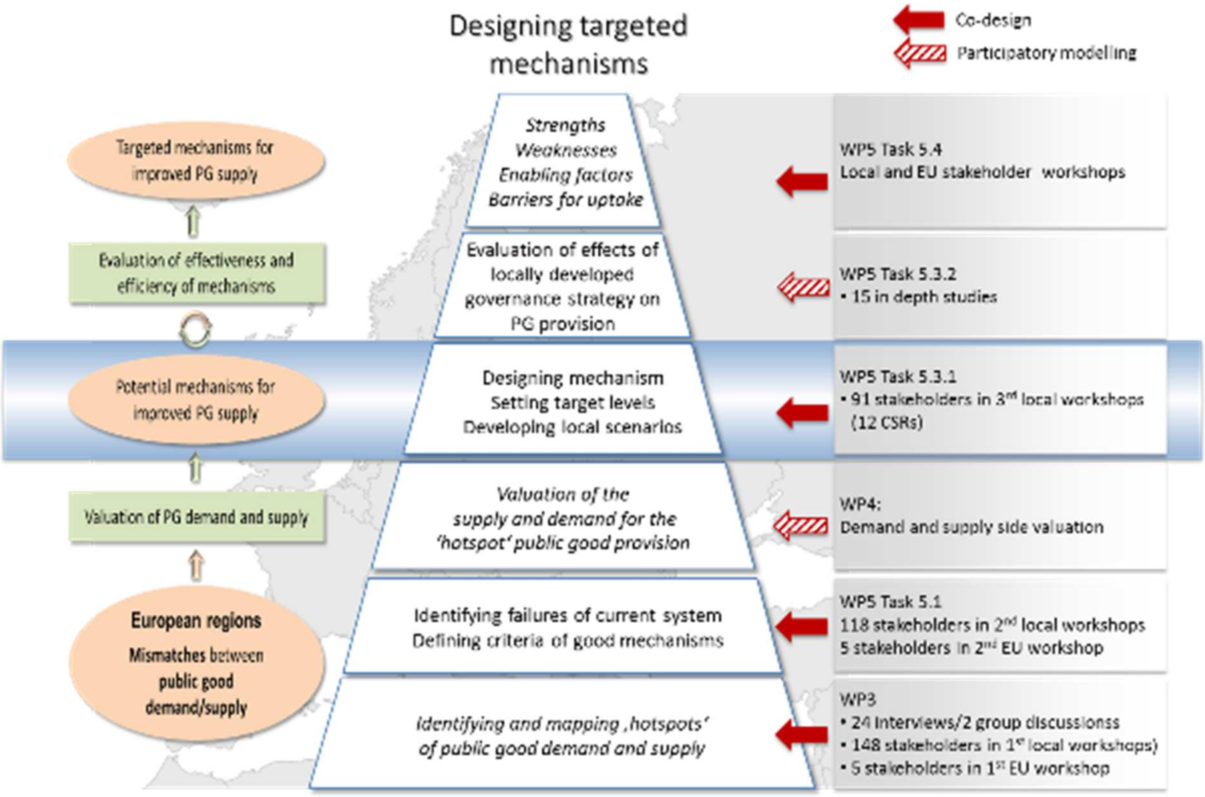

Figure 1. Formulation of governance instruments and definition of PG target levels in PROVIDE

The co-design process of the development of mechanisms already started in the 1st workshop, which was aimed at discussing the notion of public goods and identifying and mapping the main public good issues in the region (Marconi et al, 2016[1] Novo et al., 2015[2] and Novo et al.,

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[1] Marconi, V.; Raggi, M.; Zavalloni, M.; Viaggi, D.., . . . Ratinger, T. (2016) *Report synthesizing the findings of the CSR level mapping of public good demand and supply, its underlying determinants, producers and beneficiaries (Deliverable 3.2)* (PROVIDE Project (No. 633838): Brussels, 2016). Available at http://www.provide-project.eu/documents/2016/11/d3-2-report-of-csr-level-mapping-of-pgs-demand-and-suplly.pdf

[2] Novo, P., Slee,B., Byg, A., Creaney, R., Faccioli, M., . . . Desjeux, J. (2015) *Conceptual paper on the 'unpacked' notion of public goods (Deliverable 2.2)* (PROVIDE Project (No. 633838): Brussels, 2015). http://www.provide-project.eu/documents/2016/10/d2-2_conceptual-paper-on-the-unpacked-notion-of-public-goods.pdf

2017[3]). Already in this 1st workshops, in many case study regions (CSR) the current governance for public good provision, as well as improvements of the current system have been in the focus of the stakeholder discussions. In the 2nd workshops, failures and mismatches of the current governance system, as well as criteria for successful mechanisms have been discussed, and a broad number of mechanisms, potentially able to enhance the provision of the endangered public goods in the context of the regional public good issues, have been identified (Schaller et al., 2017)[2]. Particularly in the 2nd workshops, the complex system of cause-effects between mechanisms and the provision of public goods has been depicted in mind maps, describing the different public good issues and disentangling the most relevant relationships. The final set of governance mechanisms was fully developed by the local stakeholders in the 3rd local stakeholder workshops, which took place between April and June 2017 in all PROVIDE CSRs (Roberts, M., forthcoming)[4]. In the 3rd workshops, based on the results of the WP4 valuation exercise (Villanueva et al., 2017)[5], and the proposed mechanisms discussed in the 2nd workshop, the final mix of governance mechanisms was elaborated, considering the relevant local public good context as well as the main PROVIDE criteria of good governance, namely *targeting to the topic, avoidance of ancillary costs, ancillary benefits, measurability, effectiveness* and *acceptance* (Schaller et al., 2017)[6].

Table 1 presents the single PROVIDE CSRs public good contexts and the respective governance mechanisms. In table 1, the CSRs are clustered by the agricultural/forestry context into four clusters, namely 1.) Intensive agricultural land use systems, 2.) Extensive agricultural land use systems, 3.) Risk of abandonment of agricultural land use system, and 4.) Forestry.

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[3] Novo, P., Faccioli, M., Byg, A., … Zavalloni, M. (2017) *Guidelines and report on initial interviews and workshops (Deliverable 2.3)* (PROVIDE Project (No. 633838): Brussels, 2017). http://www.provide-project.eu/documents/2016/10/deliverable-2-3_guidelines-and-report-on-initial-interviews-and-workshops.pdf

[4] Roberts, M., (forthcoming) *Guidelines and reports on workshops supporting WP4 and WP5 (Deliverable 2.2)* (PROVIDE Project (No. 633838): Brussels, 2018).

[5] Villanueva, A.J., Rodríguez-Entrena, M., Gómez-Limón, J.A., Palomo-Hierro, S., Apostoaie, C.M., . . . Zavalloni, M. (2017) *Report on valuation results (Deliverable 4.2)* (PROVIDE Project (No. 633838): Brussels, 2017). Available at http://www.provide-project.eu/documents/2017/05/911.pdf

[6] Schaller, L., Kieninger, P., Gerner, L., Kapfer, M., Kantelhardt, J., Viaggi, D., . . . Hávová, R. (2017) *Report on governance mechanisms selection, methodology adaptation and guidelines for evaluation (Deliverable 5.1)* (PROVIDE Project (No. 633838): Brussels, 2017). Available at http://www.provide-project.eu/documents/2017/03/d5-1_report-on-governance-mechanisms-selection-methodology-adaptation-and-guidelines-for-evaluation.pdf

Table 1. PROVIDE case study regions, public good context and governance mechanimsm

	CSR	Public goods	Governance Mechanisms
Intensive agricultural landuse systems	AT-1	Soil functionality, landscape quality (habitats and biodiversity) and water quality in the intensive arable region "Marchfeld" in East Austria	Collective bonus, Sales guarantee and performance oriented payment by private sector, Local collective partnership, Marketing & labelling, Awareness building
	IT-2	Water availability in the hilly and mountain area of the Ravenna province in Italy	Policy interventions to foster collective reservoirs for water availability
	IT-3	Biodiversity/pollination in the hilly and mountain area of the Ravenna province in Italy	Agglomeration bonus vs. traditional agri-environmental schemes (AES) for pollination
	PL-1	Biodiversity in the the Biebrza river valley in Poland	Agri-environmental schemes (AES)
	UK-1.1	Water quality in the "Ugie river" catchment in Scotland	Green subsidies, catchment partnerships, environmental regulation, education & extension services for water quality
	UK-1.2	Biodiversity in the "Ugie river" catchment in Scotland	Greening of the CAP, change in agricultural supply chains, promotion of traditional crops, environmental regulation, green labelling, change in narratives about agriculture for biodiversity
	DE-1	Climate stability, water quantity and biodiversity in peatland areas in Brandenburg in Germany	Agri-environmental schemes (AES), Farm coordination opportunities, Value chain opportunities through market innovations.
	NL-1	Habitat, biodiversity, aesthetic quality and agricultural production in the "Kromme Rijn" area, the Netherlands	Landscape function optimisation
Extensive agricultural landuse systems	CZ-1	Water availability in Northern Bohemia in Czech Republic	Collective action based on local action group (LAG)
	BG-1	Water quality, food security, scenery and recreation in the Bulgarian South central planning region	AES, subsidies, Quality product certification
	RO-1	Natural landscape quality and rural vitality in the Dorna valley in the Romanian North East region	Targeted AES, Education/information
Risk of abandonment of agricultural landuse systems	FR-1	Water purification, habitat, flood prevention and climate stability in the Odet Watershed in Brittany in France	Decentralisation of governance (AES & payment for ecosystem services (PES)
	ES-1	Biodiversity in the Andalusian mountain olive groves in Spain	Improved agri-environmental schemes (AES)
	IT-1	Soil erosion, rural vitality and carbon sequestration in the hilly and mountain area of the Bologna province in Italy	Second pillar, operation "13.1.01 – compensatory payments in mountain areas" of RDP
Forestry	EE-1	Scenery and recreation in forest landscapes in Harju County, in Northern Estonia	Spatial planning, agreements between private forest owners and local government, Financial relief scheme for the state-owned forest management.
	FI-1	Scenery and recreation in forest landscapes in Ruka-Kuusamo in North-Eastern Finland	PES scheme: Landscape and Recreational Values Trading (LRVT), Technical assistance (guidelines and guidance)
	CZ-2	Recreation services and biodiversity of forest lands in the National Geopark Ralsko in Northern Bohemia	Fostering Stakeholder integration into National Geopark Ralsko (ass. Membership/LAG), branded fundraising activities and an institutional funding

1.1 Specific public good issues and the choice of mechanism

The overview in table 1 shows that only in the cluster of forestry similar main public good issues occur, while for specific agricultural context situations public good issues vary widely. As a consequence, also the mechanisms developed for improving the provision of PGs in the different context situations differ.

1.1.1 Mechanisms for the provision of biodiversity and habitat related public goods

Biodiversity and habitat related public good issues are identified in the clusters of intensive agricultural production and risk of abandonment of the agricultural landuse system. In AT-1 and UK-1, the intensive agricultural production is assumed to be responsible for losses of biodiversity due to habitat losses (e.g. insufficient cover for species like hares and birds due to missing landscape elements such as hedgerows, field margins, etc.), the use of pesticides (e.g. negative effects on insects, birds) and intensive management techniques (impacts on soil biodiversity). In IT-3, located in the mountainous areas of the Ravenna province, biodiversity as a driver for pollination services for the production of permanent crops is dependent on the amount of land allocated to conservation, in competition with arable land and land for the cultivation of permanent crops. In the Kromme Rijn area in the Netherlands (NL-1), agricultural intensification without the implementation of sufficient agrobiodiversity measures is held responsible for negatively influencing the natural environment in terms of biodiversity. Also here land allocation of nature conservation area is considered as not optimal. Also in the Biebrza river valley in Poland (PL-1), intensification tendencies and the abandonment of traditional agricultural practices are assumed the major risk for biodiversity. On the contrary, in the wetlands of the Odet watershed (FR-1) and in the mountain olive groves in Andalusia in Spain (ES-1), changes in biodiversity result not from intensification but from the abandonment of very specific and distinct agro-ecosystems with specific habitat structures and species composition (agricultural wetlands and mountain olive groves) rather than from intensification.

In the cases of AT-1 and UK-1, and DE-1, to achieve improvements in biodiversity, the implementation of stand-alone mechanisms appears insufficient. In all three regions a mix of mechanisms is suggested, which aims at an evenly distributed protection of biodiversity on agricultural land by the implementation of adequate management measures throughout the CSRs. The mechanism mixes combine management related policy mechanisms, such as 1st and

2nd Pillar measures, and 'supporting' mechanisms driven by the agro-food chain (marketing, labelling), as well as awareness-building. In AT-1, an important element of the mix are collective approaches, such as the operationalisation of the AES as a collective bonus and the development of a supporting collaborative partnership. While in UK-1 the mechanisms mix mainly targets biodiversity, in AT-1 and DE-1 biodiversity is only 1 of 3 PGs targeted by the same mechanisms mix.

In IT-3 and NL-1, to improve the provision of biodiversity, a better allocation of area to biodiversity protection is the target of the mechanisms developed. In NL-1, better spatial targeting of an existing nature management plan is suggested, while in IT-3, AES in direct comparison to an agglomeration bonus are tested against the question of an optimal allocation of area devoted to biodiversity protection.

In the two areas, where biodiversity appears at risk due to the abandonment of management (ES-1 and FR-1), more or less stand-alone financial incentives appear best suited: While in the case of the mountain olive groves (ES-1) improved and fostered AES seem expedient, in FR-1 the type of financial incentive is assumed to be rather replaceable (PES or AES) and also the targeting of the mechanisms is lower: here a decentralisation of payments seems key to reach locally optimal levels of maintenance of the specific ecosystem "agricultural managed wetlands".

1.1.2 Mechanisms for the provision of water related public goods

Water related public good issues such as water quality and water availability are found in all three agricultural landuse systems. In the intensively used arable areas "Marchfeld" and "Ugie river catchment" (AT-1, UK-1), water quality is threatened by agricultural fertilisation and plant protection measures (nitrate, pesticides). In DE-1, water quantity/retention is threatened by the drainage of the peatlands. In the Bulgarian Central Planning region (BG-1), water quality is not critically endangered at the current state, but protection for the future appears important. In the Odet watershed in Brittany (FR-1), the abandonment of current wetland management is assumed to endanger the wetlands functioning as areas for water purification and therefore water quality. Also the water retention potential, as a driver for the reduction of flood risk is assumed an important local public good provided by the wetlands of the Odet watershed (FR-1). In the mountain areas of the Ravenna province (IT-2), the high water intensity of the agricultural production in combination with low precipitation and scarce freshwater provision are considered the main drivers for water scarcity and therefore set at risk the PG water availability. Also in Northern Bohemia in CZ-1, water availability is at the focus of interest, while causes for water scarcity are seen in increasing drought seasons due to climate change (increases in temperature and weather irregularities) rather than related to management issues (80% of region is managed as grassland).

Also for the improvement of water quality, in AT-1, UK-1 and DE-1, mixed mechanisms approaches are suggested, which aim the implementation of management measures to be carried out on agricultural area as widely as possible. While in Austria and Germany the same mix of mechanisms as for the improvement of biodiversity is suggested, in UK-1 a specific mix of mechanisms for water quality is envisaged, again comprising 1st and 2nd pillar measures, measures set by the agrofood chain and awareness building measures, now amended by the collaborative element of catchment partnerships.

For the case of Bulgaria (BG-1), and again the case of FR-1, stand-alone financial incentives are envisaged. While in BG-1 specific water protecting agricultural management (reduction of fertilisation) compensated by respective subsidies is targeted, the financial incentives in FR-1 do not directly target water protection but the maintenance of wetland management with the expected side-effect on water purification and flood control.

For the cases of water availability in IT-2 and CZ-1, in both regions the same management adaptations are targeted, namely the establishment of water retention ponds. Also in both cases, for this establishment collective approaches are suggested: In the case of IT-2, different organisational forms of collective ponds are tested, while in CZ-1 an implementation over the collective action involving the regional LEADER local action group (LAG) is suggested.

1.1.3 Mechanisms for the provision of soil related public goods

Soil related public good issues such as carbon sequestration, humus accumulation (increasing soil-functionality in many dimensions) and soil erosion, play a role in intensive agricultural production, but also in regions facing the risk of abandonment. In the Austrian Marchfeld (AT-1), mainly the intensive arable management, with in parts insufficient acceptance and implementation of soil conserving and humus accumulating agricultural management strategies, is considered a threat to soil functionality and carbon sequestration. In the peatland areas of the Rhinluch in Germany (DE-1) the specific situation of agricultural management on deep-drained peatland areas strongly impacts on the ability of this ecosystem to function as carbon sink, due to peat degradation and the related emissions of carbon dioxide. In the mountain areas of the Bologna province (IT-1), the amount of soil erosion depends on the crops cultivated and the slope of the agricultural fields, while carbon sequestration is seen a public good mainly provided by abandoned and forestry area.

In AT-1 and DE-1, the mix of mechanisms clearly targets the objective of enhancing the soil related public goods. In AT-1, the collective bonus aims at the implementation of soil conserving management, in DE-1, the AES aims at the implementation of climate friendly peatland management. Additionally, supporting cooperative and value-chain elements are integrated in the mix. The supporting mechanism aim at enhancing acceptability of the financial incentives.

In IT-1, a currently already existing, rather untargeted AES, taking the form of a compensation payment in less favoured areas, is expected to have effects on carbon sequestration and soil erosion via its impacts on particularly the prevention of land abandonment and the related allocation of different land use systems.

1.1.4 Mechanisms for the provision of scenery and recreation

Scenery and recreation has been identified as the main public good in all three forestry CSRs. In the forest areas of Ruka-Kuusamo in Northern Finland (FI-1) and in Harju-County in Northern Estonia (EE-1), the same management context (clear cutting in private and public forests) is identified as responsible for the imbalance between the demand and provision of recreational public goods from forest areas. In future, this imbalance may increase if the cuttings become more intensive due to increased timber demand. In contrast, the Ralsko Geopark in Czeck Republic (CZ-2), a formerly military area, is opened to society for recreational use. Here, threats to the use of the recreational public goods are rather seen in an insufficient integration of the most important stakeholders into the Geopark concept. As regards the agricultural clusters, it becomes evident that scenery and recreation obviously plays no major role in the context of intensive agricultural production or against the risk of abandonment of agricultural production. Two agricultural CSRs considering scenery and recreation come from the low intensive production cluster. In both regions, the Bulgarian South planning region (BG-1) and the Romanian Dorna valley (RO-1), the public good of scenery and recreation is threatened by intensification tendencies and mismanagement. In the intensive production cluster, in NL-1 the aesthetic quality of the landscape is considered important for recreation

For the two case studies FI-1 and EE-1, where for the improvement of the public good scenery and recreation cutting restrictions or changes in overall forest management strategies are necessary, it seems apparent that financial incentives are the most suited mechanism. In FI-1, such payments are suggested to take the form of payments for ecosystem services, which are made by the users of the public goods (forest visitors or nature-based tourism entrepreneurs). In contrast, in EE-1 compensation by the state is envisaged, for private owners in form of management agreements, for public forest in form of a financial relief scheme.

In the case of the CZ-2, for further conservation of the forest area and an improved provision of scenery and recreation, a stronger integration of a broader set of stakeholder into the organisation of an already existing Geopark and better funding opportunities are is envisaged. Specifically the integration of the local action group and specific branded fundraising are suggested as potential mechanisms.

In the two agricultural regions BG-1 and RO-1, which are both characterised by low intensive and small scale agricultural production, targeted financial incentives in form of AES and support for investments in improving environmental infrastructure are seen as best suited to enhance farmers' opportunity to avoid management measures which have a negative impact on the PG scenery and recreation. In RO-1, additionally education and improved extension services are assumed a key element for the awareness building on level of the farmers.

1.1.5 Mechanism for the provision of rural vitality

Rural vitality issues become evident on the one hand in the context of the abandonment of agricultural production in IT-1, and under the condition of extensive agricultural production in RO-1. As already described, in IT-1 the financial incentive of a LFA payment, in RO-1, the financial incentive of AES is suggested to be best suited to guarantee economic viability of agricultural production and therefore also rural vitality.

1.2 Types of mechanisms

In order to solve specific public good issues in differing agricultural and forestry context situations, very individual solutions and therefore clearly differing governance strategies have been suggested.

1.2.1 Stand-alone mechanisms vs. mechanisms mixes

An important differentiation can be seen between stand-alone mechanism and mechanisms mixes involving more than one mechanism. ***Stand-alone mechanism*** mostly deal with the improvement of the provision of one specific public good, and first and foremost take the form of financial incentives: In ES-1 and PL-1, AES are designed, directly focussing on the objective of enhancing biodiversity. In FI-1 a PES scheme focusses on scenery and recreation. In BG-1, subsidised reductions of fertilisation to improve water quality, quality food certification to improve food security and LFA payments and payments for investment in environmental structure to improve scenery and recreation are envisaged. Collective stand-alone approaches, which go beyond farm level but still focus on one public good, have been developed in IT-2, CZ-2 and IT-3. While in IT-1 for the improvement of water availability membership in collective irrigation reservoir is subsidised, in CZ-2 a non-financial mechanism, a collective action, is suggested to streamline and enhance coordination and responsibility of landscape water retention. In IT-3, a collaborative bonus aims at improving pollination services. Stand-alone mechanism focussing on more than one public good are the optimised nature management plan in NL-1, the decentralised AES or PES set against the abandonment of wetlands in FR-1, and the financial incentive of a RDP payment set against land abandonment in IT-1. In the CSRs where ***mixes of mechanisms*** have been suggested, they include a financial incentive, supported by other mechanisms. In 2 PROVIDE CSRs, mechanisms mixes focus on the provision of 1 public good: In UK-1, for improving the 2 PGs biodiversity and water quality, 2 individual mechanisms mixes are suggested, both including regulatory elements, awareness-building, value-chain related mechanism and financial incentives. In EE-1 the mechanism mix combines spatial planning and tailored compensation payments for two types of forest owners to maximise the provision of scenery and recreation. In 3 PROVIDE CSRs, mechanisms mixes are designed to improve a bundle of PGs. These comprise collective bonus, collaborative partnership, marketing and labelling and awareness-building in AT-1, for improving soil functionality and the connected PGs water quality and habitats and biodiversity. In DE-1, AES in combination with farm coordination and value chain opportunities aim at improving carbon-sequestration on peatland. In PL-1, to improve natural landscape quality and rural vitality, targeted AES in combination with education/information is suggested.

1.2.2 Collective mechanisms vs. individual approaches

A further differentiation in the mechanisms suggested in PROVIDE, can be seen in collective and ‘individual’ approaches. To expand on the ***collective mechanisms***, these are particularly suggested for the improvement of public goods whose provision depends on the regional landscape (going beyond single fields or farms) and therefore require the coordination of efforts among the individual decision makers. This specifically holds true for the water related public good issues, where spatial separation of measures appears difficult and efforts to improve the public goods demands action beyond farm-level. This is for example the case for the improvement of water availability in CZ-1 and IT-2, as well as in DE-1, where rewetting appears difficult on only single separate fields. Also for the case of pollination in IT-3, the agglomeration bonus seems an option. It also becomes apparent, that collective approaches are particularly suggested in the cluster of intensive agricultural production systems. In all governance mixes in this cluster (AT-1, UK-1, DE-1) collaborative elements are included, moreover two stand-alone mechanisms in this cluster constitute collective approaches (IT-2, IT-3). The CSRs CZ-1 and CZ-2 show, that collective actions are also preferred mechanisms if PG provision is hindered by lack of coordination between decision makers and stakeholders.

1.2.3 Targeted mechanisms vs. mechanisms generally supporting agriculture

A third difference can be seen in the targeting of the mechanisms. Particularly mechanisms which work with financial incentives in form of management related compensation payments in most cases include ***management requirements targeted to the provision of specific PGs***. Targeting can characterise stand-alone mechanisms as well as mechanisms mixes. Some examples: In ES-1, the different AES that have been developed include defined management requirements (10% of area under cover crops, herbicide treatment, insecticide treatment, tillage management, etc.), which target directly at the objective of enhancing the PG biodiversity. In EE-1 and FI-1, the suggested agreements and PES schemes involve predefined (regeneration) cutting restrictions, directly targeting the PG scenery and recreation by enhancing landscape aesthetics. These restrictions target mainly mature forest stands and suggested management may vary between forest sites depending on the location, type of use and structure of the forest. In BG-1, for the PG water quality, defined fertilisation levels are assigned to subsidies. In the mechanisms mix in DE-1, the AES scheme to improve carbon sequestration on peatlands includes predefined raises in water levels, numbers of cuts, etc. In AT-1, the financial incentive of the collective bonus directly targets soil functionality by management requirements such as minimum tillage, adapted crop-rotation, intercropping. Also the remaining PGs of water quality and habitats and biodiversity are expected to be positively affected by these management requirements. Mechanisms can be ***spatially targeted to a specific area of public good provision***. For example, clear-cutting restrictions in Estonian forests (EE-1) to the aim of improving scenery and recreation are necessary first and foremost in the areas most valuable to visitors, while in regions not frequented by visitors, no demand for the PG scenery and recreation exists. Similarly in FI-1, the importance to restrict cuttings is different in different parts of the area and it is determined on the demands related to recreational use of the area and the visibility of areas.

Examples for mechanism rather ***untargeted to specific PGs*** can be found in the two CSRs FR-1 and IT-1 in the cluster of risk of abandonment. In both cases, the continuation of agricultural production under the conditions of the financial incentives comes along with the provision of public goods, which are not particularly at the focus of the program.

2 Definition of case study targets on public good provision

The targets of public good provision were developed by the stakeholders in the 3rd local stakeholder workshops (April-June 2017) (see Roberts, M., forthcoming)[7]. The definition of targets was based on the results of the WP4 valuation exercise (see Villanueva et al., 2017)[8],, particularly as these results gave an insight into the local society's willingness to pay for public good provision on the one hand, and the costs for this provision on the other. With this knowledge in mind, in the workshops it should be discussed, which levels of provision appear realistic and are aspired. Particularly the target levels used in the WP4 valuation were re-discussed and adapted.

Rather than resulting in the setting of defined levels for the provision of specific PGs in all CSRs, the workshop discussions revealed several questions to be considered around the setting of PG targets. The main point from the discussions are sketched in the following paragraph:

A major issue raised was the question of ***who is in charge*** when setting targets on PG provision. It became clear, that different stakeholders have different opinions and also agendas on targets, so a fair balance of interests appears necessary (e.g. UK-1, FI-1). The use of expert knowledge seems inevitable (e.g. ES-1). Also discussed was the question of ***trade offs***. Here, trade-offs between the provision of different PGs have to be considered (e.g. DE-1, AT-1), as well as trade-offs between different forms of land-use (e.g. agricultural production vs. recreation) (e.g. NL-1, ES-1). Optimal PG targets would reach a balance between the costs and the benefits of PG provision. Another issue was the question of ***scale of provision***. Scale was suggested to be considered in two dimensions, namely spatial scale and temporal scale. In the case of EE-1 and FI-1 for example, cutting restrictions are necessary first and foremost in the areas most valuable to visitors and nature-based tourism entrepreneurs, while in regions not frequented by visitors, no demand for the PG scenery and recreation exists. In contrast, target areas for improving soil functionality in the Marchfeld depends on the

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[7] Roberts, M., (forthcoming) *Guidelines and reports on workshops supporting WP4 and WP5 (Deliverable 2.2)* (PROVIDE Project (No. 633838): Brussels, 2018).

[8] Villanueva, A.J., Rodríguez-Entrena, M., Gómez-Limón, J.A., Palomo-Hierro, S., Apostoaie, C.M., . . . Zavalloni, M. (2017) *Report on valuation results (Deliverable 4.2)* (PROVIDE Project (No. 633838): Brussels, 2017). Available at http://www.provide-project.eu/documents/2017/05/911.pdf

patterns of soil type and agricultural management. As regards temporal dimension, e.g. in AT-1 the necessary timeframe for improving water quality is assumed to be around 50 years. Short-term targets are not expedient for this PG. Temporal scale includes also the question of the baseline level (current, past) of provision on which improvements are envisaged.

Table 3 summarises the results of the stakeholder consultation on PG targets for the CSRs where levels could be derived.

The results reveal that in many of the CSRs it was difficult to fix targets in terms of 'numbers' (e.g. NL-1). Also they show, that different stakeholder pursue different PG targets (e.g. AT-1). In some cases, fixed scientific or political, "expert-based" targets are accepted (e.g. RO-1). However, it can be seen that generally public good targets desired by the stakeholders rather range on high levels of provision (e.g. AT-1, UK-1). The results also show, that defining public good targets in the sense of agreeing on levels of provision remains difficult. Often rather the desired level of implementation of measures can be formulated, that the improvement of the PG itself (e.g. amount of area covered by management changes rather than humus accumulation (AT-1) of scenery and recreation (FI-1, EE-1).

Table 3. Target levels of public good provision

Cluster		Target levels of public good provision
Intensive agricultural land use system	AT-1	***Soil functionality*** 53.8% of stakeholders: 3/3 UAA soil conservation management 23.1% of stakeholders: 1/3 UAA soil conservation management 15.4% of stakeholders: 2/3 UAA soil conservation management 1 Stakeholder targets a "optimum" amount of area **Landscape quality** 30.8% of stakeholders: 10% of area with hedges and flower strips 23.1% of stakeholders: 7.5%, of area with hedges and flower strips 30.8% of stakeholders: 5% of area with hedges and flower strips 15.4% of stakeholders: 2.5%. of area with hedges and flower strips ***Water quality*** 77% of stakeholders: groundwater should be potable without treatment. The other three local stakeholders/experts think that the target level of "potable groundwater" is unrealistic in the region and suggest new definitions/limits and/or a highest possible reduction of the nitrate value.
	DE-1	***Climate stability:*** Always depends on reference scenario if numbers are realistic; unrealistic to convert 800,000 ha; level calculation is technical sound ***Biodiversity:*** 10 % of extensive used peatland that develop naturally is a minimum target level and should be kept ***Water quantity:*** Levels should be defined normative, but quantification is problematic, on what scale should the water quantity be accounted for?, could say that an certain amount of water has to be retained in the area to conserve the habitat types
	UK-1	***Water quality:*** Improved to the best possible level ***Biodiversity:*** Best proposed level: 25 farmland bird species
Extensive agricultural land use system	BG-1	***Water quality:*** annual rate of fertilization with manure - 170 kg per ha, share of local farms apply practice of water protection – 66% ***Scenery and recreation***: number of farms in AES –33% Investment in eco infrastructure – 100 Euro/citizen ***Food security:*** 30 farms in POD scheme
	RO-1	***Natural landscape quality***: 700-1,400 ha of additional forested areas, 1-2 mg of NO_3 per litre in mineral waters ***Rural vitality:*** under 28-33% of the population consisting of young people, +15…+20% new dwellings in the area compared to the year 2000
Risk of aband-onment of land use system	ES-1	***Biodiversity:*** 22 and 30 farmland bird species
Forestry	EE-1	***Scenery and recreation:*** Share of mature forests area covered by forest management agreements in the densely populated areas and surrounding buffer zones: 20% - in 10 years, 50% - in 20 years.
	FI-1	***Scenery and recreation:*** • Landscape and recreation value trade is actively used in the core forest area used for tourism in Ruka-Kuusamo that is agreed by partners (or proposed by Kuusamo municipality). • Quality of forest landscape improved significantly in the Kuusamo tourism area in the long run • No visible signs of clear cuts/intensive forest management operations in the identified nature-based tourism hotspots and e.g. along hiking trails and accommodation sites.
	CZ-2	***Scenery and recreation:*** 120.000 visits /year, the considered range: 80000 (current) to 300,000 (realistic) Biodiversity: 27,400 ha of forests – to be kept, 1/3 of the NGR

3 Comparative evaluation of mechanisms

The effects of the locally developed mechanisms on improved public good provision have been evaluated in individual studies for the individual cases of the PROVIDE CSRs.

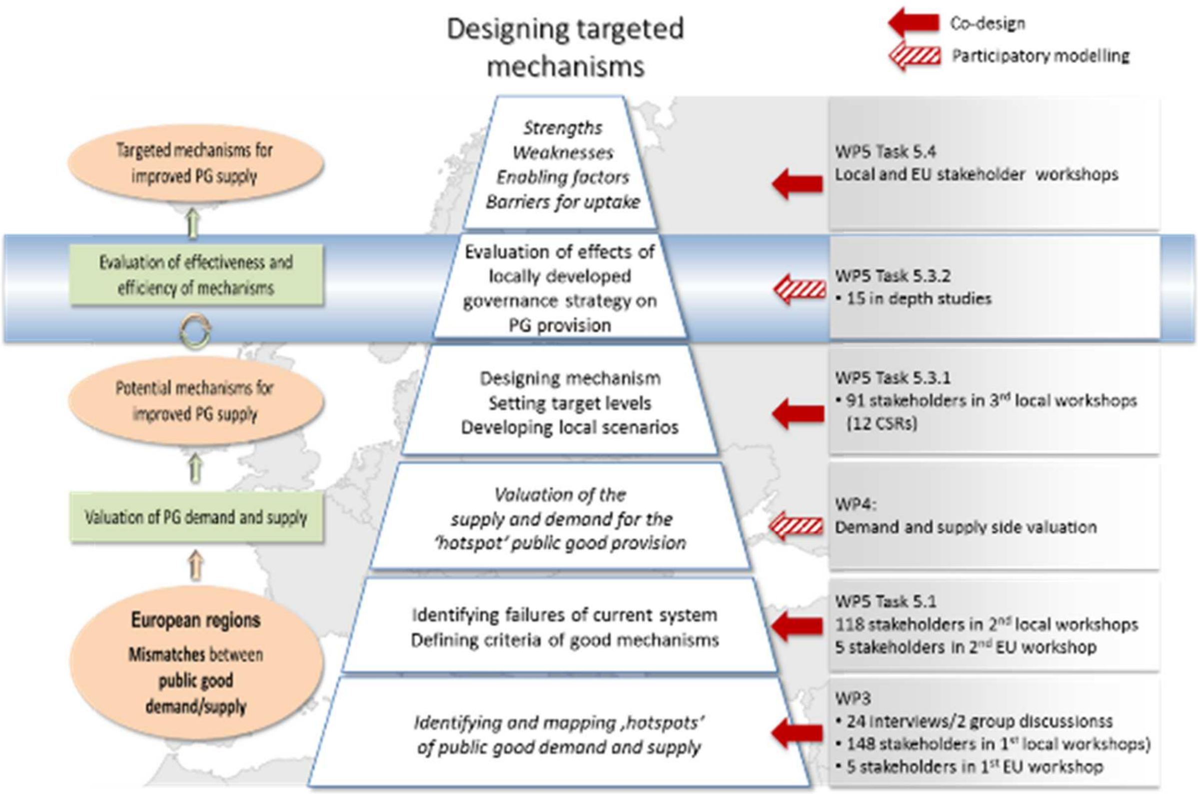

Figure 2. Evaluation of potential effects of mechanisms on public good provision in PROVIDE

The selection of evaluation approaches followed the guidelines for evaluation as defined in Schaller et al, 2017[9]. The final selection and the fine-tuning of the methodological approaches was however possible only after the successful completion of Task 5.3.1, as the selection was based on the ability of the methodological approach to meet the evaluation requirements given by the PG targets and the final governance mechanisms and mechanisms mixes.

[9] Schaller, L., Kieninger, P., Gerner, L., Kapfer, M., Kantelhardt, J., Viaggi, D., . . . Hávová, R. (2017) *Report on governance mechanisms selection, methodology adaptation and guidelines for evaluation (Deliverable 5.1)* (PROVIDE Project (No. 633838): Brussels, 2017). Available at http://www.provide-project.eu/documents/2017/03/d5-1_report-on-governance-mechanisms-selection-methodology-adaptation-and-guidelines-for-evaluation.pdf

3.1 Summary of evaluation studies

3.1.1 Methodological approaches for the evaluation of governance mechanisms

Table 4 presents an overview on the methodological approaches chosen to evaluate the mechanisms' effects on public good provision. In the table, the evaluation studies are clustered following the 3 main foci of evaluation, namely 1.) *the evaluation of improved financial incentives*, 2.) *the evaluation of mechanisms mixes* and 3.) *the evaluation of collective actions.* The evaluation of improved financial incentives is sub-clustered into the four groups of a) *optimal design of improved financial incentives*, b) *effectiveness of collective financial incentives* c) *optimised land allocation*, and d) *decentralisation of policy (financial incentives).*

Table 4 shows, that even in the same clusters and sub-clusters of evaluation studies, a wide range of methodological approaches have been used.

Except in the case of the Finish CSR, for the evaluation studies focusing on ***improved financial incentives***, mainly mathematical modelling approaches have been chosen: For the case of ES-1, where an improved and targeted financial scheme in form of an AES is evaluated, a Principal Agent Model (PAM) has been applied. In EE-1, for analysing the effectiveness of better spatial targeting of incentivised management changes, a spatial and mathematical model has been developed. In contrast, in FI-1 a Multi-Criteria Analysis (MCA) has been used to evaluate an improved and targeted PES. For studies investigating the effects of financial incentives on optimal land allocation for public good provision, in the case of IT-1 a land allocation model, and in the case of NL-1 an optimization model have been used. Also for the direct comparison of the effectiveness of area payments and collective financial incentives, as investigated in the cases of IT-2 and IT-3, mathematical and land allocation models were best suited. A mathematical model was moreover used in FR-1, in order to model the effects of decentralized organisation of financial incentives.

Table 4. Methodological approaches for the evaluation of mechanisms in PROVIDE

Evaluation of financial incentives		
Optimal design of improved financial incentives		
ES-1	Biodiversity in the Andalusian mountain olive groves in Spain – Evaluation of improved agri-environmental schemes	Principal-agent model
FI-1	Scenery and recreation in forest landscapes in Ruka-Kuusamo in North-Eastern Finland – Evaluating the PES-scheme "Landscape and Recreational Values Trading" (LRVT)	Multi-criteria analysis
EE-1	Scenery and recreation in forest landscapes in Harju County, in Northern Estonia – Evaluating agreements between private forest owners and local government and financial relief scheme for the state-owned forest management	Spatial and mathematical modelling
Effectiveness of collective incentives		
IT-2	Water availability in the hilly and mountain area of the Ravenna province in Italy – Evaluation of policy interventions to foster collective reservoirs	Mathematical model
IT-3	Biodiversity/Pollination in the hilly and mountain area of the Ravenna province in Italy – agglomeration bonus vs. traditional AES	Land allocation model
Optimized land allocation		
IT-1	Soil erosion, rural vitality and carbon sequestration in the hilly and mountain area of the Bologna province in Italy – Evaluation of existing RDP	Land allocation model
NL-1	Habitat, biodiversity, aesthetic quality and agricultural production in the "Kromme Rijn" area, the Netherlands – Landscape function optimisation	Optimization model
Decentralisation of policy (financial incentives)		
FR-1	Water purification, habitat, flood prevention and climate stability in the Odet Watershed in Brittany in France – Evaluation of a decentralisation of governance for AES & PES schemes	Mathematical model
Evaluation of mechanisms mixes		
UK-1	Water quality and biodiversity in the "Ugie river" catchment in Scottland - Evaluation of a governance mix consisting of collective bonus, sales guarantee and performance oriented payment by private sector, local collective partnership, marketing & labelling, awareness building	Fuzzy cognitive mapping
AT-1	Soil functionality, landscape quality and water quality in the intensive arable region "Marchfeld" in East Austria - Evaluation of a governance mix consisting of collective bonus, sales guarantee and performance oriented payment by private sector, local collective partnership, marketing & labelling, awareness building	Fuzzy cognitive mapping
DE-1	Climate stability, water quantity and biodiversity in peatland areas in Brandenburg in Germany – Evaluation of a governance mix of agri-environmental schemes, farm Coordination opportunities & value chain opportunities through market innovations.	Discrete Choice modelling
BG-1	Water quality, food security and scenery and recreation in the Bulgarian South central planning region – Investigating a mechanisms mix of collective action, AES and quality product certification	Principal component method
RO-1	Natural landscape quality in the Dorna valley in the Romanian North East region – Evaluating a mix of targeted AES and education/information measures	Multiple objective linear programming model
Evaluation of collective actions		
CZ-1	Water availability in Northern Bohemia in Czech Republic – Evaluation of a collective action based on the local action group (LAG)	Qualitative assessment (Ostrom); Fuzzy cognitive mapping; MAPP (Impact Assessment)
CZ-2	Recreation services and biodiversity of forest lands in the National Geopark Ralsko in Northern Bohemia – Fostering broader stakeholder integration	Fuzzy cognitive mapping; MAPP (Impact Assessment)

For the ***evaluation of mechanisms mixes***, in 3 cases participatory approaches have been chosen. While in UK-1 and AT-1, for the evaluation of the mutual effects of different mechanisms in a mechanisms bundle, the strictly participatory method of fuzzy cognitive mapping has been applied, in DE-1, the effects of different complementary mechanisms have been assessed by the use of a discrete choice experiment (DCE). In the 2 remaining cases of BG-1 and RO-1, where BG-1 investigates mix of financial incentives and RO-1 a mix of targeted AES and education/information, a principal component method based on a former DCE, and a multiple objective linear programming, respectively, have been applied.

For the ***evaluation of collective actions***, which have been developed in the two Czech CSRs CZ-1 and CZ-2, fully participatory and qualitative evaluation approaches have been used: Both studies apply a fuzzy cognitive mapping approach, which is amended by an impact assessment (MAPP) in order to estimate the effects of different future scenarios on the effectiveness of the collective actions. In the case of CZ-1, also the fulfilment of the Ostrom's principles for collective actions have been tested.

3.1.2 Evaluation results

3.1.2.1 Evaluation of improved financial incentives for public good provision

The studies on the ***optimal design of improved financial incentives*** (EE-1, ES-1, FI-1) reveal, that particular better targeting of the schemes represents a clear improvement. The results of the PAM applied in ES-1 shows that better targeting relates not only to the management restrictions and the related level of public good provision (biodiversity) which, under the condition of subsidising the respective agri-environmental practices, optimises social welfare. Better targeting also relates to the better identification of the agricultural target group, which is accessible to the schemes' adoption. From the results of the ES-1 study it becomes obvious, that AES schemes should be designed specifically for the groups of farms, whose cost of adoption are lower than the social benefit from PG provision. It can be seen that providing relatively uncomplicated agri-environmental contracts for this group of farms can lower transaction costs and have positive effects on PG provision and benefits for society. Nevertheless, the study also shows that even if targeting the schemes to the most accessible group of farms, in terms of the ratio between money spent for the subsidies and welfare gains, they are not very efficient. Mainly this is due to the fact that a huge part of the agri-environmental payments is still converted into an increase in farms' private profit rather than covering the costs incurred to improve biodiversity. Also it is shown that already light changes in the marginal costs of public funds have strong impacts on the effectiveness of the scheme. Also in FI-1, better targeting goes beyond the underlying management measures to improve public good provision (scenery and recreation). The results of the multi-criteria analysis shows that particularly such PES schemes are preferred and assumed to be most effective, which better target the users of the public goods. In the case of FI-1, the best option turns out to be a PES scheme, where obligatory payments of tourists compensate income losses, which are experienced by the forestry sector due to management restrictions. Such direct payments from users to providers are moreover considered to guarantee a good spatial targeting and a good balance of demand and supply, as only in those regions, where demand for scenery and recreation expresses in touristic activities, supply is subsidised. Nevertheless, the results of the study also reveal, that under the premise of different criteria of good governance, and also from the point of view of different sectors (forestry, tourism, public administration) different schemes are preferable. While e.g. for the criteria of spatial targeting the obligatory payments appear best suited, for the criteria of administrative easiness PES schemes between tourism companies and the forestry sector appear more applicable. The importance of spatial targeting as the basis for functioning, incentivised management restrictions is also shown in the Estonian study EE-1. Here, the spatial analysis reveals that management restriction targeted to public good provision are needed in only 25% of the target area, where provision is meeting societal demand. The results show that management agreements for private forest owners and financial relief schemes for public forests are effective to prevent clear cutting in these target areas.

The studies on the ***effectiveness of collective incentives*** (IT-2, IT-3) show that the success of such schemes depends on the public goods considered and the way they are provided. The Italian study on biodiversity/pollination services (IT-3) shows that any kind of financial incentive (AES or agglomeration bonus) increases the share of land dedicated to the provision of the public good. However, under the condition of the highest payment levels in both schemes, the collective incentives in form of the agglomeration bonus is more effective as regards attracting farms to participate and finally dedicating a clearly higher amount of area to PG provision than under a classical area payment. For the study on collective reservoirs for improved water availability (IT-2), it can be seen that here a classical financial incentive (linear subsidy) is more cost-effective than a collective scheme, as long as spillover effects are considered in the amount of payment and the administrative transaction costs are neglected. Nevertheless the advantage of a collective policy scheme could be lower transaction costs, which should be investigated for a final recommendation.

The results of the studies dealing with questions of ***optimized land allocation*** (IT-1, NL-1) particularly reveal the question of trade-offs. In the Italian case (IT-1), taking into account public good provision into land allocation optimisation always enhances total welfare, while the private profits of the farmers decrease. The evaluation study shows that for reaching the social optimum of PG provision, a focus would be on the highly valuated PG of carbon sequestration. This focus would imply that a huge amount of land would be allocated to forest, which would lead to decreases in agricultural land and therefore decrease rural vitality. As soon as a RDP comes to place, aimed at preventing land abandonment and therefore increasing rural vitality, and preventing soil erosion, the land allocated to carbon sequestration decreases. In this case, the utility and the total social welfare decreases. The results of the study also reveal that – in case a RDP is still wanted – such a program is only effective if it covers the costs of land transition, which are a major hurdle for turning abandoned land into agricultural land again. In this context the study also shows that prices for agricultural products have strong effects on land abandonment. While low prices clearly lead to land abandonment, for the other direction, namely the effects of high prices and the expectable change of abandoned land into agricultural land, the hurdle of transition costs is too high to have a similar effect. In the case of NL-1, the results of the land optimisation model show that considering different PG targets in one mechanism and optimizing land use under the consideration of trade-off targets, the optimised land allocation for the provision of the bundle of PGs not only induces smaller losses in area for agricultural production, but also boost environmental objectives. Nevertheless, the optimisation results show that under the condition of an optimised mix of agricultural management strategies, the level of individual PG provision is reduced, while simultaneously also the trade-offs between PG provision and agricultural production are reduced.

The study on the **decentralisation of financial incentives** conducted in the French CSR (FR-1) shows that for the case of the wetlands in the Odet watershed partial decentralisation is to be preferred against fully centralised governance schemes. The study specifically reveals the importance at which level benefits of public good provision are felt: For the case of wetland abandonment, where local public good values are high and heterogeneous, decentralisation is reasonable as the demand for the PGs from wetlands is better known on local level. Insofar, decentralisation can set incentives far more targeted. However, the results also reveal that the sum of area which is maintained under a decentralised scheme in the end might be lower than under a centralised governance, as only the most valued areas are maintained under decentralised policy.

3.1.2.2 Evaluation of mechanism mixes for public good provision

All 5 studies dealing with the ***evaluation of mechanisms mixes*** (UK-1, AT-1, DE-1, BG-1, RP-1) come to the conclusion that mixes of mechanisms not only enhance public good provision, but also stabilise the system of PG provision. The results of the studies show that the financial instruments (monetary incentives) are a keystone in all mixes of mechanisms: The results of the FCM approach in AT-1, make clear that the two monetary incentives (collective bonus and private performance oriented incentives) are taking a central role in the system; however the supporting mechanisms (collaboration, marketing, labelling awareness-building) stabilise the system and enhance the participation in the financial incentive schemes. The same results become evident in the German case (DE-1) where the AES remains the most important instrument in the mix, which however is only accepted under the condition of the supporting instruments of collaboration and value chain opportunities. Also the results of the FCM applied for the case of UK-1 reveal that in a mix of mechanism only for very specific PGs, such as biodiversity, specific mechanisms are decisive, while for the provision of a bundle of different public goods only the whole mix represents a stable governance system. In RO-1, the evaluation study shows that the implementation of a mechanism mix – combining AES and information-education - can solve the problem of conservation and improved provision of public goods. Also here, the financial incentive in the mix, taking the form of an agri-environmental schemes, has a direct and noticeable impact on the real benefits obtained by the farmers and is therefore a key element. However, for the adoption of PG friendly management the supporting instrument of education and information turns out to be essential. In BG-1, the results of the study shows that only under the condition of a combination of different financial incentives where subsidies are set to the maximum is able to balance the supply and demand for public goods in the CSR.

3.1.2.3 Evaluation of collective actions for public good provision

The studies on the effectiveness of ***collective actions*** (CZ-1, CZ-2) unfold the high potential of such approaches, but also the difficulties and obstacles in the organisation and implementation. For the case of water availability (CZ-1), the results of the qualitative assessment shows that to overcome a lack of coordination in water management, the local action group of LEADER can be a platform for a water retention self-governing action. The study indicates, that major obstacles for collective actions is the question of 'measures for public goods on private lands'. In the CZ-1 case, this obstacle represents the development of technical measures (building of ponds) on private lands. To overcome such obstacles, societal goals beyond the PG of "water retention" need to be integrated into the technical measures (e.g. ponds also for fishery). Also the fair distribution of costs in collective actions is crucial, while especially this precondition for commitment has been addressed with a lot of scepticism in the CZ-1 study. The study makes clear that the effectiveness of the collective action fully depends on the commitment of the members. If this commitment is not given, public coordination is to be preferred over collective action approaches. For the case of CZ-2, the results of the evaluation study show that a broader integration of stakeholders into the "elite" and narrow management structure of the local Geopark is likely to provide an increase of overall benefits. As regards funding opportunities the study shows that institutional funding is to be preferred if the focus is on safeguarding the maintenance of the activities, while other funding opportunities such as branded fundraising appears lower and less effective. However, the results of the study reveal, that branded fundraising can enhance the "reconnection" between the elite management and the broader stakeholder community.

3.1.3 Main drivers for the effectiveness of mechanisms

Across many of the evaluation studies, a major driver for the effectiveness of the proposed mechanisms turned out to be the farmers and the types of farms which are addressed by the mechanisms. In the Austrian study AT-1, besides the central role of the financial incentives in the system, the farmers' motivation to change management for the sake of better public good provision was a key element in the system. The same result was revealed by the Romanian study, where the farmers' orientation towards public goods, as a result of the level of education, is decisive for the management decisions. The Romanian study also showed that the effects of the implementation of mechanisms differ drastically for different farm types: small farms experience smaller losses by changing their management toward PG provision.

Moreover, these farms manage some amount of area in a PG friendly way, even in the absence of agri-environmental payments. In contrast, medium and large farms experience strong and severe losses when changing their management, and – under the condition of AES for extensive management – might need to intensify management on other area to compensate forage losses. Also in ES-1, the differentiation of farm types turned out to be essential for the success of the agri-environmental schemes for public good provision. Here it became obvious that common schemes across all farm types are not efficient, as they will not be accepted by farmers with high WTA and overcompensate farmers with low WTA and as they will lead to losses of social welfare. Therefore, as already mentioned above, AES schemes should be designed specifically for the groups of farms, whose cost of adoption are lower than the social benefit from PG provision. The studies IT-2 and IT-3 support this results. For the case of the agglomeration bonus to enhance pollination services (IT-3), it becomes obvious, that only larger farms are willing to collaborate, while the willingness to enter the schemes in not given for small farms. For the case of collective water reservoirs (IT-2), the results show that the necessary payments for the compensation of farms with a wider water production function in an open access scheme are clearly lower than for farms with a narrow production function.

The results of the described evaluation studies on the impacts of farmers and farm type on the effectiveness of mechanisms for improved public good provision make clear, that targeting to the land managers turns out to be one of the most important criteria for the design of successful mechanisms.

4 The studies at a glance

4.1 Evaluation of improved financial incentives for public good provision

4.1.1 Optimal design of improved financial incentives

EE-1: Scenery and recreation in forest landscapes in Harju County, in Northern Estonia – Evaluating agreements between private forest owners and local government and financial relief scheme for the state-owned forest management

The study uses a quantitative mixed method approach, combining a spatial analysis for defining the target area and a mathematical model for the assessment of the effects of management agreements and financial relief schemes for the improvement of forest management in private and public forest, to the aim of better provision of the PG scenery and recreation. The financial incentives are related to specific cutting restriction. The target area for the financial incentive schemes comprises private and state forest stand compartments in towns, densely populated areas and within a 100-meter-wide surrounding buffer zone. The analysis differentiates 4 forest types of decreasing timber values, differentiated by age and species composition. The targeted forest types are mature forests, now and during the next 20 years. 2 compensation classes are assessed for the 2 most valuable forest types. The analysis considers 3 scenarios of business as usual, sustainability driven and market driven development, mainly differing by the share and dynamics of scheme coverage of private forest and state forests, as well as the payment levels of the schemes.

The results reveal that only 26% of the total area is covered by the most valuable forest types as regards PG provision and should therefore be target of the schemes. The results also demonstrate that the governance strategy can improve the provision of the PG of good-quality forest scenery and recreation opportunities in the target area. For the scenarios, it becomes obvious that the scheme is most effective under the condition of sustainable development, as more private forest owners are attracted to the scheme. However, the stronger need for renewable resources and the increase of timber prices can also lower the efficiency due to higher compensation costs. In case of market driven development, the efficiency of strategy is the lowest. However, reaching PG provision improvement on 30% of the targeted forest compartments is still high enough for justifying implementation of the strategy.

ES-1: Biodiversity in the Andalusian mountain olive groves in Spain – Evaluation of improved agri-environmental schemes

The study uses a principal-agent modelling approach in order to optimize the design of an AES specifically targeted to the improvement of biodiversity. The study considers 6 AES scenarios, which are differentiated by the level of stringency of the management requirements (% area under cover crops, cover crop management, and insecticide-treatment) and the related outcome in terms of biodiversity (indicated by the number of bird species/10ha). The study considers 2 classes of mountain olive farmers, differentiated by their costs of providing biodiversity (costs are derived from the WP4 Willingness to accept (WTA) study, 60% of farmers represent class 1 with low WTA=lower costs, 40% represent class 2 with high WTA=high costs). Also, it incorporates willingness to pay (WTP) estimates from the previous demand-side valuation carried out within WP4. Eventually, 3 locally adapted scenarios were analysed, including business as usual, market driven and sustainability driven development.

The results show that costs to increase biodiversity provision for class 2 farms are so high, that they exceed the associated social benefit for any level of PG improvement. Therefore, class 2 farms will not response to any of the proposed AES, which clearly limits the instrument's potential to improve social welfare. As regards optimal AES design, the result suggests to design a simple AES contract particularly for class 1 farmers, which are likely to respond as their compliance costs are lower than the social benefit from PG improvement. This reduces transaction costs of the scheme for both the public administration and the farmers. The results also reveal that the implementation of this scheme will enhance PG provision, the related benefit for society and also – to some extent- the overall welfare. Nevertheless, the ratio between overall welfare gains and budget spent is limited. The results of the sensitivity analysis show, that only light changes in the marginal costs of public funds have strong impacts on the effectiveness of the scheme. Here, the results highlight the importance of the efficiency of the funding system in the optimization of public policies that require budgetary resources, such as AES. The results also show, that only a small part of the agri-environment payments goes towards compensating farmers for the extra costs incurred as a result of implementing the AES; most of the payment is converted to farmers' private profit. As regards scenarios, under the conditions of business as usual and sustainable development, the efficiency in AES implementation would increase. In contrast, under the conditions of the market driven scenario the implementation of the AES proposed is clearly weakened.

FI-1: Scenery and recreation in forest landscapes in Ruka-Kuusamo in North-Eastern Finland – Evaluating the PES-scheme "Landscape and Recreational Values Trading" (LRVT)

The study uses a multi-criteria analysis in order to assess how different stakeholders value alternative versions of a specific Payment for Ecosystem Services (PES)-schemes for the improvement of forest management to the aim of better provision of the public good scenery and recreation. The study comparatively assessed four alternative versions of the PES scheme, differentiated by voluntariness of participation and payments (for consumers=tourists), and the coverage of area by the scheme. The evaluation followed five main criteria, namely cost-efficiency of allocation, easiness and transaction costs of the scheme, avoidance of leakage of funds, acceptance, and sufficiency of the funding base. Cost-efficiency of allocation was differentiated into two sub-criteria, namely efficiency as regards spatial targeting to the most important sites for tourism and efficiency of money spent as regards area improved (maximizing spatial size of the area). The analysis included three locally adapted scenarios, namely business as usual, environmentally oriented winter tourism and increased international summer tourism, and the related changes in demands for landscape quality and recreation environments by tourists and the tourism entrepreneurs.

The results of the study show for the scenarios that tourism and the public sector experts anticipated changes in the development of tourism in the region compared to a business as usual situation. In contrast, forestry expert assessed the business as usual scenario to be most likely, but the differences between scenarios are rather small. For the evaluation criteria, cost-efficiency and acceptability of the schemes were rated most important by forestry and tourism experts, while the public sector experts rated cost-efficiency and funding base most critical for successful system. The results for the mechanisms show that the PES alternative with obligatory fees to be payed by the tourists ranked highest in all scenarios. However, the differences between the alternatives were small and different alternatives were ranked most suitable against different criteria. E.g., the already mentioned "obligatory" PES was evaluated highest against the criteria of spatial targeting, while against the criteria of administrative easiness a scheme where tourism companies by themselves organize the collection of money, as well as the contracts with foresters, was prioritized. Furthermore, the results on mechanisms show, that the obligatory PES was prioritized by both the experts from tourism and forestry. Only the experts from the public sector would prefer the also already mentioned "company-based" scheme.

4.1.2 Effectiveness of collective incentives

IT-2: Water availability in the hilly and mountain area of the Ravenna province in Italy – Evaluation of policy interventions to foster collective reservoirs

The study uses a mathematical equilibrium model to assess the effects of financial support for the construction of collective (rainwater harvesting) irrigation reservoirs. The reservoirs are built to reduce the pressure on groundwater and surface water resources. Two types of policy interventions are considered, namely a classical linear subsidy (e.g. in form of an AES), and a "collective" subsidy, which is linked to a certain member size of the collective reservoir (inspired by existing RDP in Emilia-Romagna). Particularly, the study aims at investigating which policy is suited best to reach a desired level of reservoir size under the condition of two types of access/memberships, namely an open access/membership (members can't exclude non-members to enter the reservoir) or closed access/membership (members can exclude non-members to enter). The analysis considers two types of farms, differentiated by the value of their water profitability function (profit is assumed to be a function of water), their size and their crop rotation. Moreover the study includes 4 scenarios, differentiated by the composition of the homogenous farm population.

The results show that, under the condition of open membership, a desired club size can be generally reached by a linear subsidy (e.g. AES), as long as this payment considers the spill-over effects to non-members (as the payment does not only affect the profit of the club members but also the profit of non-club member due to the spill over effects). Under the condition of closed membership, the only option to reach a desired club size is a collective policy scheme, which links a subsidy to a certain size of the club and covers the higher (transaction) costs of the increased size.

The analysis suggests how the open access case seems to be more cost effective than a closed access one. However, here we do not take into account the administrative transaction costs. If we interpret the open access case as a sort of open list, relatively more effort from the administration is required than in the case of closed access, where farmers are fully in charge of the management of the group formation.

IT-3: Biodiversity/Pollination in the hilly and mountain area of the Ravenna province in Italy – agglomeration bonus vs. traditional AES

The study uses a land allocation model within a game theoretic framework, assessing the effects of an agglomeration bonus in comparison to a “classical” AES on the provision of the public good of “pollination”. Pollination services are assumed to be strongest on uncultivated land. Therefore the allocation of 3 types of land use, namely uncultivated land, permanent crops and arable land are modelled under the condition of an implementation of the 2 types of instruments. The perspective is short-term, therefore changes of land use can happen only between arable land and non-cultivated land. The assessment includes two types of farms, with different size classes, 3 types of farmer community compositions (50/50 small and big, 100 big, 100 small), two policy schemes (AES, agglomeration bonus), and 6 payment levels (0, 100, … 500€)

The results show, that any payment increases the land allocated to public goods. However, with increasing payment levels, for AES the size of the coalition remains the same. In contrast, under the conditions of the agglomeration bonus, the size of the coalition increases. Under the condition of the highest payment levels, in an agglomeration bonus scheme the whole farmers’ community takes part. It is to note that big farms enter earlier, also under the condition of lower payments.

The results show that while cooperation on the management of an ecosystem service would be an efficient choice that is however constrained by the classic free-riding issue. Properly designed mechanisms, in this context, not only increase the rate of land allocated to conservation, but also stabilize larger coalitions that would not emerge otherwise. Under the conditions assumed in the model (biodiversity provide an ecosystem service, no transaction costs, etc etc), targeting coalitions with dedicated AES seem to be more effective than the traditional individual based AES. Further studies should account for transaction costs, spatially explicit issues and different ecosystem services.

4.1.3 Optimised land allocation

IT-1: Soil erosion, rural vitality and carbon sequestration in the hilly and mountain area of the Bologna province in Italy – Evaluation of existing RDP

The study uses a land allocation mathematical programming model in order to assess the effects of an existing rural development program (RDP), providing a payment for farms located in mountain areas, on the three public goods soil erosion, rural vitality, and carbon sequestration. The model considers the land use types grape, fruit, arable, forestry, and grassland, as well as abandoned land and forest area. The analysis considers 2 types of scenarios: one is determined by different levels of prices, the other is determined by different combinations of the 3 PGs taken into account in the optimization of social welfare. Moreover, the model assumes transition costs from one land use to the other, where particularly major land use changes, namely the transition from abandoned and forest land are "expensive".

The results show, that without any policy but under the consideration of the 3 public goods in creating social welfare, land use would shift from agricultural production to an increase of forested area and a decrease of agricultural area, as in forest area the public goods of carbon sequestration is provided. In the scenario of the social optimum, where all 3 PGs are provided, a major shift towards forest area becomes obvious, while abandoned land decreases strongly and also arable land decreases to a large extent. Under the condition of the RDP, private profits of farmers take a larger part in the total social welfare. This results in changes of land use, which lead to an increase of rural vitality and a slight enhancement of the PG soil erosion, but a clear decrease in carbon sequestration. In sum, the decrease of carbon sequestration is so strong that it cannot be balanced by the enhancement of soil erosion and rural vitality, so utility and total social welfare decreases by the introduction of the RDP.

The sensitivity analysis shows that the RDP only becomes effective when the land transition costs are covered by the payment level. Moreover, the sensitivity analysis on prices shows, that reductions in agricultural prices clearly increase land abandonment, while increases in price decrease land abandonment to a lower rate than the other direction.

NL-1: Habitat, biodiversity, aesthetic quality and agricultural production in the "Kromme Rijn" area, the Netherlands – Landscape function optimisation

NL-1: The study uses a landscape optimization model (multi-objective optimization algorithm), in order to evaluate the effects of an optimized nature management plan on agricultural production, as well as on the provision of a bundle of landscape functions. The aim is to optimize the landscape configuration of different agri-environment measures for a set of environmental objectives. The model includes 4 objectives, namely orchard production, aesthetic value, habitat suitability for a key species, and loss in pasture production (dairy cows) incited by the restoration of natural habitats. 3 types of management options are assessed, namely on-farm (management change/restoration of linear elements), off-farm (pastures taken out of production), and on/off-farm management options combined.

The optimization analysis shows that the implementation of all agri-environment measures has a positive impact on all three environmental objectives together. However, the improvement of each objective differed depending on the choice for on-farm or off-farm measures. Choosing only one of the measures e.g. induces a notable trade-off between orchard production and habitat function. This trade-off can be largely prevented when all measures are combined. Yet, when doing so, the maximum values for both objectives turn out lower in comparison to the individual management strategies. Given that none of the agri-environment experiments is better than the others, the ultimate trade-off chosen depends fully on the preferences of stakeholders and/or landscape planners.

The results show that when adding additional PG targets into the management plan and optimizing land use under the consideration of trade-off targets, the areas addressed in the original plan clearly differ from those proposed by the optimised management plan. The results show that a land allocation different from the one envisioned in the nature plan would not only induce a smaller loss in pasture production, but also boost the other three environmental objectives. This means that a combination of on-farm and off-farm measures compared to the nature plan has the double advantage of limiting the loss of pasture production and increasing the habitat for the target species, while also orchard production and landscape aesthetics can be stimulated.

4.1.4 Decentralisation of policy (financial incentives)

FR-1: Water purification, habitat, flood prevention and climate stability in the Odet Watershed in Brittany in France – Evaluation of a decentralisation of governance for AES & PES schemes

The study uses a mathematical modelling approach in order to assess the optimal level of decentralization of financial incentives, such as payments for ecosystem services, on the provision of a bundle of public goods from agricultural wetlands (water purification, habitat function and flood prevention, carbon sequestration), under the condition of the risk of land use abandonment. The modelled instrument is an area payment designed under the existing agri-environmental budget constraint. The model compares welfare from an economy in three situations of governance decentralization, namely the case where the central government is in charge of the design of agri-environmental schemes, the case where the local government (e.g. a region or a city) is in charge of the design of agri-environmental schemes and the case where both governments participate to the design of complementary agri-environmental schemes. For each case, the amount of managed wetland, the level of subsidies, the utilities and the welfare of the economy are compared. The analysis includes 3 scenarios, namely business as usual, changes in societal preferences for environmental public goods and the restructuring of farms. The scenarios differentiate in the levels of opportunity costs to maintain wetlands, the expression of public good demand, and the levels of benefits of local and global public goods.

The results show that the landscape resulting from either total or partial decentralization always improve the welfare compared to the centralized government. Even if the total of abandoned wetlands increases with decentralization, the managed wetlands are the most valuable ones, i.e. the closest ones to the consumers of their benefits. It results also to heterogeneous subsidies inside the watershed, the heterogeneity of the payments increasing with the degree of decentralization. Partial decentralization leads to welfare gains of 5.6% (in case of no additional transaction costs and BAU scenario). Without any additional transaction costs, about 25% of the budget should go to the regional government. However, this share decreases quickly as transaction cost rate increases. Considered as robustness checks, scenario 2 and 3 confirm these figures.

4.2 Evaluation of mechanisms mixes

UK-1: Water quality and biodiversity in the "Ugie river" catchment in Scotland -Evaluation of a governance mix consisting of collective bonus, sales guarantee and performance oriented payment by private sector, local collective partnership, marketing & labelling, awareness building

The study uses a participatory fuzzy cognitive mapping (FCM) approach, in order to analyse the interplay of a mix of mechanisms and other influencing factors on the provision of the public goods *water quality* and *biodiversity*. In the study, 2 individual mechanisms mixes have been analysed for the 2 public goods. In sum, 4 FCM models have been developed: for each of the 2 PGs, 1 FCM map has been developed by scientific experts, 1 by stakeholders. Both maps consist of different mechanisms, different public goods, different influencing factors, as well as the relationships between these elements. The relationships in the maps are not only defined, but also weighted. The benefit of FCM is its ability to model the effects of changes in the "strengths" of mechanisms, as well as the influence of scenarios on the whole systems of mechanisms/public goods/influencing factors. The analysis includes 3 locally adapted scenarios of business as usual, market driven and sustainability driven development.

The results show, that as long as the mix of mechanisms is part of the system, no large changes occur if the impact of the mechanisms is strengthened or set to the maximum. In contrast, if mechanisms are clearly weakened or taken out of the system, the changes in the system are big. Main effects become obvious in relation to agricultural practices, which are the precondition to public good provision. As regards the impacts of individual mechanisms in the mechanisms mixes, only in some cases PG provision is driven by a single mechanism in the mix (e.g 2nd Pillar for biodiversity in the stakeholder model). Normally, effects are related to the whole mix of mechanisms. Particularly if a bundle of PGs is considered, the mix of mechanism is the most stable way to safeguard their provision.

As regards scenarios, the market scenario in the water quality model resulted in less PG provision, which was even worse when the mechanisms were weakened. The market scenario in the biodiversity model also resulted in less PG provision, while here, setting the mechanisms at a maximum level at least the negative effects on some public goods could be prevented. The results present insights into the experiences and perceptions of stakeholders, rather than quantitative predictions of outcomes. The models of both the local stakeholders and the experts reflect that changes in the levels of public goods are mediated through changes in practices, so changes in policy have rather indirect effects on PG provision.

AT-1: Soil functionality, landscape quality and water quality in the intensive arable region "Marchfeld" in East Austria - Evaluation of a governance mix

The study uses a participatory fuzzy cognitive mapping (FCM) approach, in order to analyse the interplay of a mix of mechanisms and other influencing factors on the provision of the public goods *soil fertility*, *water quality* and *landscape quality* particularly looking at the landscape's potential to support the provision of *biodiversity and habitats*. In the study, a mix of financial incentives, a collaborative partnership, measures of labelling and marketing as well as campaigns for fostering societal awareness towards public goods has been analysed. The FCM focus on the different public goods, the awareness of rural actors towards these goods, different factors for the adoption of environment-friendly practices as well as different mechanisms and other external factors impacting on the network. The FCM is composed by the network of relationships between these elements and the relative weight of the relationships. The benefit of FCM is its ability to represent the effects of changes on the mechanisms, and simulate the influence of scenarios on the whole systems of mechanisms/public goods/influencing factors. The analysis includes 3 locally adapted scenarios of business as usual, market driven and sustainability driven development.

The results of the study show that improved private or public, collective or performance-oriented monetary incentives are central tools for addressing the environmental impacts of agriculture. Monetary incentives are considered the keystone as they feature a number of connections in the system between mechanisms and public good provision. But also ancillary factors, like enhanced collaboration between farmers or enhanced awareness building are important parts of an effective agri-environmental governance system. The dynamic simulation of the FCM evidences that aspects related to farmers´ attitude, social context, and monetary motivation are a central issue in the context of public goods provision from agricultural landscapes. Indeed, differences in the effectiveness of the monetary governance instruments under the three scenarios become obvious: Different futures (scenarios) have major effects on the effectiveness of mechanisms: e.g. in a purely market-driven context, incentives are less efficient and tools based on collaborations between farmers are likely not effective. The results reveal that discussion around governance should focus on a range of tools including monetary incentives together with supporting factors able to catalyst “soft” aspects such as awareness and social pressure.

DE-1: Climate stability, water quantity and biodiversity in peatland areas in Brandenburg in Germany – Evaluation of a governance mix of agri-environmental schemes, farm Coordination opportunities & value chain opportunities through market innovations.

The study uses a mixed method approach, consisting of a discrete choice experiment, scenario and impact assessment, and a literature study. The study assesses the effectiveness of a mix of governance mechanisms consisting of agri-environmental measure (AES) targeted at climate friendly peatland management, cooperation among farmers, and value chain opportunities through market innovations on the provision of a bundle of public goods from rewetted peatlands (climate stability, water quantity and biodiversity). The analysis includes 3 locally adapted scenarios of business as usual, market driven and sustainability driven development.

The results show, that the overall willingness to accept the AES under the current contract conditions is clearly higher than the compensation payment offered. With the add-on of support for cooperation and value chain opportunities for the grass cut on rewetted area, the WTA decreases to an extent, which is in the range of the compensation payment of the current AES measure. Under an optimal contract design, combining all three mechanisms, farmers would be willing to participate in the scheme for an average compensation of 385 €/ha*a. Under the conditions of all scenarios, the performance of the mechanisms are regarded as increasing. The largest increase is estimated for the sustainability scenario, while the market driven scenario shows only marginally positive effects for the performance of mechanism. Interestingly, for the BAU scenario, the mechanisms are evaluated negatively, particularly for value chain opportunities.

BG-1: Water quality, food security and scenery and recreation in the Bulgarian South central planning region – Investigating a mechanisms mix of collective action, AES and quality product certification

The study uses a quantitative approach in order to assess the effectiveness of financial incentives (subsidies under the nitrates directive, quality product certification and AES schemes) on the provision of water quality, local food security, and landscape and recreation. The model integrates a modified partial equilibrium model of demand and supply of public goods and is based on the principal component method. Input variables for the principal component method result from a survey on preconditions and effects of PG provision. The model considers specific scenarios for the provision of each PG, considering different levels in yields, specific management requirements and specific compensation schemes including subsid

The results show, that sufficient levels of PG provision for water quality and food security are only achieved, if the subsidies are set to the maximum. E.g. for water quality, the sole payment even of high subsidies under the nitrate directive is insufficient. Only under the precondition of an additional subsidy for LFA, the level of supply equals the level of PG demand. For the PG scenery and recreation, particularly the inclusion of support for investments in improving environmental infrastructure leads to provision levels, which equal or even slightly exceed the demand levels.

The overall conclusion is that the measures to promote supply and align it with the demand level should be applied in a comprehensive manner. Each of them, if applied separately, would not produce the desired result. In addition, the amount of subsidies received should be the maximum allowable amount provided for under the relevant measures. Only in these circumstances a balance between the level of demand and the level of supply of public goods be can reached.

RO-1: Natural landscape quality in the Dorna valley in the Romanian North East region – Evaluating a mix of targeted AES and education/information measures

The study uses a multiple objective linear programming model in order to assess the effects of subsidies for agri-environmental measures on the provision of natural landscape quality and rural vitality. The objective is to find the best practices and levels of machinery use that are both efficient and result in improvements of the public goods. The study considers different scenarios: For environmental practices it simulates different levels of farmers' orientation towards public goods, which are assumed to be a result of improved information/education. Moreover 3 different farm types are considered, namely small, medium and large farms. Also different changes in input and product prices for single farm types (rising prices of inputs for small farms, rising prices of inputs for medium sized farms, decreased prices of agricultural products sold by small farms with low negotiating power) are taken into account.

The results show that changing management towards PG orientation means small losses in economic benefits for small farms, strong losses for medium sized farms and severe losses for large farms, which needs to be compensated by an AES. In relation to the level of knowledge, education and consultancy regarding the importance of providing public goods, all farms (regardless of size) are responsive in changing the structure of their outputs in the direction of increasing the areas of land that is worked manually. The implementation of agri-environmental schemes has a direct and noticeable impact on the real benefits obtained by the farmers. All cases show that, after adopting public good oriented production methods, the immediate financial benefits decrease. The market conditions can influence the performance of the governance mechanisms taken into consideration. The macroeconomic context, as well as the negotiating power of small and medium farms influence the likelihood of adopting a behaviour that leads to the provision of public goods.

For small farms, the propensity to apply traditional practices on their own pastures exists from the beginning. This means that, even in the absence of agri-environmental payments, some amount of area is natural. For medium and large sized farms the behaviour is different, as under the condition of AES land use can also shift to more intensive forms on some area to compensate forage losses.

4.3 Evaluation of collective actions

CZ-1: Water availability in Northern Bohemia in Czech Republic – Evaluation of a collective action based on the local action group (LAG)

The study uses a qualitative mixed method approach in order to assess the effectiveness of an integration of a LEADER LAG into a collective action, which is established to improve water availability. Specifically, the collective action aims at fostering agro-technical practices (operational measures), allowing water to leak deeper in the soil, and technical measures (barriers, polders, ponds). The study reviews 8 conditions after OSTROM, which enable collective action. Also it maps knowledge using fuzzy cognitive mapping and finally carries out an impact assessment, considering 4 scenarios consisting of different governance options (current, collective action based on LAG, incomplete collective), different climate change options (current trend, high variability of weather extremes) and different levels of CAP support (current, reduction by 50%).

The results show that particularly these Ostrom's principles, where internal rules have to be developed and obeyed, are a challenge. A major obstacle is the negotiation of technical measures on private lands for the sake of best common interest. In the case of operational measures, all members need to commit themselves to maintain the technical measures. While correct behaviour will need to be encoded in the internal rules, and the sanctions for not complying need to be formulated consequently, it will be critical that the collective will succeed to create individual responsibilities of members in this respect.

The scenario analysis shows that the LAG based collective action can improve the provision of water availability in a robust way, i.e. it will help to cope with a climate change progress as well as with CAP changes. The experts emphasized that an essential condition for such robustness of the collective mechanism rest in achieving members' commitment for responsible management of water retention. An essential attribute of the proposed LAG based collective action is that the costs of maintaining the water retention facilities are distributed fairly among the members of the LAG. However, the experts are sceptical on this and therefore this attribute actually played a minor role in the effects of scenarios.

CZ-2: Recreation services and biodiversity of forest lands in the National Geopark Ralsko in Northern Bohemia – Fostering broader stakeholder integration

The study uses a mixed method qualitative approach in order to assess the effectiveness of branded fundraising and a broader integration of local stakeholders into an already existing Geopark, to the aim of improved provision of recreation services and biodiversity of forest lands. The study maps knowledge using fuzzy cognitive mapping and carries out an impact assessment, considering 4 scenarios consisting of different funding options (current, current + fundraising, current + institutional subsidies), and different levels of participation (current, open, through LAG). The study uses 7 indicators, which assess the improvements in the proposed mechanisms against the background of the scenarios.

The results of the study illustrate that benefits are likely, if the efforts of the already existing Geopark management are linked with a broader set of stakeholders. Reconnecting the "elite based" management of the Geopark with people and small and medium size businesses amends the original organization with an essence of community based organization (while maintain its operability). It also becomes apparent that adding other ways of funding improves financial stability of the Geopark for its development and maintenance: Institutional funding provides secure finances and will enable broadening activities. Obtaining financial resources by branded fundraising might be slow and the expected funds small, nevertheless the need to approach donors might go hand by hand with the “reconnection” effort.

5 Concluding remarks

Deliverable D5.2 of the EU H2020 project PROVIDE reports on the process of designing appropriate governance strategies and mechanisms, and on the comparative evaluation of the potential success, and/or the potential trade-offs of the most promising governance strategies for improved public good provision at the level of 15 European case studies.

From the results on mechanism design shown in this deliverable, it becomes obvious that specific public good issues in the specific context of different case study regions require individual solutions, which are not implicitly public-good specific: in different agricultural or forestry context situations, for the same public good issue different governance strategies can be suited. Nevertheless, the results also show that specific types of mechanisms are particularly suited for specific characterisations of the public good issue: In the case of the requirement for the improvement of single public goods, mostly financial, stand-alone mechanisms appear to be the measure of choice, while bundles of public goods are suggested to be improved best by bundles of mechanisms, going beyond financial subsidies and commonly including collaborative or collective approaches, education/information, market instruments or measures for awareness-building. As regards collaborative/collective mechanisms, moreover these turn out to be particularly suited for the improvement of public goods whose provision depends on the regional landscape rather than on the management of single fields or farms, and therefore require the coordination of efforts among the individual decision makers. Also, such collective approaches are suggested in intensive agricultural production systems, where financial incentives alone can't attract farmers' motivation to participate.

From the evaluation studies dealing with financial incentives, it becomes obvious that particular better targeting of improved financial incentives represents a clear improvement. Better targeting relates not only to the management restrictions and the related level of public good provision, but also to a better identification of the target area, the agricultural/forestry target groups and the users/beneficiaries of public good provision. For collective incentives, the results reveal that success strongly depends on the public goods considered and the way they are provided, as well as the transaction costs accompanying such approaches in comparison to linear area payments. From the evaluation on mechanisms mixes, it can be seen that such mixes not only enhance public good provision, but also stabilise the system of

PG provision. While also here financial incentives represent keystones in the governance strategies, it becomes evident that the adoption of PG-friendly management strongly depends on supporting instruments, such as collaboration between stakeholder, market driven instruments, education and information and awareness-building turns out to be essential. From the evaluation studies on collective actions, it becomes clear that such approaches are strongly dependent on the commitment of the partners united under the approach and therefore only recommendable, if compliance to the fundamental principles of collaboration are guaranteed.

Overall, D5.2 reveals the individualism of public good issues in different agricultural and forestry context situations and the related need for the design of individual and targeted solutions. The individualism of governance strategies and the high demands, particular in respect to targeting, represent major challenges for statement on the practicability and transferability of the instruments at programming and EU level, as well as the formulation of practical implementation recommendations for single strategies. These aspects will be addressed in Deliverable 5.3 (Roberts et al., forthcoming)[10], where particularly strengths, weaknesses, enabling factors and barriers for uptake, as well as issues of transferability of mechanisms will be discussed, and in Deliverable 5.4 (Schaller et al., forthcoming)[11], where the lessons learned from the mechanisms' evaluation will be used to produce policy and mechanisms recommendations.

[10] Roberts et al., (forthcoming) *Report on practicability and transferability (Deliverable 5.3)* (PROVIDE Project (No. 633838): Brussels, 2018).

[11] Schaller et al., (forthcoming) *Guidelines for the choice and evaluation of mechanisms to boost the production of public goods by agriculture and forestry (Deliverable 5.4)* (PROVIDE Project (No. 633838): Brussels, 2018).

Contract no. **633838**

PROVIDE

PROVIding smart DElivery of public goods by EU agriculture and forestry

Call identifier: H2020-ISIB-2014-2; Topic: ISIB-01-2014

Funding scheme: Research and Innovation Action (RIA)

Deliverable D5.2

Report on comparative evaluation results

ANNEX 1: CSR-SPECIFIC EVALUATION OF GOVERNANCE MECHANISMS

Organisation name of lead beneficiary for this deliverable:

University of Natural Resources and Life Sciences – BOKU

01.06.2018

Dissemination Level		
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)	

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Contents

Introduction

This document represents **ANNEX 1** of the deliverable D5.2 “*Report on comparative evaluation results*” within Workpackage WP5 “*Formulating and evaluating governance mechanisms for delivery of public goods*” of the EU Horizon 2020 project PROVIDE (PROVIding smart DElivery of public goods by EU agriculture and forestry).

While the main body of deliverable D5.2 “*Report on comparative evaluation results*” summarises and synthesizes the findings of Task 5.3 “*Practical, case study based evaluation of governance strategies*”, **ANNEX 1** of the deliverable D5.2 represents the individual evaluation studies and the individual case studies’ findings in sub-task *5.3.2: “Evaluation of potential effects on public good provision”*

Evaluation of governance mechanisms for public good provision

*

15 case studies from the EU H2020 Project PROVIDE

6 Intensive agricultural land use systems

CSR	Topic	Model	Authors
AT-1	Soil functionality, landscape quality and water quality in the intensive arable region "Marchfeld" in East Austria - Evaluation of a governance mix consisting of collective bonus, sales guarantee and performance oriented payment by private sector, local collective partnership, marketing & labelling, awareness building	Fuzzy cognitive mapping	S. Targetti L. Schaller J. Kantelhardt
IT-2	Water availability in the hilly and mountain area of the Ravenna province in Italy – Evaluation of policy interventions to foster collective reservoirs	Mathematical model	M. Zavalloni R. D'Alberto M. Raggi D. Viaggi
IT-3	Biodiversity/Pollination in the hilly and mountain area of the Ravenna province in Italy – agglomeration bonus vs. traditional AES	land allocation model within a game theoretic framework	M. Zavalloni R. D'Alberto M. Raggi D. Viaggi
UK-1	Water quality and biodiversity in the "Ugie river" catchment in Scottland - Evaluation of a governance mix consisting of collective bonus, sales guarantee and performance oriented payment by private sector, local collective partnership, marketing & labelling, awareness building	Fuzzy cognitive mapping	A. Byg, M. Faccioli C. Kyle M. Roberts
DE-1	Climate stability, water quantity and biodiversity in peatland areas in Brandenburg in Germany – Evaluation of a governance mix of agri-environmental schemes, farm Coordination opportunities & value chain opportunities through market innovations.	Discrete Choice modelling	K. Häfner I. Zasada A. Piorr F. Nanett Trau
NL-1	Habitat, biodiversity, aesthetic quality and agricultural production in the "Kromme Rijn" area, the Netherlands – Landscape function optimisation	Optimization model	F. Komossa, W.Verhagen, E. v.d. Zanden P. Verburg

6.1 AT-1: Soil functionality, landscape quality and water quality in the intensive arable region "Marchfeld" in East Austria

6.1.1 Introduction

6.1.1.1 Description of case study region

The case study region (CSR) "Marchfeld" is an agricultural area located in Austria between Vienna and Bratislava. The area is part of the sedimentary basin between the Eastern Alps and the Carpathian Mountains and is characterized by semi-arid climate, with hot, dry summers and cold winters. The region is distinctively flat. The soils in the CSR are mainly deep and fertile chernozems, characterized by rather dry conditions. Precipitation in the area is low and reaches between 500 and 600 mm/a.

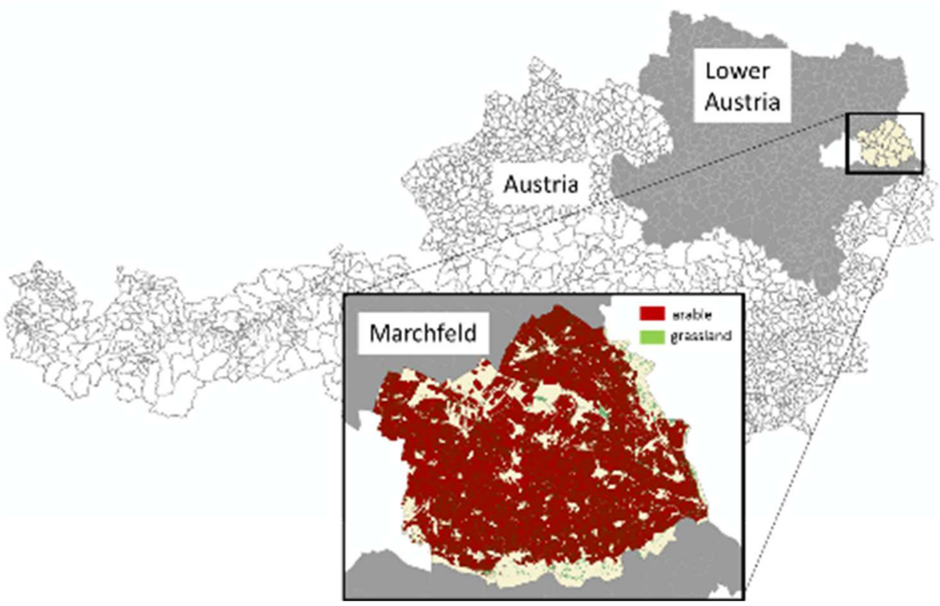


Figure 1. location of the Austrian PROVIDE CSR Marchfels

The CSR includes 23 municipalities covering 70.800 ha. The average population density is 97 persons/km², but density strongly varies in the single municipalities and reaches from 15 to 881 persons/km². Since about 10 to 15 years, the region is experiencing a strong population growth, caused by in-migration.

Agricultural management is carried out on around 50.800 ha UAA. 98% of UAA is used as arable land, and 95% of the farms are cash crop farms. The good soil quality in combination with the irrigation facility of the Marchfeld channel leads to an agricultural system characterized by intensive arable production (around 25% of agricultural area in the region is managed under irrigation). To notice that 12% of farms are currently organic with around 2% increase each year.

The Marchfeld is framed by two major capitals, Vienna and Bratislava. This leads to a multitude of sensitivities and claims affecting the regions, such as urban outmigration, growing recreation demands and land-use competition, space requirements for infrastructural planning (e.g. Roads, Highways, flood protection, etc.) and regional food supply.

6.1.1.2 Description of public good issue

One major public good issue for the regional stakeholders and experts in the Marchfeld is the functionality of the agricultural soils. Particularly due to intensive agricultural management, but also due to the climatic conditions in the Marchfeld, soil fertility and soil health are assumed to be endangered and jeopardize the future of agricultural production. Soil conditions are identified by the stakeholders to have impacts on other public goods in the region and to touch important environmental issues such as climate, groundwater, erosion, etc. Here, particularly the quality of the groundwater in the Marchfeld is seen as a critical point. At the moment, groundwater quality in the Marchfeld is very poor compared to other Austrian regions. This is first and foremost due to the high level of nitrate and pesticide pollution resulting from agricultural management, combined with the low precipitation rates leading to insufficient dilution. In many parts of the Marchfeld, groundwater treatment is inevitable to reach the standard values for potable water. To improve soil functionality and consequently also reach a positive impact on groundwater quality, changes of the agricultural management are suggested by the experts and stakeholders. Mainly these changes include measures to increase soil humus contents such as minimum tillage, intercropping and the mixing of straw, compost and harvest residues into the ground. Also changes of crop rotation are seen as potential ways to reduce chemical fertilisation and enhance soil fertility.

6.1.1.3 Description of governance-strategy

For the improvement of soil functionality in the Marchfeld we test two different **monetary incentives**: one is a private mechanisms in form of a sales guarantee and a result based premium for conservation soil management. The mechanisms is inspired by an already existing private mechanism promoted by retailers and farmers, namely a *payment for ecosystem services* program launched by WWF and Spar called “Healthy soils for healthy food”. In this program, farmers are committed to building high-quality humus soils by implementing suitable soil management measures. Farmers' conversion to humus-building management is rewarded with a sales guarantee of the crops/vegetables grown on the humus-building area, as well as a payment per CO2 t stored in the ground as measured through a monitoring assessment by WWF Austria.

The second monetary mechanism is a *collective bonus* in form of a public payment (e.g. in the framework of the Common Agricultural Policy of the EU). The instrument works via public payments per hectare, which gradually increase in accordance to increasing amounts of area under the respective management in the region. It is expected that farmers taking part in the scheme, will increase their personal efforts to encourage other/neighboring farmers to take part, in order to realize higher public payments.

In addition to the two monetary incentives we also assess different **supporting/enabling mechanisms**: one is the foundation of a local, voluntary *collaborative partnership* in form of a local work group, which is installed in order to support the design and the implementation of the management measures. The partnership is a cooperation of interested conventional and organic farmers (leading farms), the Ministry of agriculture, the national association of organic farming (Bio-Austria), and the machinery ring. It is supervised and supported by experts and scientists to include technical and scientific knowledge. The partnership works voluntarily and therefore no public funding is envisaged except for organizational support. The partnership's major goal is to support the implementation of the management changes on participating farms in providing up-to-date knowledge, training, and also technology and machinery that can be shared by several farms. Further supporting mechanisms that are tested in the model are *awareness rising measures* as well as *labelling and marketing* tools such as farm certification and branding.

From the stakeholders' point of view, the proposed strategy mix is an improvement of the existing schemes due to different factors: Installing a local work group, which is involved in the design of the management activities as well as in the technical and educational support of the implementation, will guarantee that the measures are *targeted to the local context,* as well as that farmers can evolve their *ability to implement the measures.* As regards the collective bonus, major advantages are seen in the potential to start communication processes between farmers, as well as in the payment rewarded for the agglomeration bonus going beyond cost compensation. As regards the SPAR humus project, mainly the sale guarantee is seen as an important trigger motivating farmers (perhaps even more than payments per area), and the humus monitoring program that updates knowledge of farmers.

The objective of the governance strategy is to deliver a more efficient provision of public goods from the Marchfeld agricultural landscape. The goal is to identify affordable solutions able to disclose the potential of the area and to understand how local aspects related to social, economic, institutional, and environmental features interact and become enabling factors for the implementation of the agro-environmental policy.

Public good provision: As regards soil functionality, it is to be expected that an uptake of the conservation agriculture practices will increase the soil organic matter, however the measurability of success will be critical as external factors (climate, precipitation, etc.) have a strong influence on humus accumulation. As regards water quality, it is expected that measurable changes will be reached only in the long term. This is due to the groundwater reservoir with an estimated average retention time of about 50 years. Also, nitrate content is strongly affected by external factors as well, mainly by precipitation determining dilution rate as well as leaking.

Uptake of governance mechanisms. As regards the collective bonus based on the collective partnership, a slow growth of uptake rates is expectable: while in the beginning mainly farmers involved in the collective partnership will take part, it is likely that neighboring effects will increasingly take place, as partaking farmers will advertise the measure for gaining higher compensation payments. As regards the SPAR Humus program, it is expected that this will remain a "side" mechanism, however fully exploited to the maximal extent of area funded by SPAR.

6.1.2 Methodological approach

6.1.2.1 Theoretical background

Fuzzy Cognitive Mapping (FCM) is a modelling technique rooted in Neural Networks and Fuzzy Logic which aims to reproduce the behavior of a system composed by interrelated concepts connected together with causal relationships (Kosko, 1986). The usefulness of FCM lies in its ability to shape the flow of information between concepts, elements, states, and factors in a framework which is similar to human reasoning (Bourgani et al. 2013). Therefore, FCM is a useful mean for the analysis of environmental issues in human-managed systems, which allows to capture qualitative expert knowledge, deal with ideas across several different disciplines, and combine soft and hard data sources in a semi-quantitative model (Hobbs, et al., 2002; Özesmy and Özesmy, 2004; Kok, 2009). The major advantage of the method is the possibility to handle imprecise ("fuzzy") data such as non-linear responses (e.g. when an input does not give a proportional output), feedbacks, and threshold effects, which commonly hamper the assessment of complex systems (Norberg and Cumming, 2008).

The modelling approach that was selected is indeed able to include feedback and feedforward mechanisms between different elements at play and provide a semi-quantitative understanding of issues specifically linked to the case study area. For instance, understanding drivers and causal relationships is paramount to identify hurdles and solutions when the governance tools involve a range of aspects such as social networks in the area, perception and beliefs, etc. All these aspects are hardly considered in more "standard" economic evaluations which are commonly based on tangibles and hard data sources.

6.1.2.2 Model implementation

The implementation of the model followed the discussion carried out at the 1st and 2nd local stakeholder workshops, where a mind map was developed by the stakeholders. This process allowed to identify the main factors at play and their cause-effect links in the specific context of the Marchfeld case study.

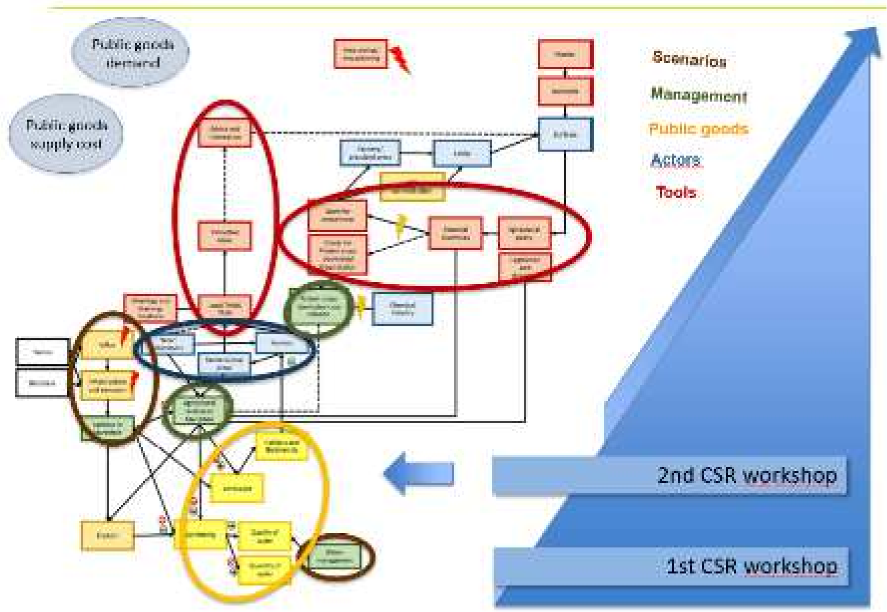


Figure 2. Mind map on conservation agriculture from the 2nd local stakeholder workshop

On the basis of the mind map, the FCM was sketched as a basic graphic connection representing the main groups of elements (clusters) and the connections as identified by the stakeholders.

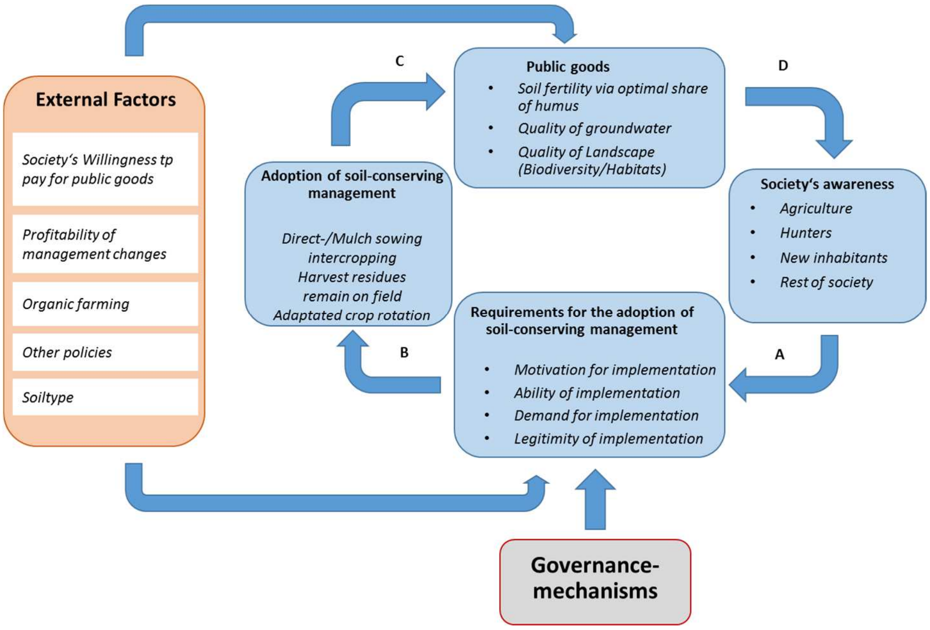


Figure 3. Basic fuzzy cognitive map elaborated from the stakeholder workshop.

Consequently, the range of connections between the elements were designed and adapted to reproduce the rationale behind the discussion of the stakeholder meetings and validated by means of an internal discussion held with scholars and experts of the Marchfeld agriculture at BOKU.

The target of the FCM was to compare two governance mechanisms in terms of: 1) their effectiveness in steering agricultural practices towards conservation agriculture techniques (minimum tillage, cover cropping, and rotations) and 2) their efficiency for public goods provisioning. The core aspect of the case study model was to identify bottlenecks and tools to improve public goods provision by means of the FCM through two different steps:

- static analysis to identify stakeholder perception of the public good topic in the Marchfeld
- dynamic analysis to understand expected outcomes and behavior of the system under different scenarios

6.1.3 Scenarios

During the stakeholder workshops three scenarios were developed: Business as usual, Market driven development, sustainability driven development.

Scenario 1 – Business as usual

In Marchfeld, under the BAU scenario conventional arable production continues. A moderate increase of organic production takes place. Agricultural production leads to sufficient income so the farms in the Marchfeld are stable. The intensity of agricultural production moderately increases, increasingly crops adapted to climate change are included into crop rotation. Irrigation will stay stable or perhaps slightly increase where possible. In general, the ecological status of the area will stay relatively stable, climate change will however aggravate water scarcity, and ground-breaking increases of groundwater quality seems unlikely. The continuing growth of the population leads to strong sealing of agricultural soils due to construction projects for housing, streets and other infrastructure, as well as industry. Soil sealing will cause price increases for agricultural land (also rent). Rural vitality decreases due to the strong influx of “new” population which can only insufficiently be integrated into existing rural structures.

Scenario 2 – Market driven development

High global competition leads to low prices for agricultural products. Due to low oil prices, prices for agricultural inputs are low. Conventional arable production in the Marchfeld continues. As soon as incentives drop, organic production decreases. Structural change takes place, small farms can’t keep up, big farms survive and grow due to cost degression. The intensity of conventional production increases, also through intensified irrigation. Increasingly crops adapted to climate change are included into the crop rotation. The ecological status of the area decreases as farmers solely meet ecological “restrictions”, while no “voluntary” efforts toward ecologically sound management are made. The use of “big” machinery increases, in many cases machinery is shared through increased cooperation (machinery sharing/machinery rings). Climate change strongly aggravates water scarcity, groundwater quality stays low due to intensive production. The strong growth of the population in combination with growing farms leads to strong land pressure. Strong sealing of agricultural soils takes place due to construction projects for housing, streets and other infrastructure, as well as industry. Rural vitality strongly decreases due to the strong influx of “new” population which can only insufficiently be integrated into existing rural structures.

Scenario 3 – sustainability driven development

Amongst other things, due to stricter laws in the direction of ecologically sustainable management, also conventional farms focus on ecologically sound management practices. The share of organic farms / organic area is increasing. Biodiversity areas and flower strips account for a larger share of agricultural land. Intercropping increases significantly. Due to changes in agricultural land management, the ecological status of the area is improving significantly. The increase of biodiversity areas, hedgerows and landscape elements leads to a more beautiful landscape. Climate-friendly soil management techniques increase humus accumulation and carbon sequestration in the soil. Groundwater quality is increasing. New marketing strategies and rising prices for agricultural products make it possible to generate an adequate income, so the farms in the Marchfeld remain stable. The farmers cooperate in the field of technology as well as in the know-how sector. The competition for land-use between infrastructure and agriculture is limited as far as possible by improved spatial planning. The expansion of public transport is increasing. Wind mills shape the landscape.

6.1.4 Participative approach

6.1.4.1 Stakeholders' input to the development governance mechanisms

The final set of governance mechanisms was fully developed by the stakeholders in the 1st, 2nd and 3rd local stakeholder workshops. Already in the first workshop, when discussing the notion of public goods and the main public good issues in the region, current governance and its failures, as well as improvements of the current system have been in the focus of stakeholder interest. In the 2nd workshop, criteria for successful mechanisms have been discussed, as well as a broad number of mechanisms which could enhance the provision of the endangered public goods in the Marchfeld have been identified. Particularly the complex system of cause-effects between mechanisms, actors and public goods has been depicted in complex mind maps for two different public good issues, namely enhancing soil functionality and better steering the conflicts between society (cultural services) and agriculture (production). In the 3rd workshop, focusing on the final public good issue of soil functionality, the final mix of governance mechanisms has been elaborated by the stakeholders, considering the criteria of good governance.

6.1.4.2 Stakeholders' input to the modelling exercise

The network for the FCM is based on the 'soil functionality" mind map developed in the 2nd stakeholder workshop. The weighting of the network was carried out via individual interviews with selected participants of the workshops. Also the scenarios were developed via individual interviews with selected stakeholders, the weighting of the scenarios impacts was done during the 4th local stakeholder workshop.

6.1.5 Results and interpretation

6.1.5.1 Analytical Step 1: network description

The first analytical step focuses on a *static* description of the cognitive map which outlines how the stakeholders "understand" the issue of public good governance in the Marchfeld. The static analysis of the questionnaires is based on graph theory techniques. That allows to sketch a first overview of the stakeholder understanding of the "Marchfeld system" and focuses on the characteristics of the weighted connections (outlined as arrows).

The sign of the relationships in the model are predominantly positive. That reflects the mapping exercise of the stakeholder laboratories where a general tendency to focus on positive mechanisms able to enhance the public goods and a lower attention towards hurdles and impediments was evidenced. The only factors acting as impediment is represented by the cost for the farmers of the conservation action and by a range of "exogenous" factors linked to the different scenario contexts (market context for instance).

The relevance and complexity of the feedbacks between concepts and factors in the system can be understood better by the network maps as shown in Fig. 3 to 5. Firstly, the figure reveals a high degree of complexity (ratio transmitter/receiver concepts) which denotes a non-hierarchical structure configuration. That means that the impact of each concept is transferred to the other concepts through a rather intricate system of feedbacks and not through linear cause-effect mechanisms.

In the figures, the size of the circles (concepts) is defined by their centrality that indicates the cumulative strength of the concept and shows how connected the variable is to other variables. Centrality is calculated as the sum of its in degree (input-arrows) and out degree (output-arrows) (Bougon et al., 1977; Eden et al., 1992; Harary et al., 1965; Kosko, 1986).

Farmer motivation (Mot), is the focal node in the BAU map. The figure also highlights the loop "Soil-water quality- soil type" and the loop "landscape/biodiversity quality- organic farming-hunters" to be relevant. The socioeconomic and infrastructure development is not connected as the stakeholders did not consider that influent in the BAU scenario.

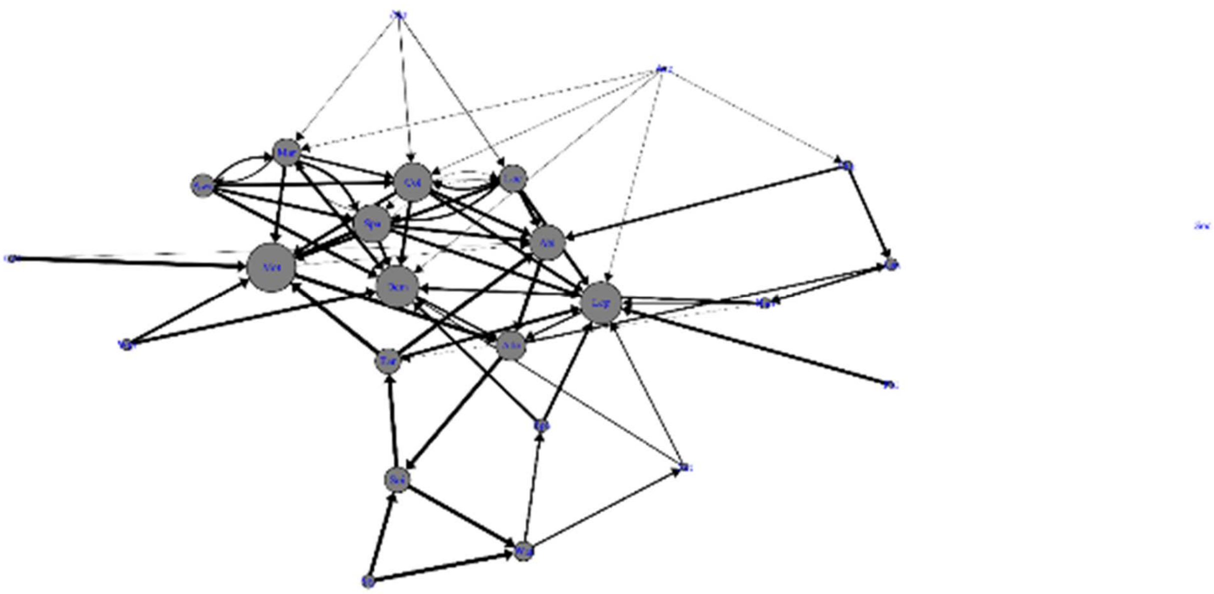


Figure 4. BAU scenario model: overall cognitive map based on average weights (arrows) and centrality of concepts (bigger circle = higher centrality). The thickness of the arrows is determined by the magnitude of the edge value (which is in the range -1 ; +1). Negative edges are red while positive edges are black. Please, cfr. To the appendix for the concept abbreviations.

In the sustainability and the market scenarios, the external factors (e.g. “Aec” and “Agr”) play a much more relevant role. That is related to the scenario building process which stimulate to imagine future conditions where external factors are “extreme”. That reduces the relative centrality of the governance tools. However, in the sustainability scenario the collective bonus and the SPAR-humus values are higher than in the BAU scenario.

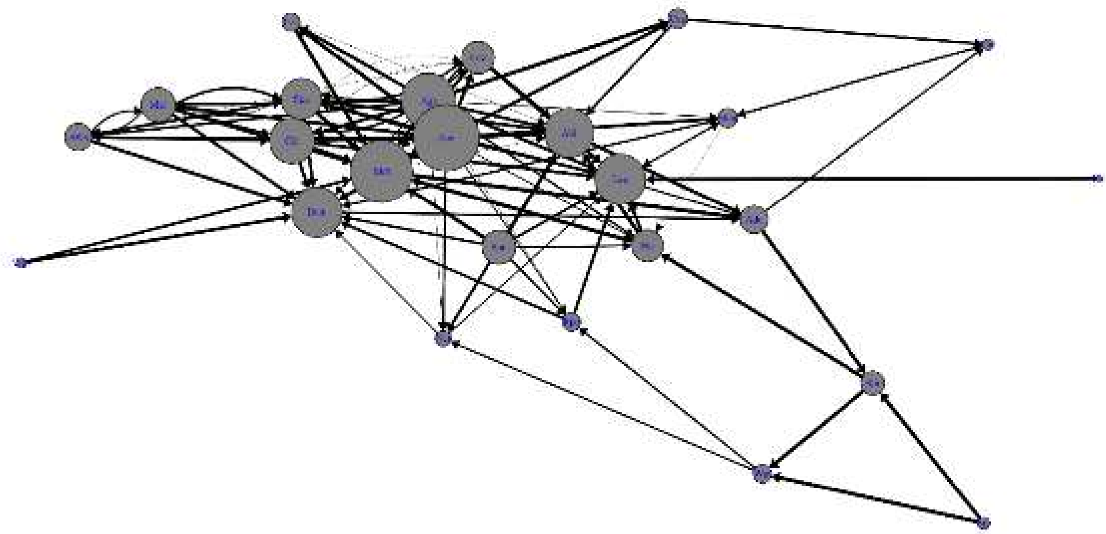


Figure 5. sustainability scenario model: overall cognitive map based on average weights (arrows) and centrality of concepts (bigger circle = higher centrality). The thickness of the arrows is determined by the magnitude of the edge value (which is in the range -1 ; +1). Negative edges are red while positive edges are black. Please, cfr. To the appendix for the concept abbreviations.

The market-driven scenario highlights much more complexity given the range of positive and negative connections. Looking at the map created for the market driven scenario, it is clear how the model is changed and the centrality of the concepts changes accordingly. Scenario elements like socioeconomic/infrastructure development and agricultural productivity are more central together with motivation and demand. That indicates that these drivers are considered much more important to steer the public goods delivery from agricultural landscapes.

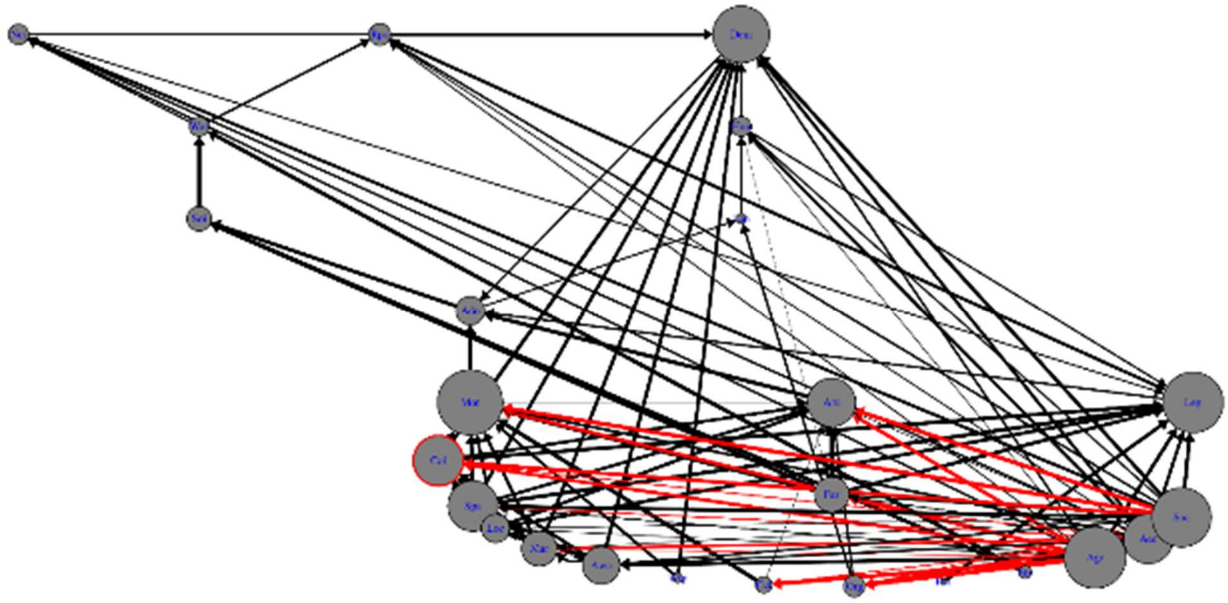


Figure 6. market-driven scenario model: overall cognitive map based on average weights (arrows) and centrality of concepts (bigger circle = higher centrality). The thickness of the arrows is determined by the magnitude of the edge value (which is in the range -1 ; +1). Negative edges are red while positive edges are black. Please, cfr. To the appendix for the concept abbreviations.

6.1.5.2 Analysis of the variability range between the stakeholder questionnaires

In the next figures 7 to 9 the results for the scenario models are presented to understand the different perspectives between the stakeholders: the model output from each questionnaire is presented in a box-plot diagram to evidence the range of differences.

The influence on the adoption factors (motivation, ability, demand and legitimacy) are particularly homogenous in the BAU scenario and close to the maximum rate of the value (close to 1.00), whereas the governance mechanisms are more variable. Variability also is caused by the fact that the stakeholders were invited to add/suggest new connections in the questionnaire in regards of the mechanism concept and their potential effects and therefore the differences of relevance are more evident.That points to a higher range of “knowledge” and understanding about the governance and their role between the local experts. On the contrary, the relevance of adoption of agricultural practices for the delivery of public goods seems converging. To notice however that the value for the local farmer partnership is particularly low and convergent between the stakeholders: that probably means the lower trust in steering the behaviour with that tool in the current scenario. Also, the idea about the links with landscape/biodiversity quality is quite consistent across the stakeholders.

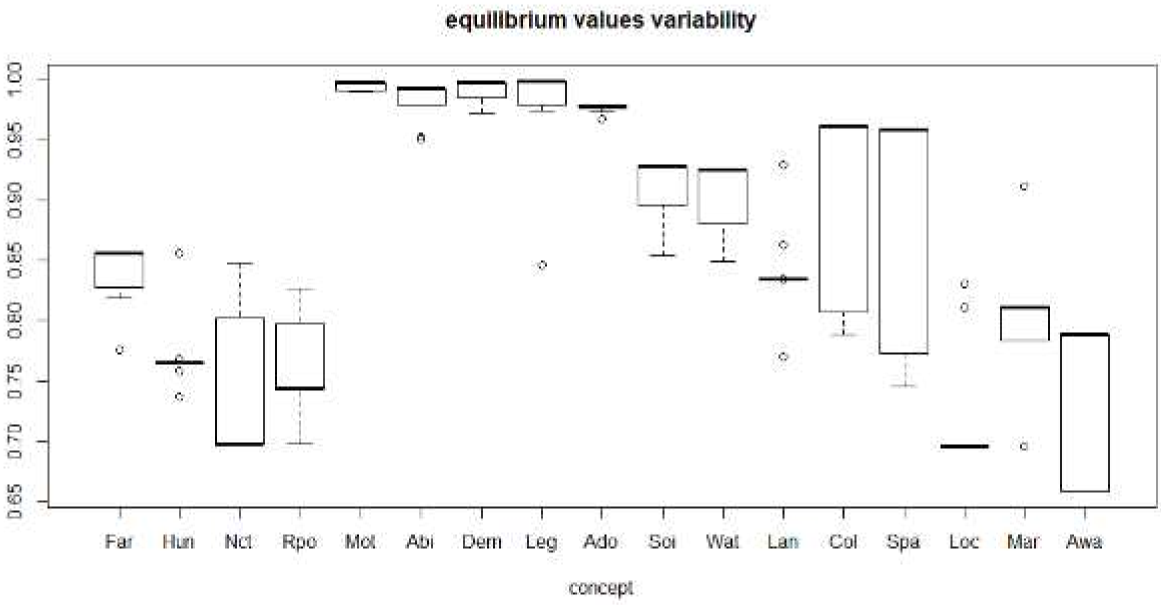


Figure 7. box plot for the equilibrium values calculated under the BAU scenario. Differences between stakeholders are mainly on the governance mechanisms and to some extent on rural population. Please, cfr. To the appendix for the concept abbreviations.

It is interesting to notice the range of variation between the scenarios and visualize whether the variability between the questionnaires is overran by the magnitude of change imposed by the scenarios (fig. 8 and 9).

The scenario changes seem more relevant than the inner variability between the questionnaires which means that the scenario impact is bigger than the range of perception differences between the stakeholders. Interestingly, some ranking inversions can be noticed. For instance, the rural society actors gain more relevance than farmers under the market scenario whereas famers are the most relevant in the BAU and sustainability scenarios because the lower "public" pressure under the market scenario determines a higher importance of the internal society loop. Indeed, demand and legitimacy remains high in market-driven scenario whereas the higher role of public input (like the collective bonus) is more evident in the sustainability scenario.

The public goods and adoption of practices trends are negative in the market scenario and positive in the sustainability scenario (as expected) even though the difference is limited.

Among the pubic goods, changes are more evident for landscape/biodiversity, whereas soil and water are much more resilient to change. That means a rather slow increase or decrease of quality in comparison to BAU which should be related to the rather short-time range considered by the stakeholders when building the scenarios and the time lag related to the improvement of groundwater quality.

Relevance of the governance is widely different between the 3 scenarios: Collective bonus is higher than the SPAR-Humus in the BAU and sustainability scenarios, whereas the SPAR-Humus performance is better under the market scenario where the collective bonus attains a clear lower value. However, the range of variability concerning the collective bonus is extremely high and the range of the results should be weighed against that consideration.

Regional marketing is less effective in the market scenario than in the BAU which points to a lower possibility to attach products to the landscape in the market driven context. On the contrary, awareness campaigns relevance in the market and the sustainability scenarios point to the importance of that tool as an effective leverage able to steer the governance of the system.

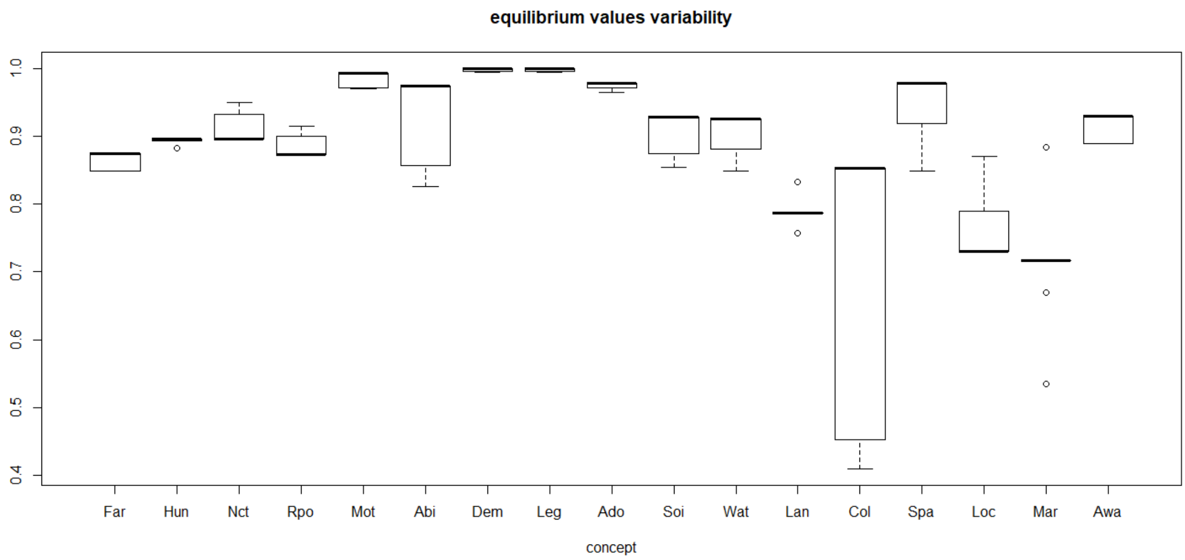


Figure 8. box plot for the equilibrium values calculated under the market-driven scenario. Differences for the collective bonus are evident. Please, cfr. To the appendix for the concept abbreviations.

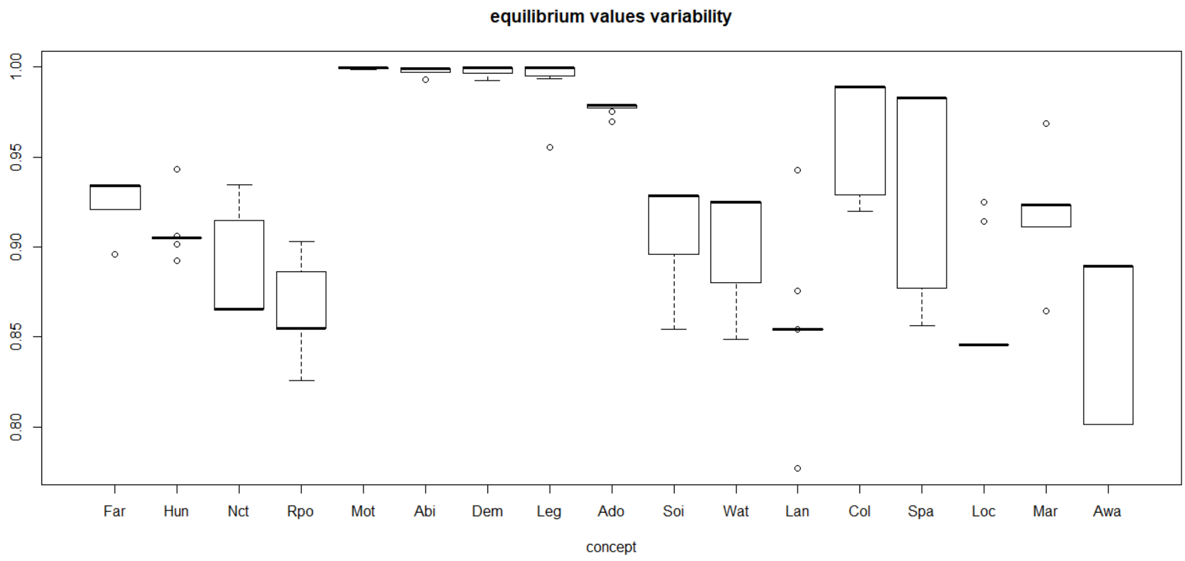


Figure 9. box plot for the equilibrium values calculated under the sustainability scenario. Please, cfr. To the appendix for the concept abbreviations.

In the following table (table 1) the average differences between the market and sustainabilty scenarios is reported in numerical terms in comparison to the BAU scenario. To notice, the fall which is expected by the experts for organic farming, collective bonus, and cost efficiency of conservation practices under the market-driven scenario.

Table 1. comparison of results between BAU vs. market and sustainability scenario.

Concept	% change BAU vs. market	% change BAU vs. sustainability
Far	2.800899	10.24897
Hun	15.50617	17.41809
Nct	20.90577	17.76197
Rpo	15.90105	13.13438
Mot	-0.88013	0.350896
Abi	-4.17579	1.173893
Dem	0.41365	0.412787
Leg	0.439296	0.411587
Ado	-0.18292	0.040395
Soi	-0.78974	0.00327
Wat	-0.53641	0.000258
Lan	-7.14793	2.085145
Col	-20.3612	5.579083
Spa	4.742054	4.924826
Loc	6.682611	18.43231
Mar	-6.84403	14.5101
Awa	24.232	16.25127
Cef	-38.6044	33.66818
Org	-59.7133	29.96841

6.1.5.3 Analytical step 2: dynamic simulation

The dynamic simulation is based on analyzing the results of the models with a progressive reduction of the SPAR-humus and collective bonus activation levels (Figure 9). That simulates the effects of a reduced effectiveness of these tools in the case study area and outlines the expected effects on conservation practice adoption.

From the results, it is evident that the effectiveness of the governance tools is higher under the market-driven scenario where the progressive reduction of governance has relevant impacts on motivation and ability of farmers towards the conservation practice adoption. Indeed, the SPAR-Humus and the collective bonus were considered having positive effects on the ability due to “neighboring effect” and the possibility for the farmers to “measure” effectively the results of the humus project in the field. Demand and legitimacy, on the contrary are more stable and less affected by the governance changes.

The change induced by the reduced governance are less evident in the sustainability scenario. That is likely pointing to a lower additional effect of “public” governance in the “utopic” sustainability context where self-regulating social loops seem strong enough to steer the landscape towards more environment-friendly production. In particular, the relevant role played by a stronger organic farming movement which is expected in the sustainability scenario is able to counterbalance the reduced presence of governance.

Even though the centrality of the governance tools is somewhat overrun by the external factors in the market-driven scenario, the results of the simulation highlight that these tools are far more needed than in the other scenarios. In particular, in the context of the Marchfeld the impact of the governance on the ability of the farmers to implement the conservation practice is considered paramount.

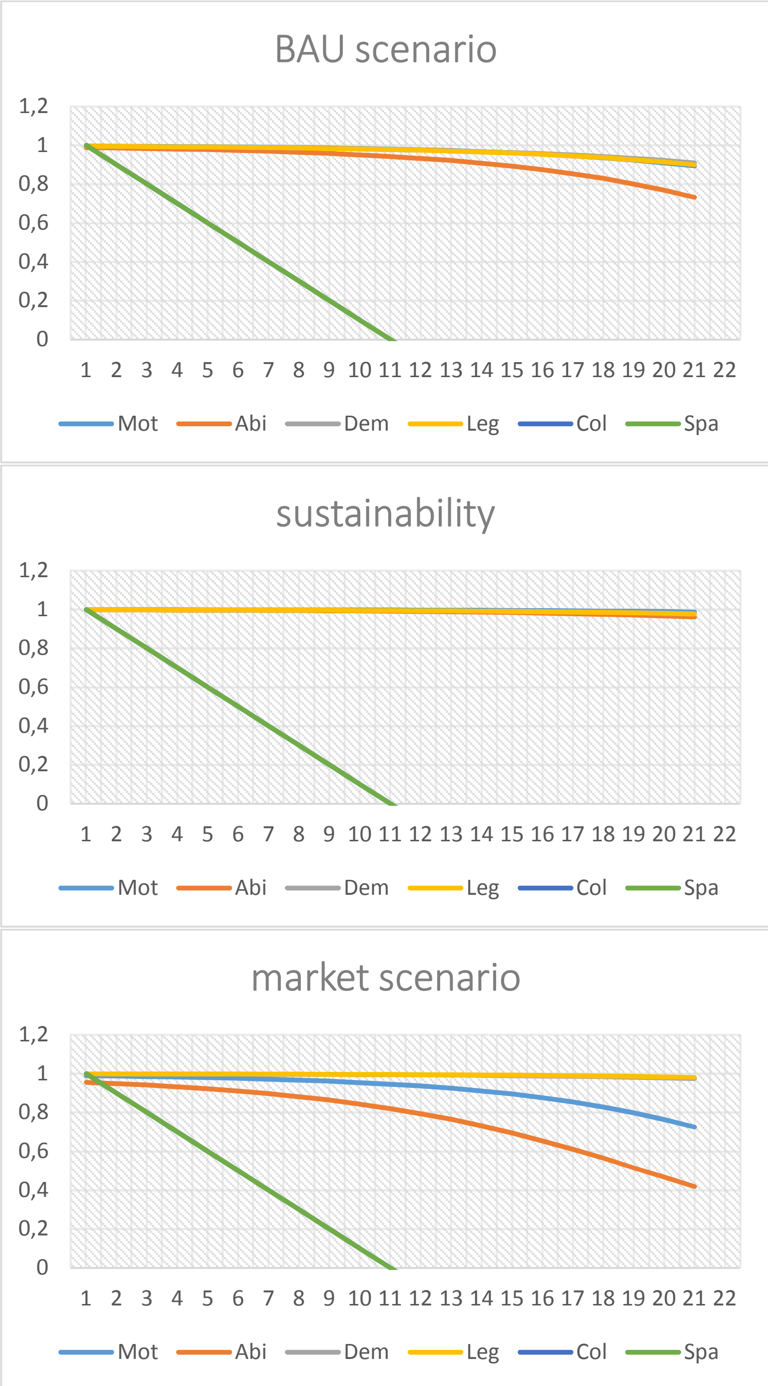


Figure 10. comparison of impacts of governance factors (SPAR-Humus and collective bonus) on adoption factors for conservation agriculture practices. Ability is the main concept that is linked to the governance tools in the BAU and market scenarios. However, motivation is also steered under the market scenario where the impact of reducing the governance tools is exacerbated. In the sustainability scenario, the relevance of governance is less evident as the internal “moral/emotional” loop is able to counteract the reduced governance impact.

6.1.6 Discussion

6.1.6.1 Discussion of results

So far, the preliminary results allow to highlight some general discussion points:

First of all, the model is sensitive to changes and to the different stakeholder opinions. The comparison between the governance vs. the no-governance models outlined negative changes in adoption and public goods as it was expected. Some refinement in the model structure as suggested in literature (e.g. Kok, 2009) could be however required during the final stakeholder laboratory.

The problem of public goods governance in agricultural landscapes is complex and governance type alone is not enough to explain the effective adoption of conservation agriculture practices. Ancillary factors such as awareness and marketing were considered as much as important as the governance tools. That adds complexity to the model and clearly underlines that a range of driving factors determine the success or the failure of a governance mechanism.

The local feedback between awareness of public goods from the local population, demand of environment-friendly agriculture, and practice adoption was evidenced (see e.g. Cumming et al., 2014). But a clear disconnection happens at the level of translating the demand in adoption as the farmers are forced to privilege farm viability (and so driven by monetary incentives). In this context, it could be interesting to understand deeper the role of hunters and hunter associations which seem to have a stronger "grip" on farmers (also because many farmers are also hunters in the Marchfeld) but in the stakeholder interviews their interest in public good provision was not always confirmed. An important result concerns the role of governance on affecting ability of farmers. That is an important result in understanding the role of governance tools that is complicate to achieve with other standard assessment tools.

A final element to discuss regards the strong concern in the stakeholders between practice adoption and effect on public goods. The positive impact is generally assumed but the temporal delay factor seems relevant. That is in particular for the water quality issue as the improvement of practices would not be translated in improved conditions in the short-medium term. That delay is also present for the other public goods and reduce the relevance of the local population pressure on farmers. That is an issue that will need further discussion in the final stakeholder laboratory as factors like awareness campaigns were considered crucial to steer the public goods problem. Society groups like farmers and hunters were considered more aware of the problem (the first concerned with soil quality, the second with landscape elements and biodiversity) and able to re-wire the public good issue with the local context. That aspect seems interesting but requires a focused discussion during the final stakeholder laboratory to understand better its relevance and possibilities to leverage on that.

6.1.6.2 Discussion of the chosen methodological approach

The cognitive map as defined during the stakeholder meetings concerns a wide range of factors and relations. The fuzzy cognitive mapping is therefore a suitable tool to understand more in depth the problem, and the range of possibilities to define effective governance mechanisms. During the stakeholder interviews, the method outlined a range of strengths including the easiness to understand and the possibility to collect information on a complex issue in an easy and affordable way (as stated by the stakeholders).

As all models, the fuzzy cognitive mapping is also affected by the risk to oversimplify the system. However, the assessment included a number of connections and factors that seem to well represent the Marchfeld system and the stakeholders were left free to add comments and modify the network.

A specific advantage of the method concerns the possibility to include “soft” issues like social demand on farmers or ability. Even though these seem to have a more limited grip on farmers, their presence was evidenced and it can represent a valid tool to be discussed with stakeholders to define governance mechanisms which involve quantitative elements such as monetary incentives together with more qualitative “catalyst” elements such awareness and social pressure.

APPENDIX

Nomenclature of the FCM concepts:

Id	Concept_ger	Acronym	Concept_eng
1	Landwirtschaft	Far	Farmers
2	Jägerschaft	Hun	Hunters
3	neubürgerinnen	Nct	New rural Citizen
4	übrige gesell.	Rpo	Other rural society/population
5	Motivation	Mot	Farmer motivation
6	Fähigkeit	Abi	Farmer ability
7	Nachfrage	Dem	Demand for adoption
8	Legitimität	Leg	Legitimity of adoption
9	Umsetzung	Ado	Adoption
10	bodenfruchtbarkeit	Soi	Soil quality/ organic cont.
11	grundwasser qual.	Wat	Ground water quality
12	landschaftsqualität	Lan	Landscape „quality“/ biodiversity
13	kollektiv bonus	Col	Collective bonus
14	SPAR-humus	Spa	SPAR project
15	lokale kollektive partnerschaft	Loc	Local collective farmer partnership
16	marketing regionale labls	Mar	Regional marketing/ labelling
17	sensibilisierung	Awa	Awareness campaign
18	WTP	Wtp	WTP
19	Wirtschaftlichkeit	Cef	Cost efficiency of Cons. Agr. practice
20	biologische landwirtschaft	Org	Organic agriculture
21	Bodentyp	Sty	Soil type
22	landwirtschaftliche produktion	Agr	Agricultural production/ intensity
23	zustand des agrarökoszstems	Aec	Agroecosystem conditions
24	socioeconomic and infrastructure	Soc	Socioeconomic and infrastructure development
25	other policies	Pol	Other policies (natura2000, Nitrate/water directive, land-use planning)

6.2 IT-2: Water availability in the hilly and mountain area of the Ravenna province in Italy

6.2.1 Introduction

6.2.1.1 Description of case study region

The case study region is the hilly and mountain area of the Ravenna province. The entire province is 1859 km² and 391,290 inhabitants live there.

6.2.1.2 Description of public good issue

The area is characterized by intensive agricultural production that focuses on fruit production. Especially in hilly area, water availability is limited due to the high-water intensity of the agricultural production (e.g. actinidia), low rainfall, and scarce freshwater. To overcome this issue, in the last thirty years a number of collective reservoirs have been built. These reservoirs are aimed at collecting rainwater to be used in summer. They are collectively owned and managed by group of farmers.

6.2.1.3 Description of governance-strategy

The latest two Rural Development Plans of Emilia-Romagna provided financial support for the construction of rainwater harvesting reservoirs with the objective of rationalizing water use and to preserve the consumption of groundwater. Personal communication with key regional stakeholders provided hints on the interest on this type of policies.

6.2.2 Methodological approach

6.2.2.1 Theoretical background

Preliminaries

We model the construction of the collective reservoir as a club. Within this framework we assess when and which type of policy intervention is required to increase the number of users of the reservoir so to decrease the rate use of groundwater. In the following text, the term club and reservoir are interchangeable.

Assume that there is a desired level of groundwater availability g^d.

Imagine a set $N=(i…n)$ of farmers, who are homogenous in terms of water productivity, Each farm has a revenues function determined by the use of irrigation water, $f(w)$. Water can come from two sources: groundwater (g) or a reservoir (r): $w=g+r$. Assume that they can only use either groundwater or reservoir so that a reservoir user has $f(r)$ and a groundwater users has *f(g)*. Denote with $S \subseteq N$ the subset of farmers (with cardinality *s*) that belong to the club. Consequently, there are *n-s* groundwater users.

In what follows we:

1) Analyse the club equilibrium in two cases that can be interpreted as social rule that govern the access to the club. The two cases are the "open membership" one (where, club member cannot exclude non-members from entering) and the "closed membership case" (where, club member can exclude non-members from entering).
2) After having analysed these two equilibria, we characterized the policy scheme that can be implemented to reach the societal desired level of groundwater extraction.

Profits for club members

Profit for a single member of the club (the reservoir) is:

(1) $\pi_{i \in S} = f(r) - k \cdot r - t(s)$

where *k·r* is the cost related to the size of the reservoir, and *t(s)* is the cost of managing the reservoir linked to the number of users, where: $t(s) = \frac{1}{s} T(s)$ with minimum (the solution of $\frac{\partial t(s)}{\partial s} = 0$) at $\breve{s}$. The function is "U" shaped in s. We can interpret *t(s)* as the cost of coordinating the club.

Profits for non users:

Assume that there are spillovers, namely that $\frac{\partial \pi_{i \notin S}}{\partial s} \geq 0$. One possibility is to assume that costs for groundwater users depend on the total number of groundwater users.

(2) $\pi_{i \notin S} = f(g) - cg - \left(\frac{n-s}{n}\right)\alpha \Rightarrow f(g) - cg - \alpha + \frac{s}{n}\alpha$

foc: $f_g - c = 0$

The spillovers do not affect the individual amount of groundwater used ($\frac{\partial g^*}{\partial s} = 0$), but only profits.

6.2.2.1.1 EQUILIBRIA

Open membership equilibrium

If the club is open (users cannot effectively exclude outsiders from entering), the equilibrium is given by the point where profit for members is equal to profit for non-members. As we observed, for both club members and non-members, the optimal quantity of water (respectively from the reservoir and from groundwater) does not depend on *s*. so the equilibrium condition are given by:

(3.a) $\pi_{i\in S}(r*) = \pi_{i\notin S}(g*)$

Substituting equation (1) and (2) into (3.a) we obtain:

(3.b) $$f(r*) - k \cdot r* - t(s) - f(g*) + c \cdot g* + \alpha - \frac{s}{n} \cdot \alpha = 0$$

The solution of (3) is the number of reservoir users in open access s^O.

Several hints can be obtained by analysing 3.b. Implicitly deriving s^O with respect to k yields:

$$\frac{\partial s^O}{\partial k} = -\left[\frac{r_k^* \cdot f' - k \cdot r_k^*(k) - r^*}{-t_s(s) - \frac{\alpha}{n}}\right] \Rightarrow \frac{\partial s^O}{\partial k} = -\left[\frac{r_k^* \cdot (f' - k) - r^*}{-t_s(s) - \frac{\alpha}{n}}\right] \Rightarrow \frac{\partial s^O}{\partial k} = -\frac{r^*}{t_s(s) + \frac{\alpha}{n}}$$

Note that *r*>0* and $\frac{\alpha}{n} > 0$ so $\frac{\partial s^O}{\partial k} < 0$ if $t_s(s) > 0$ which is sure if $s^O > \breve{s}$ but it depends if $s^O < \breve{s}$. That in turn it implies that a reduction of the profit for club member leads to an increase in the minimum club size and a reduction in the open access equilibrium club size. (which in turn implies that a subsidy in the club that increases the club member profits causes a reduction in the minimum club size and an increase in the open access equilibrium club size.) see figure 1 below:

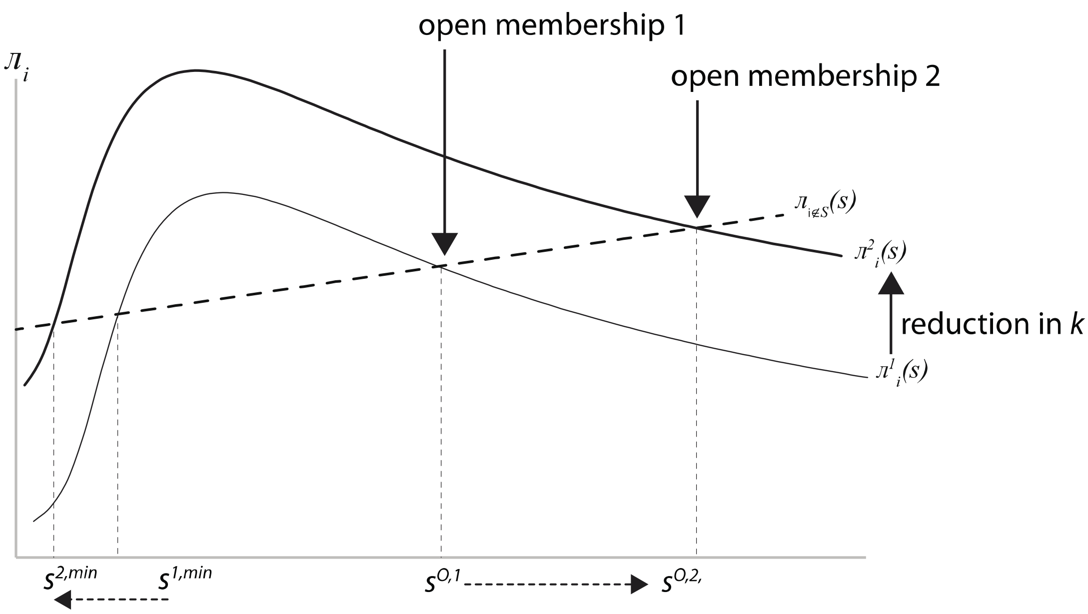


Figure 1. equilibria in open membership with different level of the parameter k.

Closed membership

Closed membership implies that club members can effectively exclude non-members from entering the club. The emerging club is the one that maximizes the average profits for club members. If the average profits for a club member would decrease, in case of closed membership, those farmers that are members of the club would close the access. Thus:

(4) $\max \pi_{i\in S} = f(r) - k \cdot r - t(s)$

the two FOC are:

FOC 1: $\frac{\partial \pi}{\partial q} = 0 \rightarrow f_q - k = 0$

FOC 2: $\frac{\partial \pi}{\partial s} = 0 \rightarrow -\frac{T(s)}{s^2} + \frac{T_s(s)}{s} = 0 \rightarrow T_s(s) - \frac{T(s)}{s} = 0$

From the FOC we get the individual amount of water used by each reservoir user, which is the solution of FOC 1: q^*. Note that q^* is independent from the number of users (FOC 2). The number of reservoir users (n-size) is the number of users that minimize the average costs for member $s^C = \breve{s}$. All together we have the q-size of the reservoir: $s^C \cdot q^*$. in figure 2 below a graphical comparison of closed vs open membership:

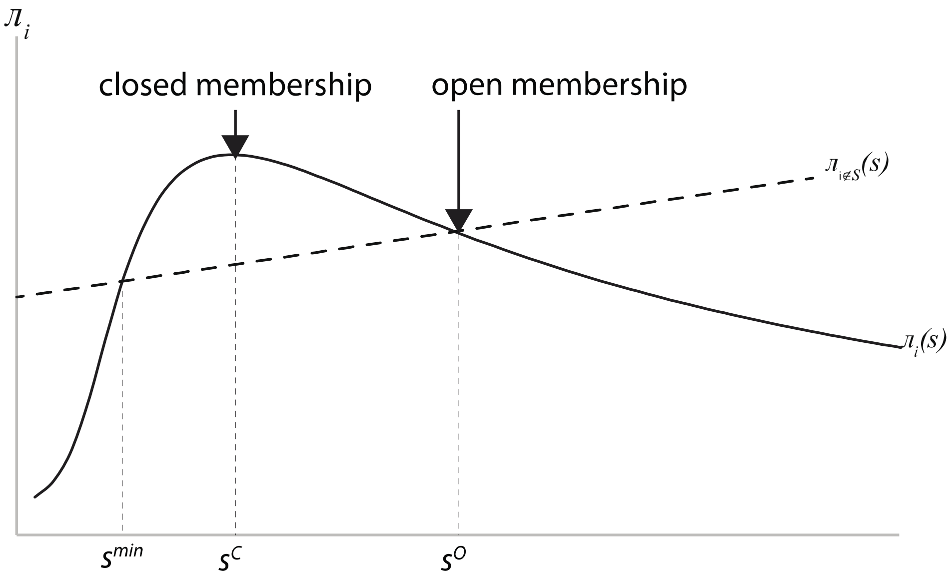


Figure 2. Closed vs open membership equilibria.

6.2.2.1.2 Policy

Assume that there is a desired level of groundwater availability. The available groundwater, after irrigation use, is given by:

(5) $$g^d = \bar{G} - (n - s) \cdot g^* \rightarrow g^d = \bar{G} - n \cdot g^* + s \cdot g^*$$

where $\bar{G}$ is the amount of water available in the aquifer before irrigation.

From (5) is obvious that g^d can either be reached by designing policy that affect g^* (either by using tax or quota) or by subsidizing the club. For the time being we work on this latter option, namely we design a subsidy for club members in the simplest form. In this latter option, the desired level of groundwater is translated in the desired level of club member s^d.

By subsidizing club members, equation (1) becomes:

(6) $$\pi^P_{i \in S} = f(r) - k \cdot r - t(s) + p^O$$

where p is the level of the payment.

Policy in Open Access

Given equation (6), equation (3) becomes:

$$f(r^*) - k \cdot r^* - t(s^d) + p^O - f(g^*) + c \cdot g^* + \alpha - \frac{s^d}{n} \cdot \alpha = 0 \quad (7)$$

comparing equation (7) with equation (3) we can derive the subsidy required to reach a level g^d:

$$p^O = t(s^d) - t(s^O) + (s^d - s^O) \cdot \frac{\alpha}{n}$$

Note that the higher the spillovers of the club on the non-club members ($\frac{\alpha}{n}$), the higher the payment level required to reach the desired club size.

See figure 3 below:

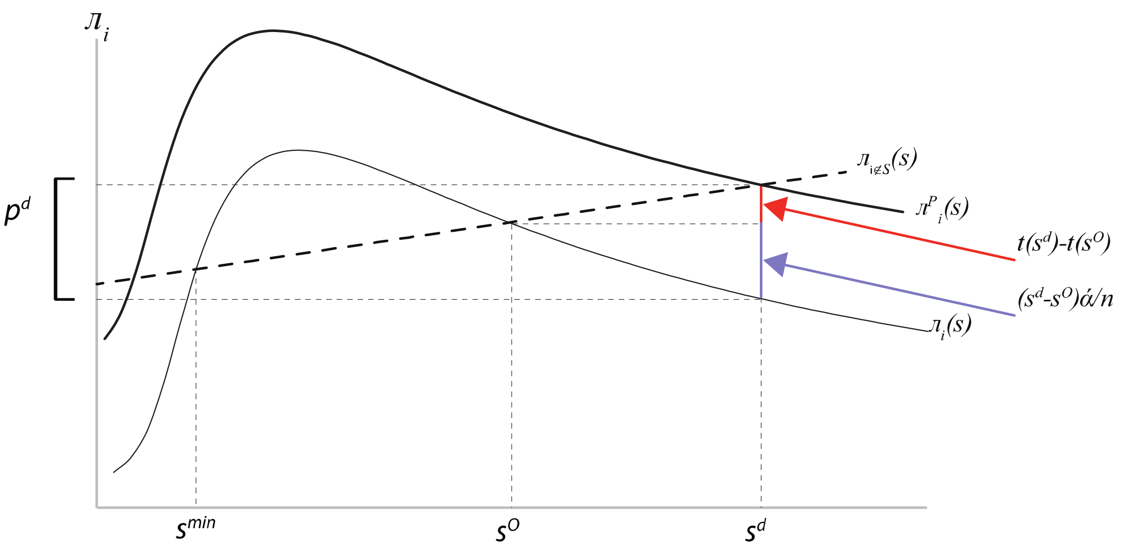


Figure 3. Payment level, in case of open membership, to reach a desired club size s^d.

Policy in Closed membership

Recall equation (6), namely profits for club members in case of the policy:

$$\pi^P_{i\in S} = f(r) - k \cdot r - t(s) + p^C$$

Again, in a closed membership, the club that emerges is the one that maximizes profits for the average club member:

Thus the club member program is:

$$\max \pi^{P}_{i\in S} = f\left(r\right) - k\cdot r - t\left(s\right) + p^{C}$$

The FOCs are:

FOC 1: $\dfrac{\partial \pi}{\partial q} = 0 \rightarrow f_{q} - k = 0$

FOC 2: $\dfrac{\partial \pi}{\partial s} = 0 \rightarrow -\dfrac{T\left(s\right)}{s^{2}} + \dfrac{T_{s}\left(s\right)}{s} = 0 \rightarrow T_{s}\left(s\right) - \dfrac{T\left(s\right)}{s} = 0$

The club member and the use rate of reservoir are not affected by the policy parameters.

Consider instead a policy that subsidizes water consumption from a reservoir:

$$\max \pi^{P}_{i\in S} = f\left(r\right) - k\cdot r - t\left(s\right) + p^{C}\cdot r$$

In this case, the water use of reservoir users increase:

$$\frac{\partial \pi}{\partial q} = 0 \rightarrow f_{q} - k + p^{C} = 0$$

but not even this type of policy scheme affect the n-size of the club:

$$\frac{\partial \pi}{\partial s} = 0 \rightarrow -\frac{T\left(s\right)}{s^{2}} + \frac{T_{s}\left(s\right)}{s} = 0 \rightarrow T_{s}\left(s\right) - \frac{T\left(s\right)}{s} = 0$$

So not even this policy scheme can be set to reach the societal desired level of groundwater.

One possibility to affect the size of the emerging club in case of closed membership is to formulate a policy scheme where the subsidy is attached to a minimum participation rule set at s^{d}. In other words, given s^{d}, the subsidy level is the one that equalizes the profit for a club member at $s^{C} = \breve{s}$ with the profit for s^{d}. Mathematically:

$$\pi^{*}_{i\in S} = \pi^{*}_{i\in S}\left(p^{C}, s^{d}\right)$$

or:

$$f\left(r^*\right)-k\cdot r^*-t\left(\breve{s}\right)=f\left(r^*\right)-k\cdot r^*-t\left(s^d\right)+p^C$$

which entails:

$$p^C=t\left(s^d\right)-t\left(\breve{s}\right)$$

The policy scheme thus needs to cover the higher costs that an increase in the club above the optimal one entails. Note that spillovers do not affect this payment level. This is represented graphically in Figure 4.

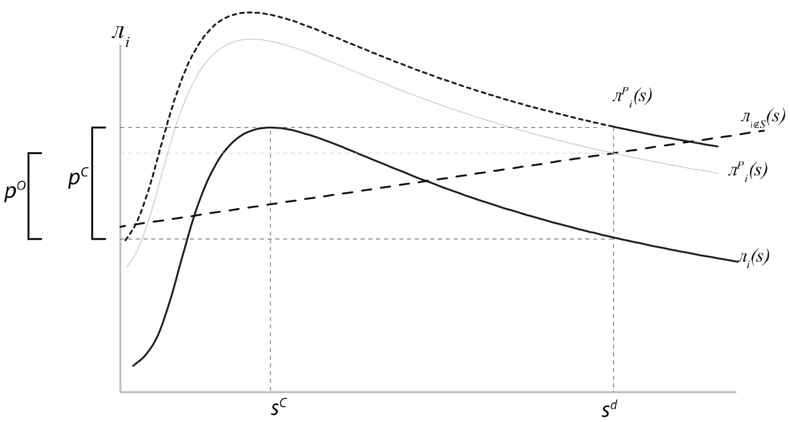


Figure 4. Payment level, in case of closed membership, to reach a desired club size s^d.

Comparing p^C with p^O shows that the relative level of the payment in the two club membership rules depend on the difference between the coordination costs of the two club-size equlibria, and on the spillovers.

$$p^C-p^O=t\left(s^O\right)-t\left(\breve{s}\right)-\left(s^d-s^O\right)\cdot\frac{\alpha}{n}$$

Note, that in case there are no spillovers (α=0), p^C is surely greater than p^O, since $t\left(s^O\right)>t\left(\breve{s}\right)$

6.2.2.2 Model implementation

For the time being we use secondary data on profit as a function of water from Viaggi et al. (2010). The profit functions are the following:

$$\pi_{i\in S}=-ar^2+br-kr-\left(ds^2-es+fs\right)$$

and

$$\pi_{i \notin s} = -ag^2 + bg - cg - \alpha + \frac{s}{n}\alpha$$

We used 2 farm types, which are differentiated by the value of the water profit function:

Table 1. Profit function parameter for the four farm types that are considered.

	a	b	c
Cl2	-0.00008	1.2748	2548.8
Cl3	-0.00001	0.5031	11283

The cost of construction/management of the reservoirs is *k=0.05 €/m³*. The cost of groundwater extraction is: *c= 0.1 €/m³*. The coordination costs are assumed to be the following: $d = 2.5$; $e = 100$; $f = 1750$. The value of the spillover is assumed to be *α=1500*.

For the club analysis, we consider four scenarios that are differentiated by the composition of the homogenous farm population, but are characterized by the same population size: *n=100*.

We did not include any result from WP4. Given the abstract nature of the analysis we, the target level of the groundwater availability is determined in relation to the scenarios concerning the composition of the farming population.

6.2.3 Results and interpretation

The following table shows results for water consumed for members and non members, and profits without considering coordination costs for club members and without considering the positive spillovers for non-members (using the mathematical notation previously described: $f(r^*) - k \cdot r^*$ and $f(g^*) - c \cdot g^*$).

Table 2. Water consumption and profits without considering coordination costs and spillovers for members and non-members for two farm types.

	water used	water used	profits	profits
	Groundwater (*g*)	Reservoir (*r*)	$\pi_{i \notin s}$	$\pi_{i \in s}$
Cl2	7342.5	7655	4313	4688
Cl3	20155	22655	4062	5133

In Figure 5 and 6 we respectively depict the entire club analysis of respectively a scenario composed by 100 CL2 farms and by 100 CL3 farms. We assumed that in both cases, the desired level of club member is s^d*=50*. Despite the relatively small differences in the profits (Table 2), the equilibria are rather different. The most important results are listed in **Errore. L'origine riferimento non è stata trovata.**. As the theoretical analysis showed, the closed membership equilibrium is only affected by the transaction cost function parameters, and thus are not affected by the composition of the farm population. The same is true for the payment required to reach a given n-size of the club. However, the difference between the payment in the closed versus open access equilibria is more pronounced in the CL3 case, since this farm type is characterized by a relatively ampler water production function.

Table 3. Results of equilibria analysis

	cl2	cl3
s^{min}	5	0
Closed Membership equilibria	20	20
Closed Membership Payment (€/s)	2250	2250
Open Access equilibria	31	39
Open Access Payment (€/s)	2137	1458

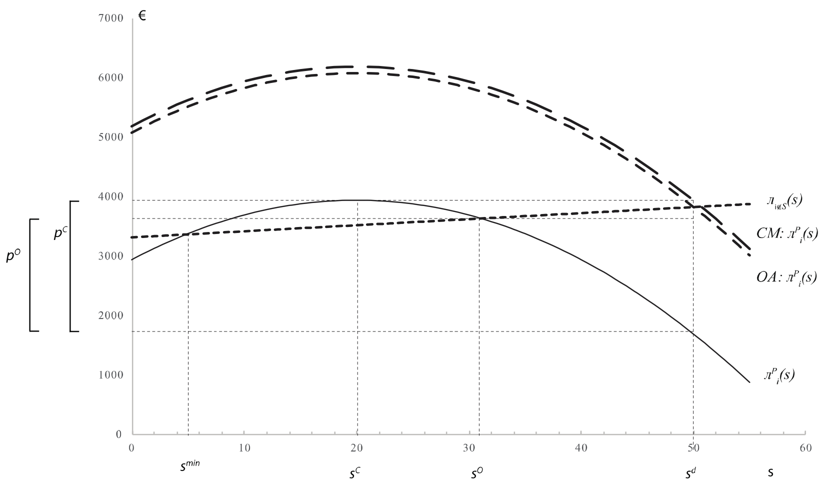


Figure 5. Equilibrium analysis for farm type CL2

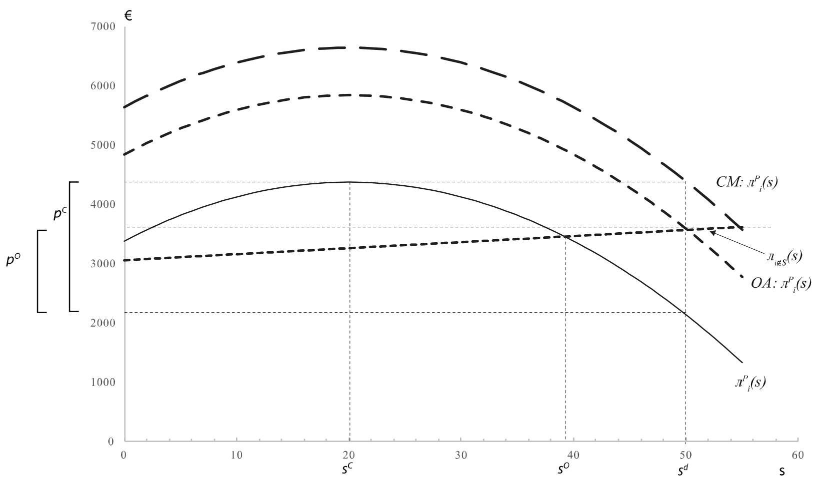


Figure 6: Equilibrium analysis for farm type CL3

6.2.4 Discussion

6.2.4.1 Discussion of results

The case study focuses on the role of policy in the emergence of collective irrigation reservoirs, drawing inspiration from existing measures in Emilia-Romagna, where the local Rural Development Plan provides incentives for such reservoirs with the aim of reducing the pressure on groundwater and surface water resources. With the reservoir construction as the contribution to a "blue club", we theoretically analyse the circumstances in which policy measures are necessary to reach the desired level of the reservoir size, so that the pressure on groundwater resource is reduced. We are also able to identify optimal policy parameters as a function of the membership of the club.

First, the theoretical analysis shows the importance of the the type of access and membership to the club for the design of the policy mechanism. A simple linear subsidy is sufficient to affect the reservoir size in case of open membership, even though potential positive feedbacks from the reservoir to the non-user increase the payment level required. However, this type of payment is ineffective in case of closed membership, since it affects the q-size of the reservoir, but not the n-size. In case of closed membership, minimum participation rules that explicitly link the subsidy to a desired n-size of the club are required. Indeed, in E-R, policy scheme that incentivizes the construction of collective reservoirs include such a collective conditionality constraints. This type of policy design seems hence appropriate in case the public intervention cannot affect the rule that determines the access to the club. Second, the need to coordinate entry rules and payment, hits at the important role of coordination between the CAP, water policy objectives and other local rules that can affect entry. While it seems that an open membership would entail lower cost to reach the societal goals, a proper comparison would require the assessment of the administrative transaction costs in the two cases.

6.2.4.2 Discussion of the chosen methodological approach

The application of a "club" framework to the problem at stake enables to endogenize the choice of cooperating with respect to both the construction of the reservoir and the policy enrolment. However, several limitations apply.

First, we use a relative simple cost function, where we separate coordination costs and abstraction costs. That eases the interpretation of the results, but yields the funny result that individual water consumption does not depend on the n-size of the reservoir. Further development of the model could include a non-linear cost function dependent on the total size of the reservoir. As it is often the case when the endogenous formation of club is addressed, the model is based on a homogenous population of players/farmers. While this most likely would represent a fruitful extension, the problematic issue is that in this case several possible composition (type of farmers), of the club could emerge. Finally, abstraction from groundwater is often difficult to monitor and its limitation is difficult to enforce. The inclusion of a club perspective within a principal-agent framework seems promising.

Another set of weaknesses relate to the empirical potential of this study. The empirical application is clear mainly anecdotal and based on data already available. So it suffers of all qualifications linked to data limitations, especially concerning heterogeneity in profitability by farmers and their water demand. However, it shows the relevance of the topic addressed in the specific regional setting. The coordination costs that determine the cost curve for the coordination component will remain difficult to determine, however, as the amount of data on past project is growing, a better understanding of size choices based also on this approach could be useful for future policy design.

6.2.4.3 Discussion of the participative elements in your modelling approaches

We presented the model and its results to the IV stakeholder workshop. Stakeholders showed interests on the topic since it directly refers to actual policy measure in the region. Moreover, the provided interesting interpretation of the two access cases. Indeed the two access cases seem to represent two different measures within the regional Rural Development Programme that both incentivize collective reservoirs. In one case, group of farmers form the club (closed access case); in a second case, local Water User Associations are the eligible recipients of financial support, and they collect the farmers interest in the project in a sort of open list case.

Furthermore, the Stakeholders provided the explanation for the imposition of minimum participation rule in the actual policy measure. The inclusion of such a rule was due to the limitations imposed by the EU that was necessary to denominate the reservoir as an infrastructure.

6.3 IT-2: Pollination in the hilly and mountain area of the Ravenna province in Italy

6.3.1 Introduction

6.3.1.1 Description of case study region

The case study region is the hilly and mountain area of the Ravenna province. The entire province is 1859 km^2 and 391,290 inhabitants live there.

6.3.1.2 Description of governance-strategy

Agri-Environmental Schemes (AES) are aimed at incentivizing the provision of a wide range of public goods (PG) and ecosystem services that are key for the sustainability of our societies. Their effectiveness is often debated, since for example, the conservation of biodiversity and natural resources requires a landscape perspective that implies the coordination of efforts among the individual, mostly farmers, decision makers. An increasing field of research focuses on the design of such policy schemes, like the agglomeration bonus. These researches often rely on simplified model structures that do not endogenize the formation of the group of farmers cooperating, the coalition.

6.3.2 Methodological approach

6.3.2.1 Theoretical background

We formulate a land allocation model within a game theoretic framework to assess the formation of the coalition, based on the notion of the "internal-external stability" of the coalition. We assume a four-stage game in a Stackelberg setting, which is solved by backward induction.

First, the regulator sets a policy scheme, which is either a traditional, individual agri-environmental scheme, or an agglomeration bonus. Second, players *i* decide whether being part of the coalition ($i \in S$) or not ($i \in R$). Third, the coalition is the leader and members maximize the coalition aggregate benefit, knowing how non-member will react. Fourth, non-members decide, individually maximizing their own benefits.

Farmers can allocate land to arable crops ($c \in Q$), permanent crop ($c \in W$) or non-cultivated land (g). We consider only a short-term period where land allocated to permanent crop is not a decision variable. The total area of non-cultivated land determines the pollination service, a

PG, that in turn affects the productivity of the permanent crops. The model is first solved analytically for the non-coalition members (fourth stage). Non-members maximize:

$$\Pi_i = \sum_q p_q x_{i,q} - \frac{1}{2} k_{i,q} x_{i,q}^2 + \sum_w p_w \bar{x}_{i,w} - \frac{1}{2} k_{i,w} \bar{x}_{i,w}^2 + P x_{i,g} \ \forall i \in R \quad (1)$$

s.t. $$p_w = \bar{p}_w F\left(x_{i,g} + \bar{X}_{-i}^R + \bar{X}^S\right) \text{ with } 0 < F\left(X_g\right) \leq 1 \quad (2)$$

$$\sum_q x_{i,q} + \sum_w \bar{x}_{i,w} + x_{i,g} = L_i \quad (3)$$

where, $x_{i,c}$ is the land allocated to each crop, and $x_{i,g}$ is the land allocated to biodiversity. p_i , $k_{i,c}$ and P respectively marginal revenues, farm-specific cost coefficient for each crop and agri-environmental scheme level. The analytically derived FOC of the above maximization problem are then introduced as constraints in the maximization problem of the coalition that is implemented in GAMS (third stage). Finally, the stability of the coalition is assessed (second stage) and the results of different policy schemes are compared (first stage).

6.3.2.2 Model implementation

We calibrate the farm specific parameters through a PMP approach on data coming from the Ravenna province, in Emilia-Romagna (Italy), which is an area characterized by intensive fruit production. The crop plans for two farm types are drawn from the 2010 Agricultural Census. The two farm types are both specialised in fruit trees, but in different size classes (type A: 5-10 ha; type B: 10-20 ha).

6.3.2.3 Scenarios

We analyse different scenarios differentiated by the composition of the farmer population, and type and level of the payment. In particular, we analyse three farm population compositions ($N^A=10$, $N^B=10$; $N^A=20$, $N^B=0$ and $N^A=0$, $N^B=20$). We consider six payment levels (*P=0*, *100*, *… 500*) for two schemes: a traditional agri-environmental scheme (superscript AES) and a coalition bonus (superscript CB) that incentivizes the production of public good only by coalition members.

6.3.3 Results and interpretation

Figure 1 shows the payoffs for coalition members and free-riders in the two policy schemes characterized by the same level of the payment. Thus the only differences is that in case of the traditional agri-environmental scheme (AES) the payment is offered to the entire population of farmers, whereas in the coalition bonus scheme (CB) they payment is conditional on being a coalition members. The graph shows that the AES scheme is not capable to influence the size of the stable coalition, whereas the CB causes an increase I the stable coalition.

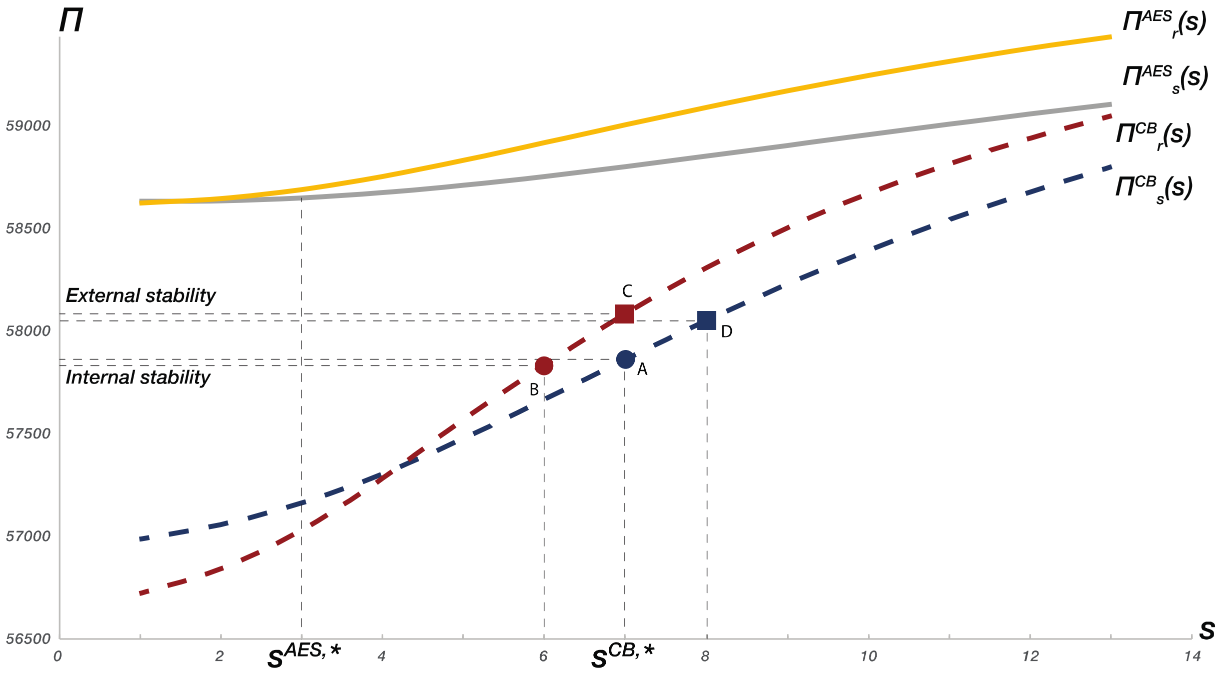


Figure 1: Profits for coalition members and free-riders in the coalition bonus and traditional payment policy schemes for the same level of payment.

Table 1 shows the entire result set in more details, and several findings can be drawn. First, any payment type, not surprisingly, increases the land allocated to public goods. However, the AES does not affect the coalition size that remains fixed at s*=3, whereas the CB causes an increase in s* from s*=3 to s*=20 which is the entire population size. Note that only the largest farms are willing to cooperate. Second, the AES reaches a higher extent of land allocated to public goods than the CB, but the CB is more efficient given the ration expenditures/land allocated to PG.

Table 1. Summary of results.

Payment type	Payment level	s*	s*,A	s*,B	$\sum_i x_{i,g}$	$\sum_{i\in S} x_{i,g}$	Expenditures (E)	$E/\sum_i x_{i,g}$
AES	0	3	0	3	11.7	3.4	0	0
	100	3	0	3	13.3	4.0	1333	100
	200	3	0	3	15.2	4.4	3037	200
	300	3	0	3	17.3	4.8	5185	300
	400	3	0	3	19.6	5.2	7846	400
	500	3	0	3	22.2	5.6	11078	500
	600	3	0	3	24.9	6.0	14933	600
CB	0	3	0	3	11.7	3.4	0	0
	100	4	0	4	13.1	7.0	700	53
	200	4	0	4	13.6	7.9	1580	116
	300	5	0	5	15.6	11.8	3540	226
	400	6	0	6	18.0	15.5	6200	344
	500	10	0	10	27.0	26.6	13300	492
	600	20	10	10	38.4	38.4	23065	600

6.3.4 Discussion

6.3.4.1 Discussion of results

Indeed the results show that while cooperation on the management of an ecosystem service would be an efficient choice that is however constrained by the classic free-riding issue. Properly designed mechanisms, in this context, not only increase the rate of land allocated to conservation, but also stabilize larger coalitions that would not emerge otherwise. The main policy recommendation is thus to increase the difference between traditional, individual payment, and the collective bonus.

6.3.4.2 Discussion of methodological approach

The use of an endogenous coalition formation framework enables to improve the existing analysis of a collective approach in rural policies. More specifically, while most of the research so far has assumed the existence of groups of decision-makers cooperating, here we are able at the same time to endogenize not only land enrolment rate and policy parameters, but also the choice of cooperating, so to have direct policy recommendations on the design of a collective approach toward the provision of agri-environmental public goods.

The main issues with the aforementioned framework is the difficulty to scale up the assessment of these type of policies, unless relying on simplified numerical examples. Future works should try to make an effort n this prospect, given the high interest on the topic from policy makers.

6.3.4.3 Discussion of participative elements in the modelling approaches

The results of the model were presented at the 4th local stakeholder workshop. The analyses were appreciated by the stakeholders, most of them working in the regional administration offices related to the agri-environmental schemes od the regional Rural Development Programme. More specifically they pointed out how it is indeed possible, in theory, to somehow translate the policy recommendations into actual measures, by modulating the payment in different situation, so to mark the difference between coordinated and non-coordinated efforts. However, they expressed concerns over the enrolment rate in these policy mechanisms due to the complexity of the regulations governing agri-environmental measures. Moreover, they acknowledge the need for the coordination of farmers in this prospect, but they also express the concern over the possibility that the regional administration assumes this role. To conclude it seems that local stakeholders are in need for examples of successful application of these measures.

6.4 UK-1: Water quality and biodiversity in the "Ugie river" catchment in Scotland

6.4.1 Introduction

6.4.1.1 Description of case study region

The Scottish case study region corresponds roughly to the north-eastern part of Aberdeenshire, Scotland, centred around the watershed of the river Ugie, located between the towns of Peterhead in the east, Turiff in the west, Fraserburgh in the north and Ellon in the south. This area covers approximately 800 km^2, corresponding to about 1% of Scotland's land surface. The population density for the wider region (Aberdeenshire) is approximately 40.8 inhabitants/km^2. The area is characterised by relatively intensive agriculture in a Scottish context. Aberdeenshire as a whole accounts for ca. 26% of the arable area in Scotland though it only represents around 9% of Scotland's land surface[12]. The soils in the area are dominated by mineral gleys in the eastern part, mineral podzols in the western parts interspersed with smaller areas of brown soils and peaty soils[13]. Most of the area falls within land capability classes 3.1 and 3.2[14], which is reflected in the mixture of arable and mixed agriculture which dominates in the area. Arable crops include barley (used as livestock feed as well as in the whisky industry), brassicas, potatoes and vegetables. The topography is more flat to the east and gradually becomes more varied and undulating towards the west. Apart from agriculture, the area is characterised by the fishing industry based in the nearby town of Peterhead. Similar to the situation in the rest of Aberdeenshire, the oil and gas industry provides another important source of employment in the area.

6.4.1.2 Description of public good issue

The two main public good issues identified by regional level stakeholders for the Ugie area are water quality and biodiversity. The relatively intensive agricultural production characterising the area is seen to influence both water quality and biodiversity negatively, though it is at the same time seen as something that contributes to other public goods in the form of food security, employment and rural vitality, as well as providing private goods in the form of income. In the case of water, the main problems are linked to the use of molluscicides ('slug pellets') as part of the area's vegetable production, as well as farm yard run-off. This is seen

[12] www.aberdeenshire.gov.uk/statistics
[13] http://map.environment.gov.scot/Soil_maps/?layer=1
[14] http://www.hutton.ac.uk/sites/default/files/files/soils/lca_map_hutton.pdf

as especially problematic because the river Ugie is used for drinking water abstraction. Consequently, the water has to be treated using expensive water treatment technologies before it can be safely used for human consumption. Other water related problems include riverbank erosion and reduced levels of aquatic biodiversity. Terrestrial biodiversity is impacted through loss of habitat as well as through some agricultural practices such as pesticide usage.

6.4.1.3 Description of governance-strategy

For water, the suite of selected governance mechanisms (based on discussion during the 3rd regional stakeholder workshop) consisted of green subsidies, catchment partnerships, environmental regulation, education & extension services (for both the general public as well as farmers), public pressure and green labelling. For biodiversity, the following governance mechanisms were selected: Greening of the Common Agricultural Policy, change in agricultural supply chains, promotion of traditional crops, environmental regulation, green labelling, change in narratives about agriculture. During the participatory modelling these mechanisms were further amended (see results).

Stakeholders emphasised improving the way existing mechanisms are used rather than employing completely new ones. This included better coordination between different actors as well as different governance tools so that these would work together and reinforce each other rather than taking piecemeal approaches or sometimes pulling in opposite directions. In order to be targeted to the topic the participants thought that there needed to be a clear connection between actions, governance mechanisms and outcomes, and that there needed to be clear objectives. In addition, reliable, long-term funding and maintenance of targets for governance tools were seen as crucial to achieve substantial outcomes as well as the ability to take into account complexity and diversity at the local level and involving both local and national level actors.

Participants discussed that more holistic approaches would produce more benefits than just increases in the numbers of species and water quality. They expected that better implementation and coordination of these measures would also improve soil quality and reduce erosion, improve land productivity, reduce the need for inputs and water treatment, and increase carbon storage. They would also provide extra benefits in the form of increased (or maintained levels) of pollinating insects, increased and healthier fish populations and more recreation opportunities. Health benefits could also accrue if the production of some 'luxury' goods (e.g. beef) were reduced. In addition, more targeted approaches could help to avoid unintended negative outcomes, reduce transaction costs and improve effectiveness. Likewise, emphasising cooperation and extension, could help to increase trust and reduce the need for costly monitoring (of farmers). Finally, including both local and national levels could help to increase the acceptance of governance measures.

6.4.2 Methodological approach

6.4.2.1 Theoretical background

Fuzzy cognitive mapping is a semi-quantitative method to explore system dynamics, including the effects of feedback loops and time lags (Kok 2009). Fuzzy cognitive mapping consists of first identifying the factors driving a system and then identifying how these factors influence each other, including specifying the direction and strength of the influence using relative numbers (e.g. -1 to +1). The model can then be run in a series of iterative steps to learn about the behaviour and trajectory of the system. The strengths of the influences as well as the outcomes in terms of changes in the factors in the system are given in relative values only. The method is therefore not suited to predict outcomes in terms of absolute values. Advantages of the method include that feedback loops can be included and that qualitative information and expert knowledge can be used as input in the creation and validation of the model.

6.4.2.2 Model implementation

To implement the modelling we conducted two workshops, one with researchers (natural and social scientists) working on issues of environment and governance at the James Hutton Institute in August 2017, and one with local stakeholders (mostly associated with farming) in the case study region in October 2017. In each workshop participants were divided into two groups, one looking at water quality and one looking at biodiversity. At the beginning of the workshop participants were informed about the results of the valuation studies, so they could take this information into account during the model construction. The valuation results were not explicitly included in the models given that fuzzy cognitive mapping uses relative numbers only. For the same reason and taking into account discussions at the previous regional level stakeholder workshop no specific target levels were specified for water quality or biodiversity.

Instead, emphasis was on identifying drivers and barriers for the improvement of public good provision and understanding the system dynamics.

Separate models were co-constructed for water quality and biodiversity. The facilitators used the online fuzzy cognitive modelling tool 'mentalmodeler' as the visual interface for the construction of the model and a laptop connected to a projector so that participants could see how their input was translated into a structure for the model. As starting point for the model we presented the workshop participants with a set of factors (represented by boxes) including the governance mechanisms and private as well as public goods (including but not limited to water quality and biodiversity) from agriculture identified in previous workshops held at the regional level (Aberdeenshire). The facilitators went over all the factors with the participants, and gave them the opportunity to modify these and/or add new ones in. Participants were then asked to identify how different factors influence each other by connecting the factors with arrows showing the direction and type of influence (negative or positive). For each identified relationship, they were then asked about the strength of the influence, which was represented by numbers between -1 and +1 (the closer to -/+ 1, the stronger the influence). Discussions were an important part of the process, and these were audio recorded as well as captured through notes. After constructing the model with the participants, outcomes of changes in the governance factors (and later on the scenario factors) were explored both in the mentalmodeler online tool and in the excel based modelling tool called 'FCMapper' by setting individual governance mechanisms (and scenario factors) as well as the total combination of governance mechanisms to a high level and inspecting the outcomes.

6.4.3 Scenarios

For the scenarios, the workshop participants were presented with the generic scenarios and their parameters and then asked for their input to create locally relevant versions of the parameters and scenarios (Table 1). In both workshops, the participants thought that 'climate change' as specified in the general scenarios was not the right parameter to include, but that variability especially in terms of precipitation and extreme events was more important than average changes in temperature. Population increase was seen as something that could have impacts at different levels from local to national and (less so) global. There were mixed opinions with regard to whether or not only local population trends should be considered, or whether national population changes or indeed global population changes should also be included. In both workshops, participants thought that it was not very likely that population would increase significantly at the local scale under any of the scenarios. However, population growth at the national and global scale could have an influence on the local area by increasing the demand for agricultural produce. In the local stakeholder workshop, there was also some discussion on consumption patterns and willingness to pay for public goods. The participants seemed generally to think that most consumers go for the cheapest options and that this is not going to change, and that willingness to pay for public goods is and will remain quite low. However, one of the participants pointed out that people in general have higher expectations in terms of living standard, which influences overall consumption patterns and that this could also have an influence on agriculture. This was therefore added to the ‘population increase’ box as a factor that could potentially have more influence than population numbers in themselves. In the local workshop, participants suggested ‘Brexit’ as another factor that should be added to the scenarios. However, they felt that this was mainly something that added uncertainty to the system rather than something that was pointing in any specific direction. In both workshops, some of the discussions in relation to the scenarios were about the timescale on which these were operating and should be evaluated. Participants pointed out that factors such as climate change can only meaningfully be considered over a long time scale whereas other factors such as prices and consumption patterns operate over much shorter time scales. This made it difficult for them to relate to the scenarios as whole over a unified time scale.

In the researcher workshop, the participants considered the impact of the market scenario for both the water quality and biodiversity models. In the local stakeholder workshop, for the water quality model, participants considered the ‘business as usual scenario’, while the biodiversity group focused more generally on establishing relationships between the different scenario elements and the model elements without reference to a particular scenario. For the local biodiversity model, subsequently, the model was run with different settings for the included elements to simulate the market scenario and the sustainability scenario.

Table 1. Scenario parameters discussed during the workshops.

Parameter	Scenario 1: Business as Usual	Scenario 2: Sustainability driven	Scenario 3: Market driven
Climatic variability, especially in terms of precipitation	Moderate increase in climatic variability & extremes following current trends	Limited increase in variability	Significant increase in climatic variability & extremes
Population increase/ increased living standards (added in local stakeholder workshop)	as given (moderate)	low	Low in local area, high in central/urban Scotland & globally
Consumption patterns and willingness to pay for public goods	as given (low WTP for PGs)	significant WTP for PGs	no WTP for PGs
Prices of natural resources especially oil	as given (moderate)	high (reflecting scarcity)	low (not reflecting scarcity)
market price volatility	as given (high)	moderate	very high
Technical progress	as given (no big breakthrough)	Significant, environmental-friendly progress	extraordinary, market-oriented progress
Brexit (added in local stakeholder workshop)	High uncertainty	High uncertainty	High uncertainty

6.4.4 Participative approach

6.4.4.1 Stakeholders' input to the development of governance mechanisms:

The governance mechanisms initially chosen as starting points for the modelling were selected in discussion with stakeholders at two regional workshops (round 2 and 3 of the regional level workshops). During the modelling workshops, these governance mechanisms were discussed by the participants and in some cases modified further and new ones added in. As an example, local stakeholders in the biodiversity group chose to split the factor 'changed supply chain' into 'input supply chain' and 'output supply chain'. Both of these were seen as relevant factors that influence agricultural practices and viability, though through different pathways. Some governance mechanisms were not connected to any other factors in the final models constructed by the participants, and were in effect therefore left out of the models.

6.4.4.2 Stakeholders' input to the modelling exercise

Altogether, four different models were created, two for biodiversity and two for water quality. One of each was created together with scientific experts, and one of each together with local stakeholders (mainly associated with farming). While we provided some governance factors and public (as well as private) goods as starting points for building the model (based on stakeholder input during previous regional level workshops) participants modified and added in new factors, and also chose not to include some of the factors. Which factors were included and how these factors were connected to each other was therefore ultimately determined by the participants. Afterwards the models were further refined based on the discussions at the workshops.

6.4.5 Results and interpretation

In none of the models was there a very large difference between fixing the governance mechanisms at a maximum level compared to running the models without introducing any changes. However, the governance mechanisms were already part of the 'no change' model runs. We therefore also ran the models setting the governance mechanisms to a zero value to be able to compare a situation of weakened or no governance mechanisms and strengthened governance mechanisms. As expected, the differences in outcome between these two model runs were larger than when compared to the 'no change' model run (figures 1-4). In all cases the biggest changes in outcomes were primarily in relation to agricultural practices, which had been included as intermediate step between governance mechanisms and the public good outcomes. While this may 'dilute' the outcomes in terms of impacts on public goods, it seems to be a more realistic representation of the pathway of influence, as well as including existing uncertainty about the uptake/implementation of governance mechanisms and about the effects of the implementation of on-the ground management changes on the provision of public goods.

We investigated the effects of individual governance mechanisms as well as the whole package of governance mechanisms taken together. In some cases, changes in provision of public goods seemed to be linked mostly to one particular governance mechanism, e.g. in the local stakeholder model focusing on water quality, changes in biodiversity & habitats seemed mainly to be driven by pillar 2 subsidies. However, in most cases the effect was not clearly related to any one governance mechanism but to the whole suite of governance mechanisms taken together. Even in the cases where a single governance mechanism was particularly influential, this was only in relation to particular public (or private) goods but never on the whole suite of desirable public goods. This seems to indicate that an array of different governance mechanisms are indeed needed in order to promote the delivery of the different public and private goods which stakeholders find important.

Maybe more informative than the numerical model prediction are the arguments behind the participants' ratings. For example, according to local stakeholders promoting traditional crops in order to improve biodiversity on agricultural land was not likely to be effective because they doubted that there would be any uptake from farmers unless there was any consumer demand for this kind of produce. This in turn was seen as unlikely as they evaluated consumer behaviour as mainly driven by prices. In addition, they questioned the validity of the concept of 'traditional crops' and reacted negatively against the idea of going back to something that had been outdated and was not seen as part of modern farming. As these were stakeholders mainly linked to farming it gives a good indication of the likelihood of this particular governance mechanism to be successful unless the way it is presented and implemented is carefully considered.

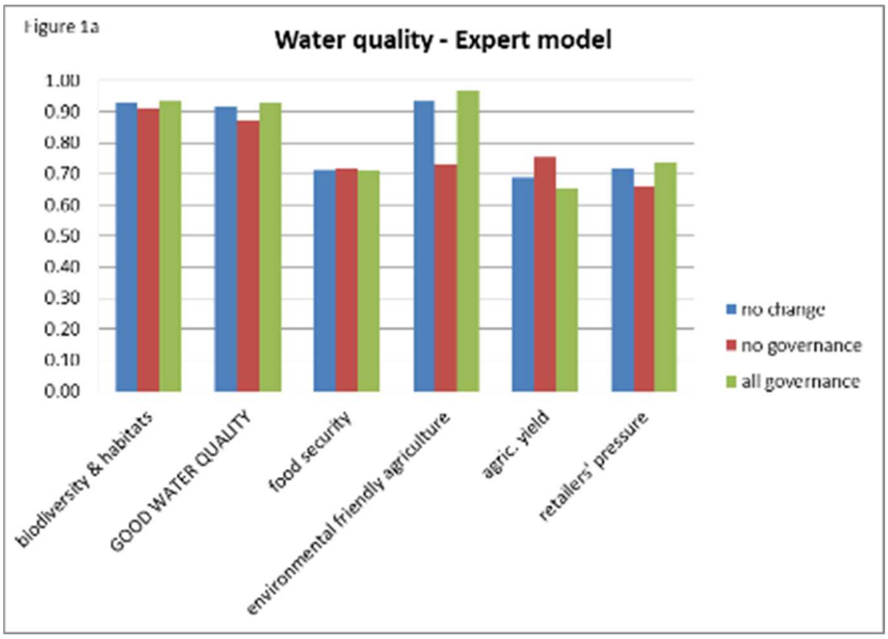


Figure 1a
Water quality - Expert model
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
biodiversity & habitats
GOOD WATER QUALITY
food security
environmental friendly agriculture
agric. yield
retailers' pressure
no change
no governance
all governance

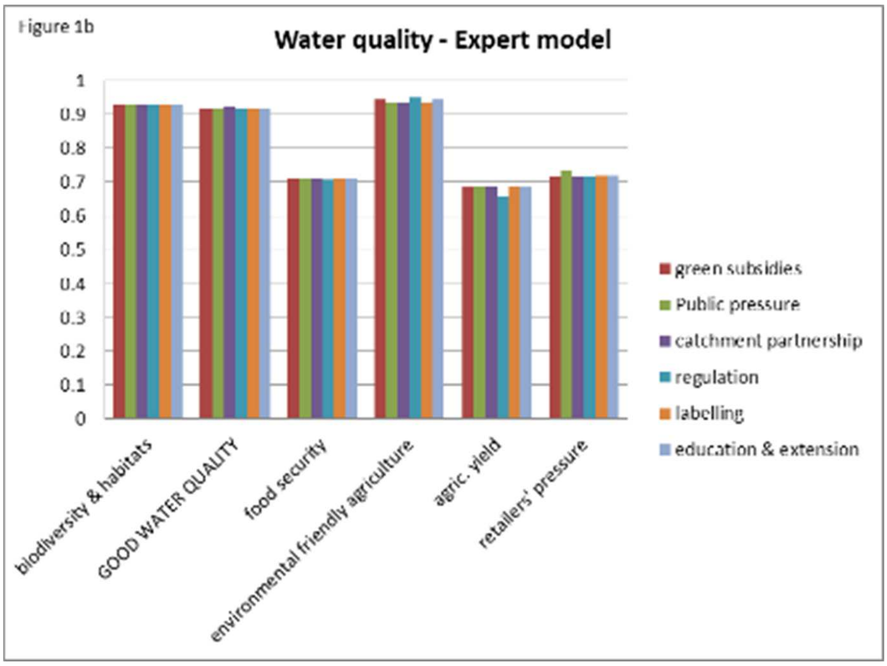


Figure 1b
Water quality - Expert model
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
biodiversity & habitats
GOOD WATER QUALITY
food security
environmental friendly agriculture
agric. yield
retailers' pressure
green subsidies
Public pressure
catchment partnership
regulation
labelling
education & extension

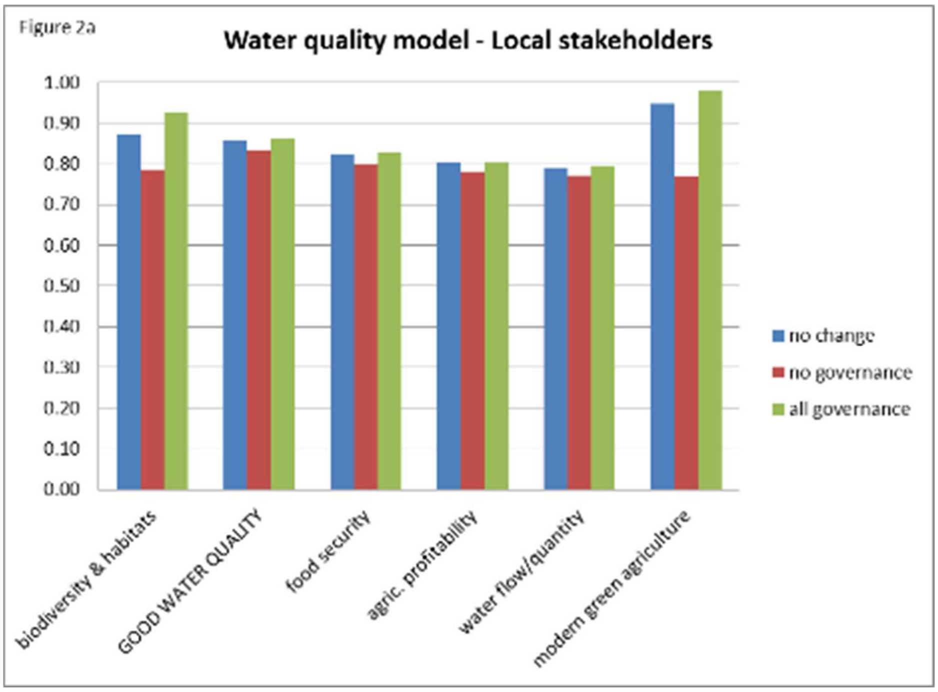


Figure 2a
Water quality model - Local stakeholders
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
no change
no governance
all governance
biodiversity & habitats
GOOD WATER QUALITY
food security
agric. profitability
water flow/quantity
modern green agriculture

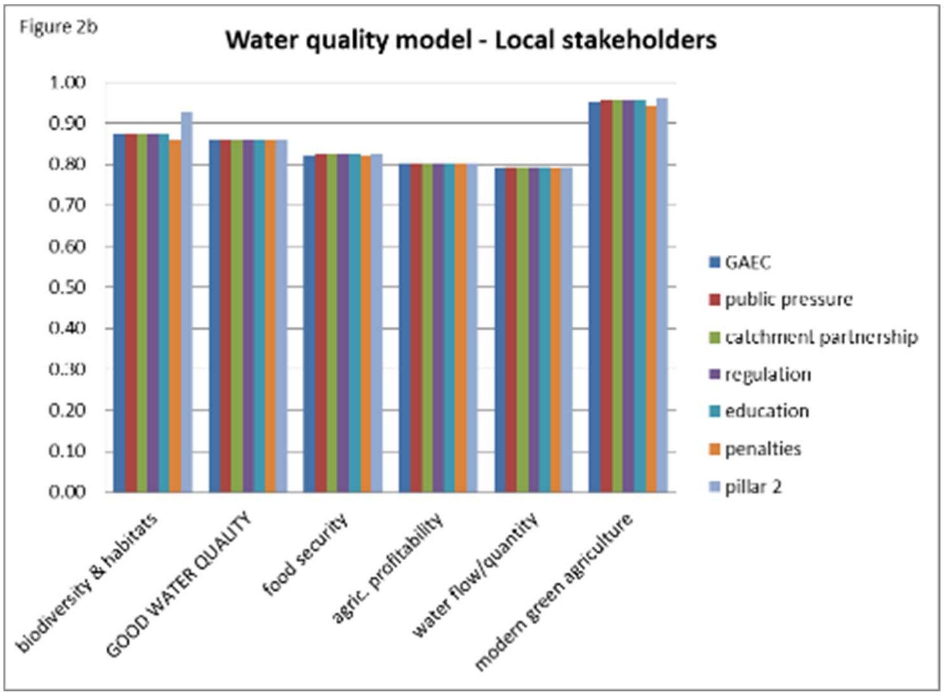


Figure 2b
Water quality model - Local stakeholders
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
GAEC
public pressure
catchment partnership
regulation
education
penalties
pillar 2
biodiversity & habitats
GOOD WATER QUALITY
food security
agric. profitability
water flow/quantity
modern green agriculture

Figure 3a

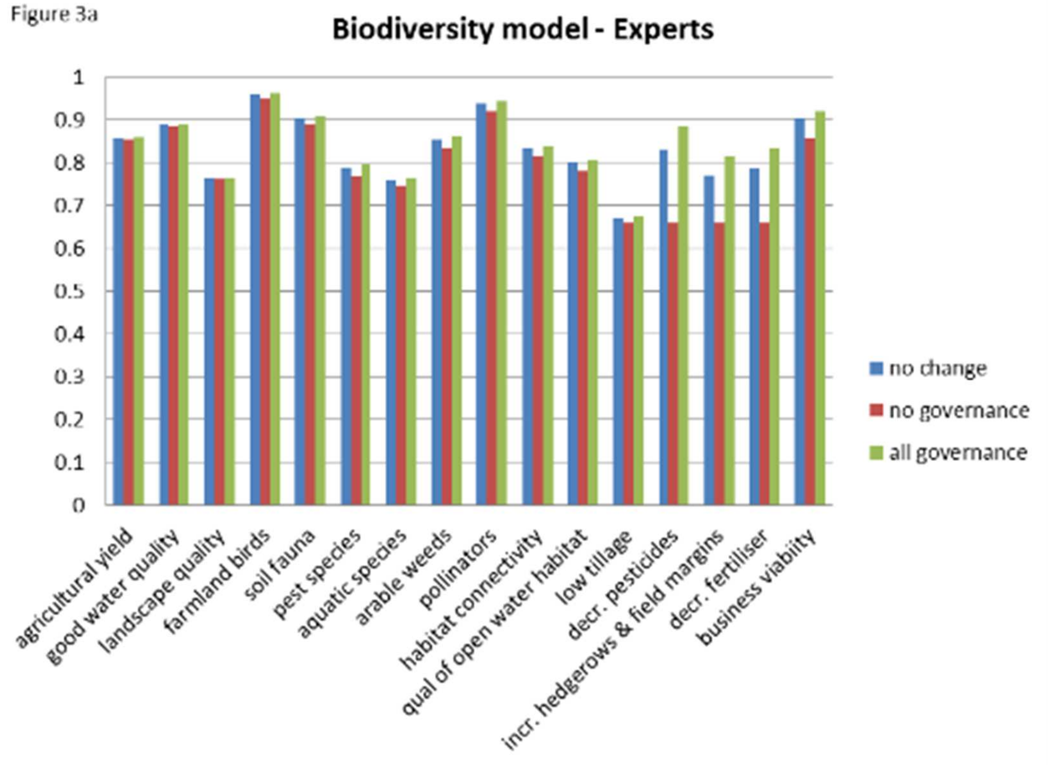
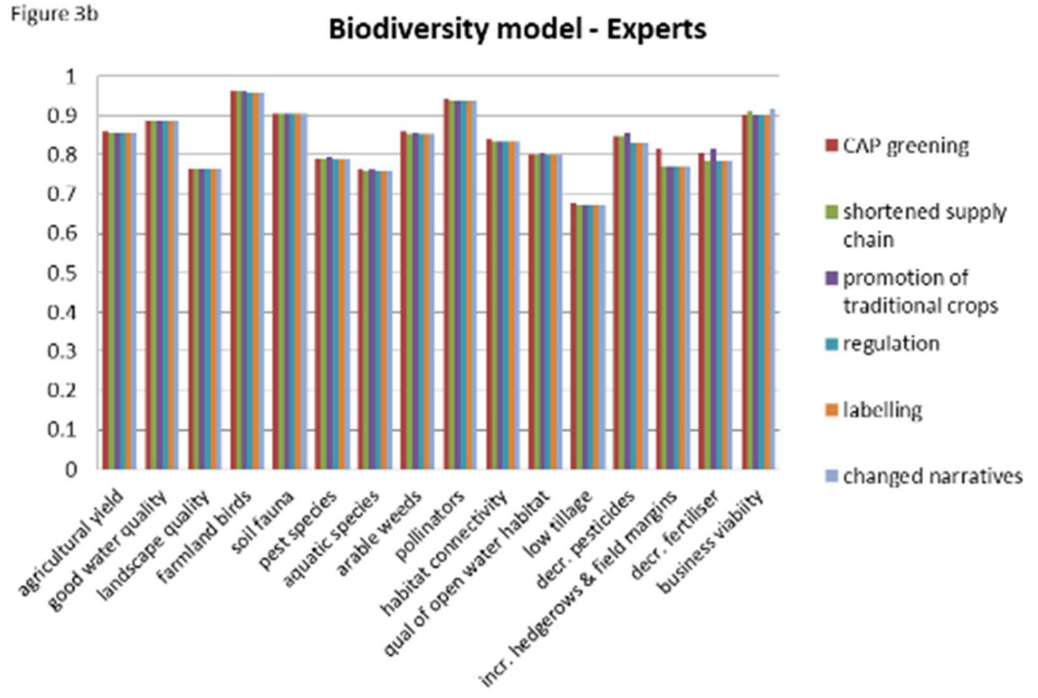
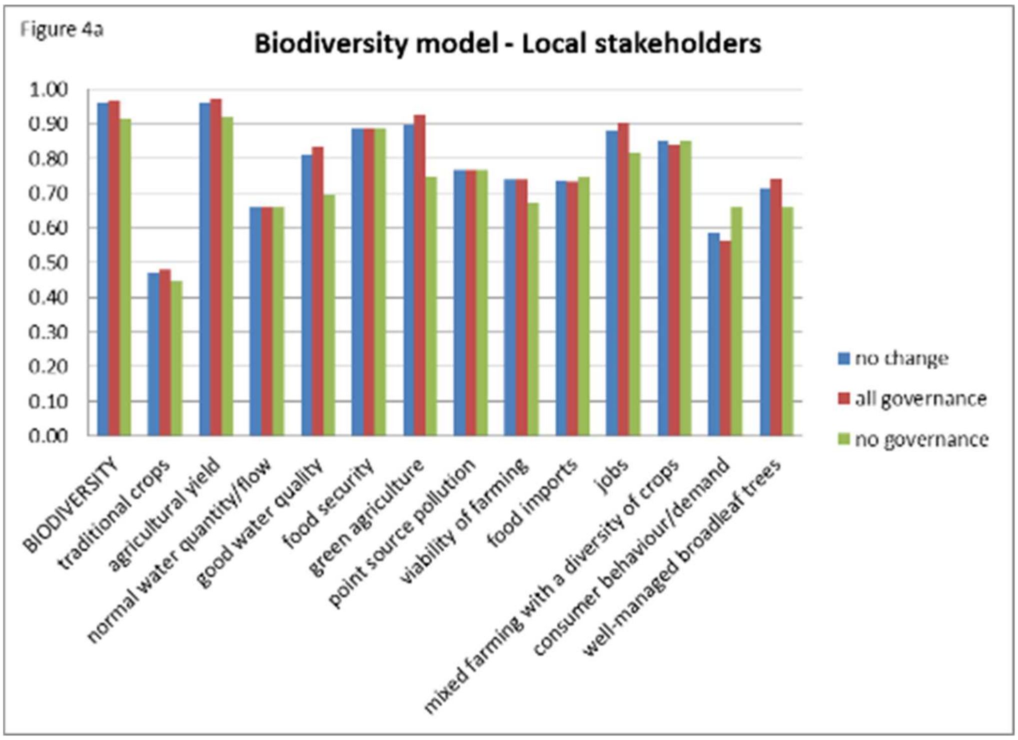


Figure 3b





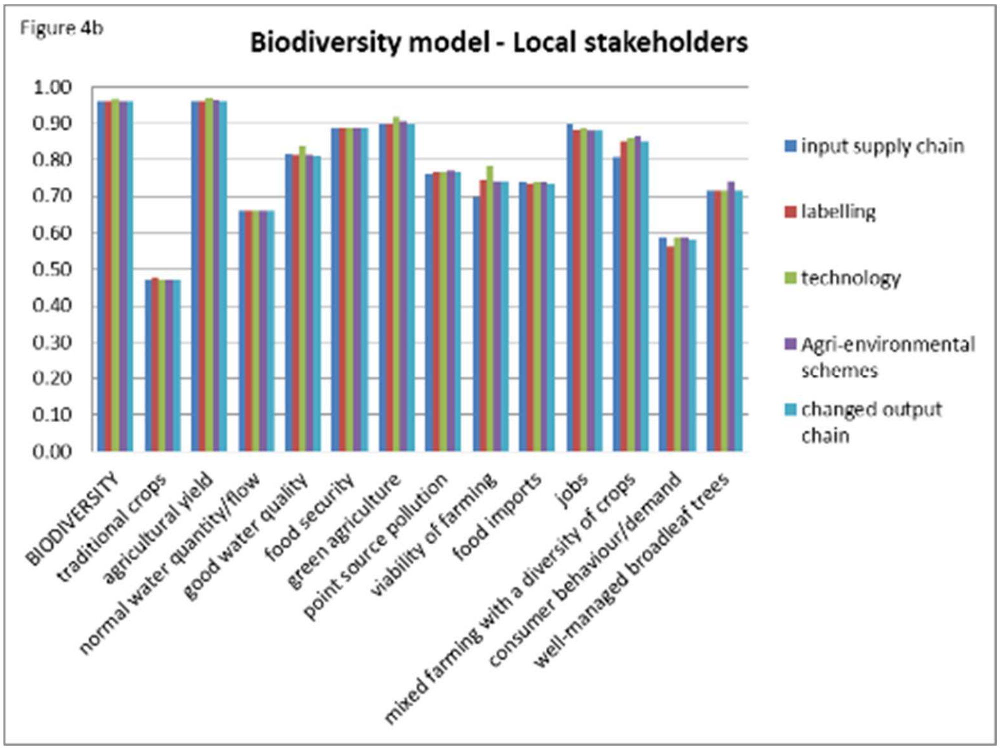


Figure 1-4. Outputs from running the models constructed with experts and local stakeholders for water quality and biodiversity. 'No change' corresponds to running the model without changing the settings for the governance mechanisms included in the model. 'No governance' corresponds to running the model with all governance mechanisms set at zero. 'All governance' corresponds to running the model with all governance mechanisms set at one. Bars for individual governance mechanisms correspond to running the model with that governance mechanism set at one, while not changing the other governance mechanisms. The height of the bars indicates the relative magnitudes of the 'output' levels of the different factors.

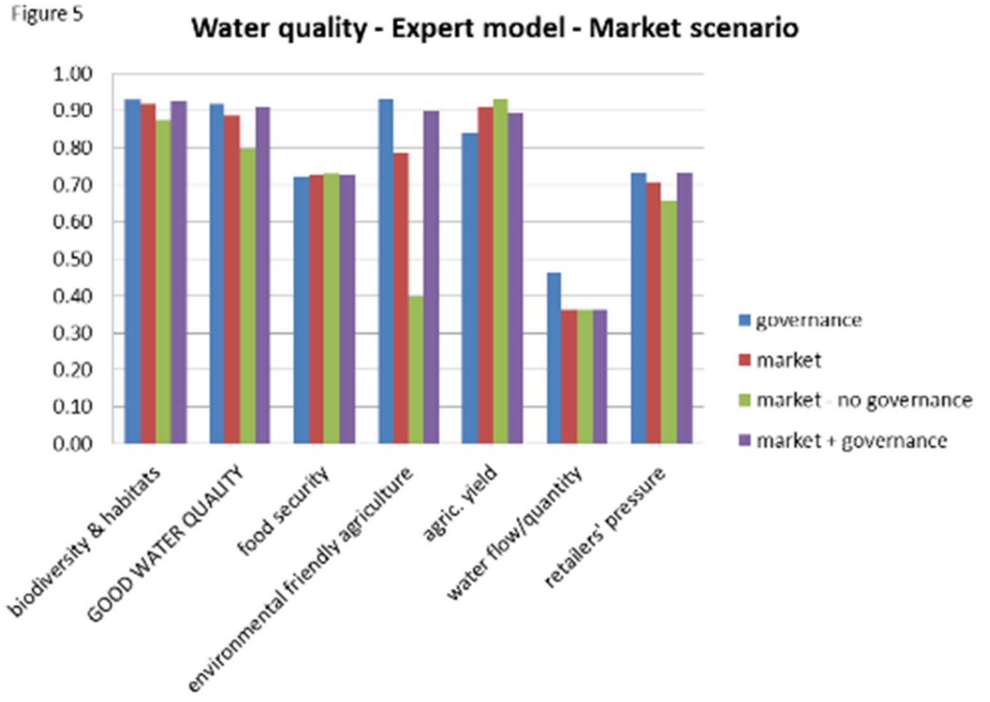
Although we did not explicitly include the valuation results or other indicators of efficiency, some of the elements in the models as well as the discussions during the model construction make it possible to gauge how efficient different governance mechanisms might be. In all models 'agricultural yield' was included as a factor which could give an indication of some of the costs farmers may experience as a result of the implementation of different governance and management mechanisms. Other factors which are related to costs, were added in by participants in some of the models. For example, in the two biodiversity models (experts + local stakeholders) viability of farming/ business viability was added as another factor in the system, which was influenced by governance mechanisms and other factors. Discussions during the model construction provided additional insights into efficiency and costs. For example, the local stakeholder group on biodiversity identified aspects of agri-environmental schemes which reduce their efficiency by raising the costs to farmers (e.g., time consuming and complicated application procedures, centralised design of rules/ management regimes, and risks of fines), while the expert group on biodiversity discussed trade-offs introduced by some measures by improving certain aspects of biodiversity (such as arable weeds) which at the same incur costs to the farmers (by competing with crops and thereby lowering their yield). Similar discussions also emerged in the water quality group, where farmers mentioned over-regulation as an important cost for farmers, which potentially represents a barrier to the adoption of green agricultural practices.

In the expert workshop the group focusing on water quality chose to look at the market scenario. Introducing the scenario variables (high consumption, high climatic variability, low input prices and high price volatility) resulted mostly in reductions in the public goods as well as a reduction in environmentally friendly agriculture (figure 5). The reductions were stronger without any governance mechanisms operating and were lessened by setting governance mechanisms at a high level. According to participants, this made sense because the implementation of governance mechanisms would likely help to offset the increased pressures on the environment due to climate change and more intense agriculture (due to higher demand for agricultural products and more profitability of agriculture in the market scenario).

In the local stakeholder workshop, the group working on the water model chose to look at the 'business as usual' scenario with the factors 'high priority on health', 'changing political input' and 'technical progress'. In this case some public goods ('good water quality' and 'food security') were positively influenced by implementing the scenario whereas others were negatively influenced ('biodiversity and habitats' and 'water flow')(figure 6). Setting governance at high levels together with the scenario factors produced similar results to implementing the model with governance but without the scenario factors set at high levels.

In the case of the expert workshop, the biodiversity group included the factors 'high climate variability' and 'production focused technological breakthrough' in their version of the market scenario. Most public goods were negatively affected by implementing the market scenario (figure 7). In some cases, setting the governance mechanisms at a high level together with the scenario variables brought the levels of public good provisions back to levels similar to those without the market scenario, while for others (e.g. good water quality, farmland birds and pollinators) the levels were still lower than before adding in the scenario factors.

Figure 5



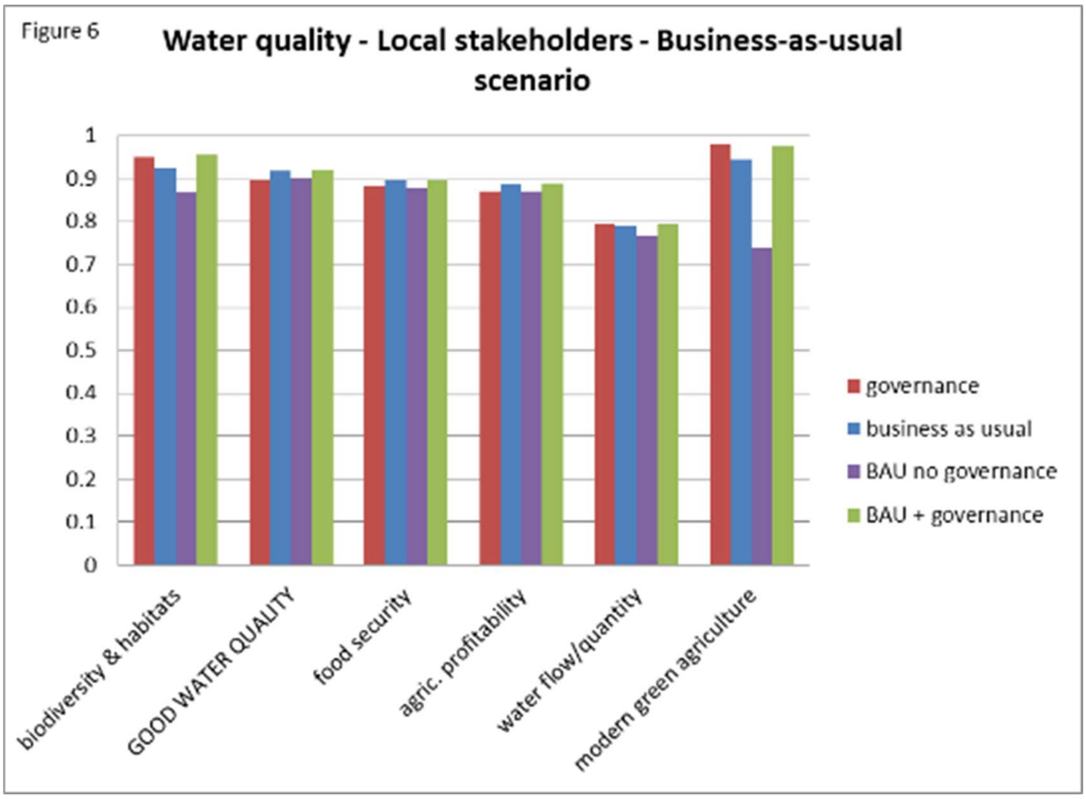


Figure 6
Water quality - Local stakeholders - Business-as-usual scenario
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
biodiversity & habitats
GOOD WATER QUALITY
food security
agric. profitability
water flow/quantity
modern green agriculture
governance
business as usual
BAU no governance
BAU + governance

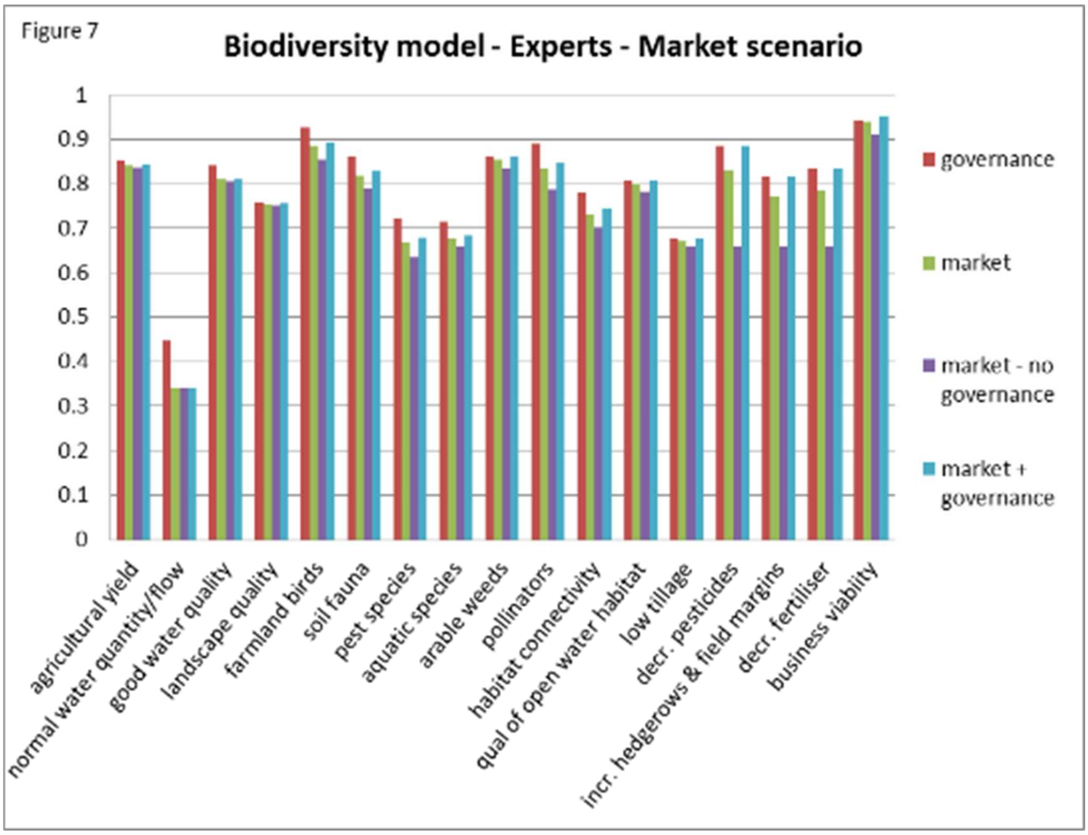
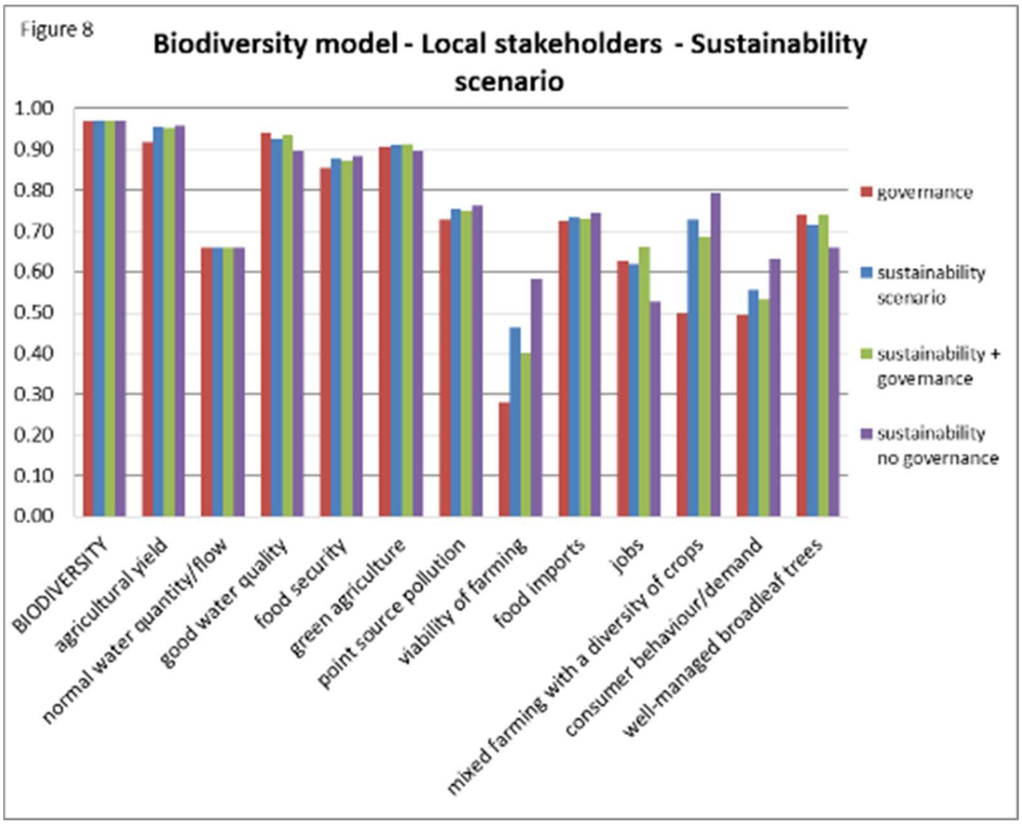


Figure 7
Biodiversity model - Experts - Market scenario
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
agricultural yield
normal water quantity/flow
good water quality
landscape quality
farmland birds
soil fauna
pest species
aquatic species
arable weeds
pollinators
habitat connectivity
qual of open water habitat
low tillage
decr. pesticides
incr. hedgerows & field margins
decr. fertiliser
business viability
governance
market
market - no governance
market + governance



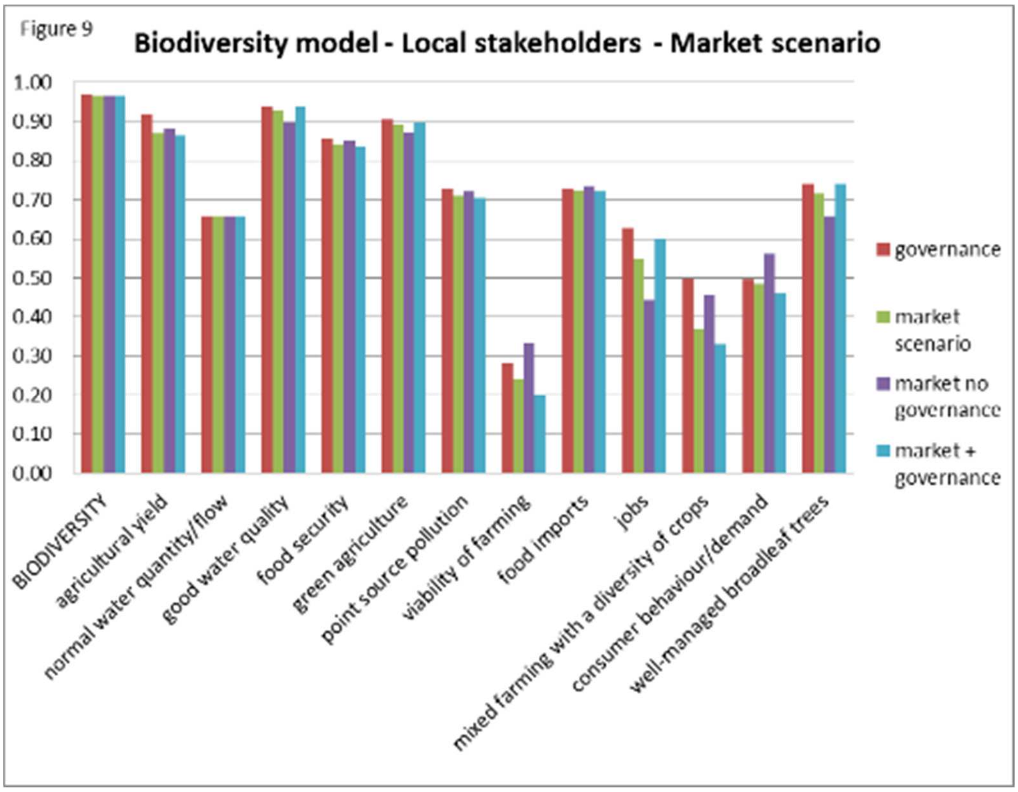


Figure 5-9. Outputs from running the models constructed with experts and local stakeholders for water quality and biodiversity respectively and including scenario factors (model outputs with governance but no scenario factors are included for comparison). For the different scenarios, the scenario factors were set at levels corresponding to the scenario outline and with governance mechanism either not fixed, fixed at zero or fixed at one. The height of the bars indicates the relative magnitudes of the 'output' levels of the different factors.

In the local stakeholder workshop, the group working on biodiversity discussed the relationships between the scenario factors and the other factors in the model on a more generic level without linking it to any particular scenario setting. Subsequently, the market scenario and sustainability scenario were run in the model with the scenario factors set at levels reflecting the two scenarios (for the market scenario 'more efficient technology', price volatility', 'variable weather patterns' and 'population/lifestyle change' were set at 1, while 'oil price' was set at 0.3, for the sustainability scenario 'more efficient technology' and 'oil price' were set at 1, while 'price volatility', 'variable weather patterns' and 'population change/lifestyle change' were set at 0.3). Running the market scenario settings resulted in reductions in some of the public goods such as 'good water quality' whereas others such as 'biodiversity' and 'water flow' were not affected (figure 8). For some of these factors, setting governance mechanisms at high levels together with the scenario factors produced similar results to running the model with governance mechanisms at high level without fixing the scenario factor levels. For a few factors (e.g. 'mixed farming'), combining high levels of governance and setting the scenario factors resulted in lower levels compared to running either the governance or the scenario settings by themselves. Adjusting the values for the scenario factors to reflect the sustainability scenario, produced similar patterns of mixed results (figure 9).

6.4.6 Discussion

6.4.6.1 Discussion of results

The models built together with experts and local stakeholders reflect their conceptualisations of the system and of the ways in which different factors influence each other, as well as the uncertainties associated with these. The models are therefore most suited to providing insights into the experiences as well as perceptions of stakeholders, rather than providing quantitative predictions of outcomes. Nevertheless, the modelling exercise provided useful insights into the implications of employing different governance mechanisms, because such mechanisms are also based on particular conceptualisations of the system and stakeholders behaviours' and responses, which are often linked to stakeholders conceptualisations' of the system. The models of both the local stakeholders and the experts reflected that changes in the levels of public goods are always mediated through changes in practices. Changing the settings for governance mechanisms in the models therefore had more (direct) impacts on the practices compared to (the indirect impacts on) the levels of public goods. This reflects that implementation of governance mechanisms will always involve uncertainties both in relation to the uptake and in relation to the effects on the public good levels.

Trying to identify links between individual governance mechanisms, agricultural practices and public good levels also highlighted where there may be barriers or where particular conditions need to be fulfilled for a governance mechanism to have any impact. In the local stakeholder group focusing on biodiversity, discussions around 'promotion of traditional crops' for example showed that farmers would be more likely to respond to consumer signals rather than subsidies in this regard, but also that the concept of 'traditional crops' had negative or questionable associations for farmers. Choice of entry points and wording may therefore have significant impacts on whether or not promotion of traditional crops would be an effective way of promoting on-farm biodiversity. Similarly, complicated application procedures, centralised prescriptions and a 'policing' approach to subsidy schemes were seen as factors that undermined farmers' willingness to participate.

Comparing the models constructed by the local stakeholders and the experts, respectively, shows that local stakeholders saw technological progress as a way to improve public good provisions as well as agricultural yields in a win-win setting. In contrast, experts did not include technology in their base models, but conceived trade-offs between agricultural yield and public goods. This points towards fundamental differences in how the relationship between agriculture and the environment is conceptualised by the two groups. While participants in the local stakeholder group did recognise that agriculture sometimes caused environmental problems they fundamentally saw the link between farming and the environment as a positive one, whereas experts had a more negative view of the same relationship. While on the one hand this may mean that root causes of environmental problems, and therefore appropriate solutions, are viewed very differently by the two groups, farmers' self-identity as environmental stewards may also help to create common ground with other stakeholders, and needs to be taken into account in governance seeking to improve the environment or the delivery of public goods (Harrison et al., 1998). In both groups there was an emphasis on complexity and the importance of the specific characteristics of localities, habitats and species, which makes it challenging to design and employ centrally designed governance mechanisms successfully. Similarly, both groups recognised the need to use a suite of different mechanisms, and the model outputs confirm that no single governance mechanism would be able to ensure high levels of all public goods. This includes more conventional (e.g. regulation, penalties for non-compliance, subsidies/payments) governance mechanisms associated with the state as well as less conventional governance mechanisms associated with other actors (e.g. public pressure, labelling, partnerships, etc.).

In the scenarios part, the discussions and identified relationships between scenario factors and the other model components pointed towards many perceived uncertainties in the form of, for example, world markets, consumer demand and political decisions, but also that both experts and stakeholders generally expect that there will be significant impacts on agriculture and public goods in the future. At the same time the workshops showed that different actors are likely to differ in their views on the influence of different factors on agriculture in the future. Mostly, the participants did not include any direct effects of the scenario factors on the governance mechanisms, and this was reflected in the model outputs for the scenarios: the governance mechanisms were still having effects on the levels of public good provisions, though mostly the levels were different from running the model without the scenarios. This seems to fit well with expectations that more would need to be done to maintain similar levels/improvements in public goods in the future.

6.4.6.2 Discussion of methodological approach

Fuzzy cognitive mapping is particularly suited to represent dynamic aspects such as feedback loops and to make use of qualitative information and stakeholder input. It provided a good entry point to discuss the perceived links within the system. The models constructed in our workshops did not enable us to evaluate the efficiency of the selected governance mechanisms. The effectiveness could be evaluated in relative terms by comparing the impacts of individual governance mechanisms to each other and to the impact of all the governance impacts combined. In addition, as the modelling was implemented together with stakeholders, the discussion in relation to for example setting the 'strength' of each identified influence also included discussions of efficiency and effectiveness and provide as important data as the actual modelling outcome.

6.4.6.3 Discussion of the participative elements in the modelling approaches

Fuzzy cognitive mapping is particularly suited for participatory approaches as it can handle qualitative input, is intuitively easy to understand and can be done 'in real time' so that stakeholders can immediately explore consequences of adding in new factors or changing relationships in the system. This approach can help to facilitate discussions about the system and elicit stakeholders' perceptions about linkages and importance of different factors in a system in a structured way. To fully make use of this method, the discussions around the model construction are therefore as important as the actual model, especially given the more qualitative and perceptions-based nature of the model (and hence its outputs). A weakness as in most modelling approaches is that the more complex and hence closer to participants' perceptions of reality the model is, the less likely is it that there will be very noticeable changes in the system when the model is run as effects get diluted. In addition, some participants may object to the quantification of relationships required by the model.

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6.5 DE-1: Carbon sequestration in the peatland area "Upper Rhinluch" in Germany

6.5.1 Introduction

6.5.1.1 Description of case study region

Based on the stakeholder discussion in the case study region Märkische Schweiz, located in the East of Berlin as part of the Federal State Brandenburg and a concentration on the peatlands in the regions as a hotspot region for public good supply (mainly carbon sequestration), we decided to include another Brandenburg peatland area (Rhinluch, located in the Northwest of Berlin) to get a more robust information basis about the peatland management situation in the region as well as the implementation, efficiency and effectiveness of related governance mechanisms.

The **Märkische Schweiz nature park** extends from the Eastern fringe of Berlin (25 km distance from the city) towards the Oder valley at the German-Polish border, covering a total of 576.4 Km² and encompasses ten municipalities. The main settlements are Strausberg (ca. 26,000 inh.) and Müncheberg (ca. 7,000 inh.). The region is located in the humid continental climate zone, characterised by severe winter, no dry season and warm summers. The average annual temperature is 8.8°C with -1.2°C in January and 18°C in July. The average annual precipitation does not exceed 500-560 mm/year (27 mm in February to 70 mm in July) (MLUR 2000). The morphology is the result of cyclic glacial advances and peri-glacial geomorphologic processes, resulting in heterogeneous natural conditions (geomorphology, pedology and topography). Therefore the regional can be subdivided into landscape zones, including glacial valleys, ground- and end-moraines plateaus and slope sides. The elevation ranges between 5.8 m and 144 m. The soil typologies are quite heterogeneous, but are all characterised by a general low fertility. The agricultural structure with an average farm size of 235 ha per holding is result of agricultural historical development of the last 300 years. It includes the early agricultural land reclamation through the establishment of extensive drainage system with canals construction, increasing farm and field sizes of the socialist collectivization of the mid-20th century with extensive removal and re-modelling of landscape elements, such as fences, hedges, and even drainage ditches as well as the comprehensive technical modernization and transformation into more extensified management systems after accession to the European Common Agricultural Policy (CAP) in 1990. According to the local stakeholder assessment, the glacial valley "Rotes Luch", a 15 km long continuous peatland area, is of specific interest, because there the provision of public goods is especially dependent on and changing with the land management.

The **Upper Rhinluch landscape** is located about 50 km Northwest of Berlin and consists mainly of a peatland area around the small flood stream Rhin. Administratively, the landscape is part of the municipalities of Kremmen and Fehrbellin, which together cover an area of 477 km² with 15,892 inhabitants (2014; 33.3 inh./km²). The core peatland area itself, however, is very thinly populated concentrated in the two minor settlements. The farming system of the Rhinluch peatland had been historically (especially in the 1960-1990) under strong intervention into the water management (melioration) in favour for optimised agricultural production. A very complex system of streams, dikes, dams, polders, weirs, canals, flood gates, pre-flooder (36 m water streams per ha) had been established and monitored to lower the water table and to allow farming practices. As a result, the water level in the main streams is about 60-80 cm below ground level (partly 150-200 cm). In the Upper Rhinluch landscape less than 50 farms are active (124 farms in total in both municipalities with an average farm size of 265 ha).

The general soil fertility conditions are very heterogenic, but rather low, due to sandy soils, but also moraine soils. Through the intensive agricultural land use, soils are additionally degraded (and will further degrade). The grassland is of rather low quality and biodiversity compared to the German average. Precipitation takes place rather in winter time, causing droughts in spring and summer, flooding in winter. Farms already perceive droughts as very severe and see need for irrigation. Water levels are very heterogenic and difficult to control.

The core zones close to the central water streams are permanently and temporally re-wetted and only extensively used for grazing by cattle and sheep. Other areas are more intensively used for grazing and fodder production (3-5 cuttings per year). More peripheral areas with better soil conditions are used for arable production, including intensive vegetable and asparagus cultivation. Further intensification of these floodplains is not aimed, mainly due to the limited market potential for livestock products.

Rhinluch area is the largest migratory crane resting place in Europe and therefore of ecological importance beyond the region itself. Therefore extensive nature protection areas (ca. 3,500 ha) have been established. At the same time the region is well-known for cranes resting there, which attracts visitors and generates public interest. Nature protection requires high water tables. Complete flooding creating shallow water areas supports especially amphibians, cranes, storks, etc. Keeping water in the landscape prevents moors and peatland to dry out. Higher water tables can also improve irrigation situation for agriculture in dry summers. However, farms oppose complete flooding as well as temporary flooding schemes and restricted cutting of grassland because they fear losses in production.

6.5.1.2 Description of public good issue

We investigate possibilities for better PG provision in peatland areas through improved water table management and related land use management. The public goods that are especially affected by the water table management are climate stability, water quantity and biodiversity. Peatlands are carbon rich soils that work as a carbon sink. When they are used for agricultural production they are often deeply drained from early spring until autumn. Oxygen gets into the soil and mineralisation processes take place, causing greenhouse gas (GHG) emissions, mainly as carbon dioxide (CO_2). Therefore drained and agriculturally used peatland areas make up 5 % of overall German GHG emissions, contributing to climate change. Peatlands have the ability to function like a swamp, storing water in seasons with high precipitation and release it during drier seasons. This provides water for groundwater recharge and freshwater supply. Drainage of peatlands changes the functionality of the soils and often leads to water scarcity during growing season in our case study area. Additionally, drainage causes a loss of typical peatland habitats for species. Hence, raising the water table about 10 cm below ground and extensifying the system will keep the functionality of peatlands and lead to better PG provision.

6.5.1.3 Description of governance-strategy

According to stakeholder workshops and in-depth interviews with farmers who manage peatlands we considered and investigated a mix of three governance mechanisms (GMs): 1) an agri-environmental measure (AEM) targeted at climate friendly peatland management, 2) cooperation among farmers, and 3) value chain opportunities through market innovations. The aim is on the one hand to protect and re-establish peatlands and to keep water in the landscape system through a raised water table, but on the other hand to allow farmers to manage their land, and to maintain their business activities. As a result several public goods, among them climate stability, water quantity and biodiversity will be enhanced.

Until now, only limited knowledge and experiences are available about the measure uptake, effectiveness and optimal measure design. Effectiveness of the measure requires implementation at larger functional, hydrological scales, e.g. watershed, landscape scale, beyond farm scale. Therefore, coordination between farmers is conditional to reach a better PG provision. We investigate the perception and openness of farmers to coordinate and agree with neighbouring land user for a common measure implementation. Additional value chain opportunities through market innovations (such as a heat power plant based on cut grass from peatlands) or new sales markets (niche products and high quality meat from cattle adjusted to high water tables) contribute to a socially accepted rewetting of peatlands.

The overall mix of compensation for forgone income through 1) an AEM, 2) coordination of communication and cooperation among neighbouring land managers and 3) additional value chain opportunities will results in enhanced PG provision, mitigate public bads and would be widely accepted by farmers and society.

6.5.2 Methodological Approach

6.5.2.1 Theoretical background

Our theoretical approach to assess the governance mechanism (GM) is based on the assumption, that the willingness to accept (WTA) of peatland and water level management change by farmers is increasing when cooperation between neighbours and regional value chain opportunities related to peatland management is enhanced. Accordingly the required amount of financial compensation for the income foregone and increased work efforts can be reduced, when coupling with cooperation and value chain approaches.

Therefore the overall theoretical model (see Fig. 1) integrates elements and mechanisms, incl.

(i) results of discrete choice experiment (DCE) on the WTA of the AES
(ii) a scenario and impact assessment exercise (to assess the likelihood of GM implementation) and
(iii) a literature study on the environmental effectiveness of the land use change.

These elements are connected through a number of hypotheses:

(i) There is a minimum financial compensation for which farmers accept the AES.

(ii) The cost of financial compensation needed is reduced, when regional cooperation/coordination and regional value chain opportunities are enhanced.

(iii) Under different scenario settings (BAU, sustainability-oriented, market-oriented) the regional framework conditions (environment/climate, economy, population/demography, technology/innovation, policy/governance) are changing.

(iv) Changed framework condition affect the likelihood of the GM implementation, also affecting the cost of the AES implementation and thus the cost of PG supply

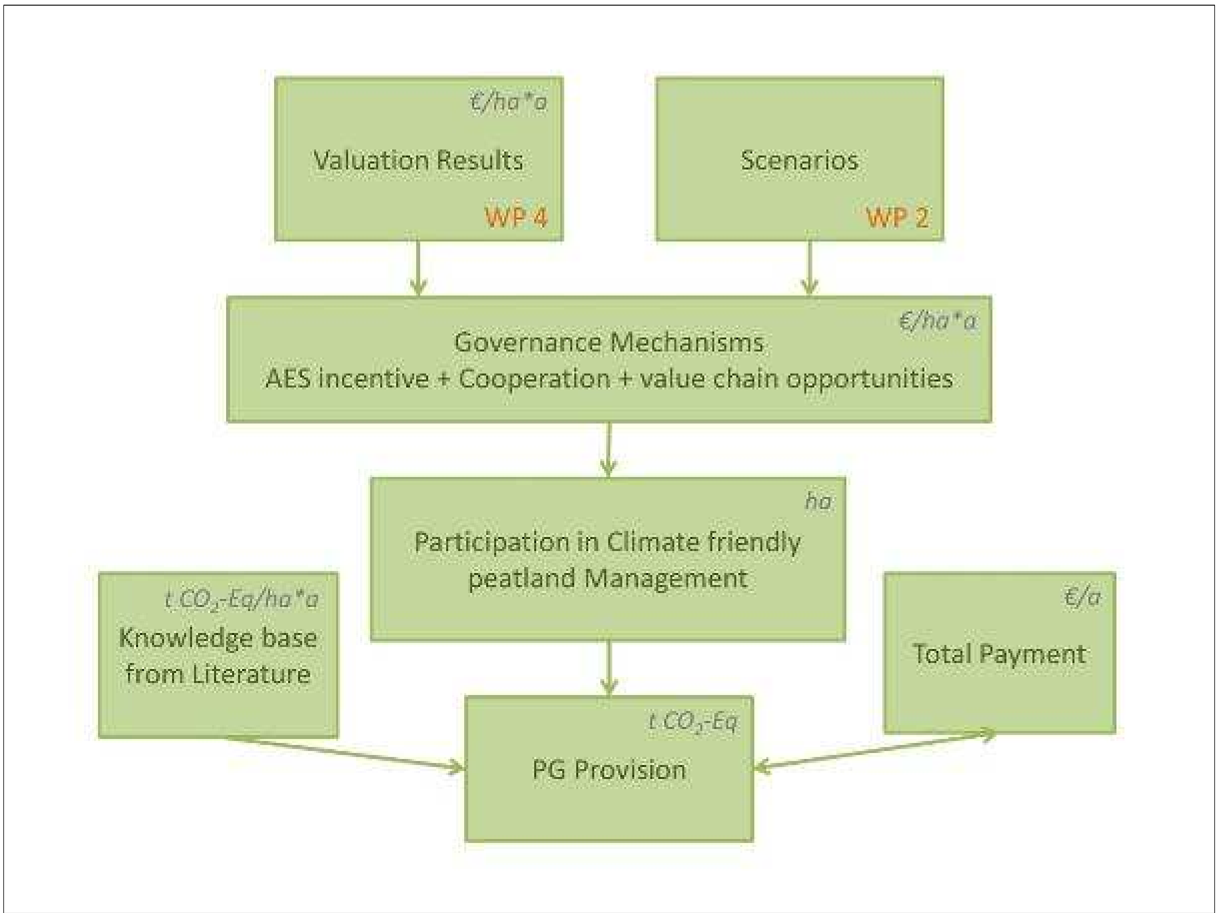

Figure 1. Overview of the model, showing how WP4 results and activities in WP2 feed into the assessment of optimal PG provision.

6.5.2.2 Model implementation

As for the management of peatlands no current target levels of PG provision can be set, we can only clearly state the target level for landscape management that in turn is affecting the PGs biodiversity, soil functionality, water quantity, and climate stability. With the current state of knowledge within science it is not possible to estimate clear target levels for PG provision, because the effect of peatland management on PGBs provision is not entirely clear or quantified. There are normative levels such as: Germany aims to cut its GHG emission by 2050 by 80-95 %. Please also see our reporting on the third regional workshop on this. But the effect of a specific landscape management on those PGs are only of qualitative dimension such as a raise in water level to 20 cm below ground will lead to reduction of GHG emissions and therefore contribute to climate stability; it will enhance habitat for species and therefore have positive impact on biodiversity, etc. But a quantification of the effect of water level and extensive management on the PG provision is not done yet and in fact subject of current research (such as in EU H2020 projects like PEATWISE that try to estimate the impact of organic soil management on ecosystem services provision).

We therefore address in our model not target levels of PGBs, but an optimized peatland management, that has a target levels of 10 cm groundwater level below ground, no fertilization and one usage of land per year (mowing, grazing, mulching). The effects on PGBs provision are calculated under several assumptions (see also D4.2).

As an example, the normative target level for climate stability is set as: 12 Mio t CO_2-Eq have to be saved until 2030 from the field of agriculture (Bundesregierung, 2016). If 800,000 ha of carbon rich soils would be converted to extensively wet managed grassland 12 Mio t CO_2-Eq could be saved[15]. Hence the most ambitious target level could be rewetting 800,000 ha of peaty soils. This equals about 72 % of all agriculturally used peatlands and 51 % of all peatlands in Germany.

We integrated the results of the supply valuation in our model. A higher participation in the proposed agri-environmental measure will result in more land under climate friendly peatland management, which in turn will enhance the PG provision. If we consider WP4 results, we can estimate that under future scenarios the PG provision will drop through reduced acceptance and participation in the schemes or will rise through a higher acceptance and participation.

In our model we calculate based on the WP4 results different payments for the different GMs and can in turn calculate the provision and price of climate stability and for which price how much GHG emissions could be mitigated.

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[15] About 15 t CO_2-Eq/ha*a emissions could be avoided, assuming an improvement from drained intense grassland management (~25 t CO_2-Eq/ha*a emissions) to extensive wet grassland management (~10 t CO_2-Eq/ha*a) (see e.g. Drösler et al., 2013). 15 t CO_2-Eq/ha*a times 800,000 ha = 12,000,000 t CO_2-Eq

6.5.3 Scenarios

Scenario: Business as Usual

The business as usual scenario was assessed by the local stakeholders as a situation where population numbers in general will not vary in the region but where the age structure depends on the investments of the government in education and social organization. The economic dimension was not pictured very positive. There is either no change or a weaker economic performance especially because the farmers in the region are primary producers and due to the fact that they see no market opportunities in heat and energy sector. The sector was described as a closed market. Economically a willingness to pay for public goods by consumers is seen in the crane related tourism which is perceived as the willingness to pay for an environmental good.

Policy support for agricultural aid is expected to get reduced in general. Looking at the dimension of the climate and environment temperature, precipitation and extreme weather events are not expected to vary a lot between the three scenarios but was also not described in further detail. It was stated that intensive grassland management will lead to a further loss of biodiversity and that extensive management can lead to biodiversity increase in the region. Also it became clear that under the business as usual scenario the fen will sink in further and make cultivation unfeasible.

The discharge of water after the winter is done to early at the moment. Pumping of water for a few weeks to allow cultivation would be positive for cultivation and would avoid early outlet but is too costly. From 1.1.2019 local pumping stations will take care of pumps and polders and so the fees for the property owners will be doubled (circa 28€/ha). This leads to the claim that society should pay the fees.

Regarding the dimension of technology and innovation the usage and support of heavy machinery will be increased leading to less support for new labour opportunities and to a destruction of the dams.

Scenario: Sustainability-driven

Under the sustainably driven scenario participants pictured a society where either the population in the region declines due to abandonment of farming activities or it even grows when people are moving back from an overpopulated Berlin into the countryside. Economically a large potential is seen in the tourism sector.

Consumers are well educated and aware of the importance to buy climate friendly products. The quality of the agricultural product is of primary importance but producers can incorporate costs for ecosystem services in the product price because there is a larger willingness to pay for public goods by the society. Also products made from insects are seen as a possibility for this future scenario.

The government expropriates to reach the goals of a targeted designation of protected areas. The designation of prioritized land use management is done by the regional agency for environment. In general the public funds are increased and payments for the environment and for public goods are made. The first pillar funds of the CAP are integrated in the second pillar. Cooperation is present and steered by the government not done in a bottom up organization. Also under this sustainable driven scenario participants said that the peat land soils are preserved but agricultural cultivation is not feasible on the preserved soils.

The technological and innovation dimension is seen as an area where large open access data hubs with a lot of accessible information, also used for ecological steering and the measurement of ecological effects, are established. In general technical problems are solved and dams, polders and a water retention basin are maintained by the water and soil association. In addition the water and soil association provides the possibility to work with a two-sided damming system which allows to discharge or to supply water to a certain area. The technological regulations promote light machinery and/or the employment of five workers per hectare.

Scenario: Market-driven

In the market driven scenario a large number of negative climate effects in and more extreme weather events are anticipated. The population is decreasing in the region but there is no consensus about the age structure of the population. There could be either a large number of old people in the region or a baby boom could occur. Mostly poor people move to the countryside therefore region has to look after the population and take care of them to connect them somehow to the countryside/homeland.

The economical dimension is one the one hand described as in general low in investments and on the other hand as a situation with high potential for economic growth and market dominance. All activities have to be economically profitable for farmers. The risk of resource scarcity is increased and peatland protection is not possible on privately owned areas; a maximum would be some form of peat care on privately owned land. The solution to guarantee peatland protection would be expropriation. The agricultural soils are exploited in the region. The number of regulations imposed by the government is low, as well as the investments in the agricultural sector. Agricultural support/funding is given up under this future vision.

In contrast to the sustainability scenario with free access to data here data monopolies and privately owned data, e.g. by google, is envisioned. Relating to the developments of machinery there is nearly no room for improvements because large machinery is already in use and heavy machinery is prevalent. An area of technical innovation could be the development of better harvesting machines for paludiculture systems. The existing dams in the area will maximally be preserved but no investments in dams are made.

Table 1. Scenario parameters discussed during the workshops.

	Parameter	Scenario 1: Business as Usual	Scenario 2: Sustainability-driven	Scenario 3: Market-driven
Climate and Environment	Temperature, precipitation, extreme weather events	nearly no differences between scenarios	nearly no differences between scenarios	a large number of negative climate effects in general; more extreme weather events
	Nature and biodiversity	intensive grassland management leads to loss of biodiversity; extensive management leads to biodiversity; further sinking of turf and lower agricultural production	targeted designation of protected areas; designation of prioritized land use management by the regional agency for environment	peatland protection not possible on private owned areas, maximum some form of peat care (or expropriation); region marketing aiming at water tourism;
	Agricultural cultivation conditions (soil, water)	sinking of fen makes cultivation unfeasible; outlet of water after winter to early (actual); pumping of water for a few weeks to allow cultivation would be positive and would avoid early outlet but is expensive; from 1.1.2019 local pumping stations take care of pumps and polders → payments by property owners will be doubled (circa 28€/ha) → claim: should be paid by society	bog soil preservation but no agricultural cultivation	Fresh sowing possible → conservation of turf; exploited soils
Economy	Regional economic development	range from stable to weaker economic performance (primary producer); no market opportunities in heat and energy sector	tourism as general potential for the region development	in general low investments; all actions have to be economically profitable for farmers; risk of resource scarcity; high potential for economic growth; concentration/market dominance
	Prices and volatility for agricultural products, inputs and resources	No information given	No information given	No information given
	Consumers' willingness to pay for public goods	willingness to pay for crane related tourism as environmental good	quality of the product is the priority but payments for ecosystem services can be incorporated in the product price; increased willingness to pay; marketing of products with less carbon emissions	No information given

Population and Demography	**General remarks**	No information given	insects will be eaten (CO_2 friendly); change of mind in the population has to be slow that agriculture can develop in parallel	poor people move to the countryside; region has to look after the population, take care of them → connection to homeland
	Population (natural development and migration)	no change	Population decline due to abandonment of farming activities; population increase due to overpopulation in Berlin and people moving to the countryside	Declining population numbers
	Age structure	will depend on governmental structures (social, material, education)	No information given	Larger number of old people; maybe Baby boom
	Edu-cation	No information given	Needs educated population to effectively market CO_2 friendly products	No information given
Technology and Innovation	**Digitalisation**	all data already available (GPS-Systems)	Data can be used for ecological steering; open access data; autonomous farmers, measuring of ecological effects; large data networks (data hubs);	Data monopolies; privately owned date (e.g. google)
	Bio-technology	No information given	No information given	No information given
	Machinery and equipment	support for heavy machinery instead of labour; dams will be destroyed	Regulations towards light machinery or employment of 5 workers per ha; 2-sided damming (water discharge and water supply) with an additional large retention basin; polder and water retention (water and soil association); maintenance of dams by water and soil association; technical problems are solved	nearly no room for improvements already large machinery in use; dams will be maximally be preserved but no investments in dams; harvesting machines for paludiculture; heavy technology
Policy	**Regu-lation**	No information given	expropriation to reach aims	no regulations;
	Market intervention and support	total agricultural aid gets reduced	funds increased; payments for the environment and public goods; funds from the first pillar of the CAP are integrated in the second pillar	in general few investments; agricultural support is given up; politics have to react faster to conditions in landscaping; population has to be able to support itself with own labour
	Participation and governance	No information given	cooperation is steered by the government (no bottom-up organization)	No information given

6.5.4 Participative approach

For the regional foresight exercise and evaluation of the governance mechanism, we employed a hierarchical participatory process (Abildtrup et al., 2006) to adopt the pre-defined scenario framework (business-as usual, sustainability-driven, and economy-driven) and related global driving forces to the regional situation to develop regional future scenario narratives. These are then applied for testing for effects on the selected governance mechanisms and coupled to the choice modelling results of the farmer's willingness to accept study.

In a first step, stakeholders develop regional future scenario narratives for the three scenario settings. Therefore, future developments in the five different scenario dimensions (i.e. economy, climate and environment, technology and innovation, population and demography, policy) as main driving forces with a total of 15 sub-dimensions (3 for each dimension) are discussed with stakeholders. For the workshop, we prepared one world café table for each of the three basic scenarios. Stakeholder discussed then the future manifestation of the 15 sub-dimensions. For some of the sub-dimensions, no information was given as workshop participant felt unable to determine a future development or the sub-dimension are irrelevant to them. Stakeholders entered a table in groups. The scenario exercise and the basic scenario were introduced. After that participants wrote statements on cards, which were pinned on the table cloths. Doing so, the scenarios were stepwise enriched and densified (see Tab. 1) and combined to consistent scenario storyline in the follow up.

In a second step, the workshop participants were ask to estimate the impact of the developed future scenarios on the future development and relevance of the governance mechanisms (i.e. agri-environmental measure, regional value chains and farmers cooperation in the context of peatland management) in terms of the future uptake of these GMs. Therefore, scorecards have been prepared in beforehand, which allowed the determination of the effect on the GM based on a Likert-scale scheme (-2, -1, 0, +1, +2) (see Fig. 3). So workshop participants estimated the effect of the each of the three scenarios on each of the three GMs. It has been decided to set a maximum range to -50% up to +100%. In total, large group of 32 participants from research, administration, nature conservation and farming in the region participated in the workshop. Roughly the half of them (N=16) participated in the impact assessment exercise.

In the following process, the average future impact assessments of the GMs – differentiated into different types of stakeholders – are coupled with the results of the farmers' choice experiment to estimate the area expansion of peatland conservation management measure in the region departing from today's situation. Doing so, we are also able to estimate the PG (carbon sequestration) effects.

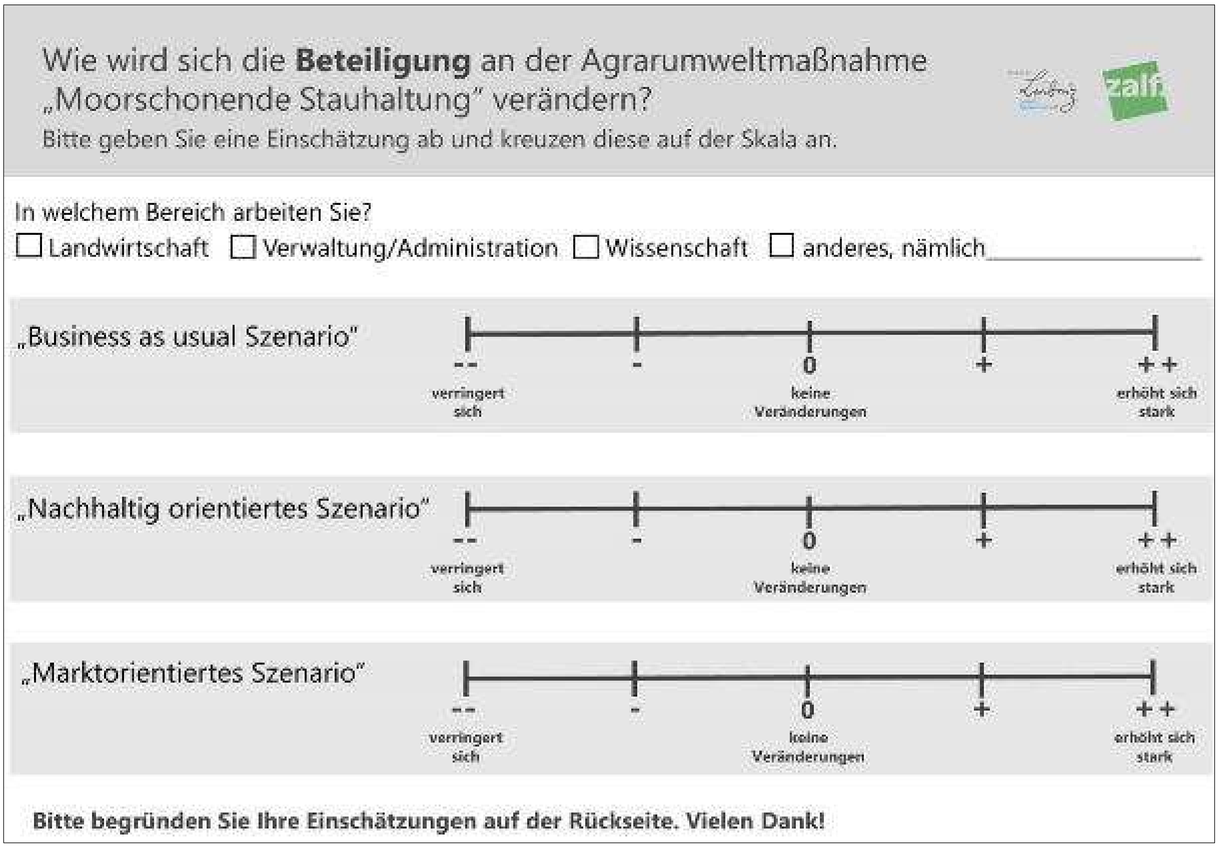

Figure 2. Example of an assessment choice card, which has been used to collect stakeholders' estimation of the probability changes of the governance mechanism (here: participation in an agri-environmental measure).

6.5.5 Results and Interpretation

We investigated three governance mechanisms and modelled the effect of them on the provision of the PG Climate Stability. The effect of climate friendly peatland management can only be modelled for Climate Stability, where reliable knowledge base from the field of natural science exists. The effect of this peatland management on the PGs Water Quantity and Biodiversity is so far not quantified and therefore the effect of the governance mechanisms on the provision of the PGs biodiversity and water quantity cannot be modelled.[16]

[16] Qualitative estimates for the effect of a raised water table in peatland areas on biodiversity and the water system can be found in Naturkapital Deutschland – TEEB DE (2015). Rewetting of peatland has a positive effect on both PGs.

In the following we present the costs for the provision of PGs under the three GMs. The costs are calculated from the results of the discrete choice experiment (DCE) conducted in WP4 and are now analysed in detail according to the GMs for WP5.

6.5.5.1 Individual Governance Mechanisms

<u>GM 1 – Financial Incentive</u>

The overall average willingness to accept under the current contract conditions (five years; no support for cooperation; medium effort; no acceptance of cut grass assured) is calculated as 522 €/ha*a.

<u>GM 2 – Cooperation</u>

Offering support for cooperation by the water and soil associations would reduce the minimum financial compensation level by 53 €/ha*a. Hence, an average payment of 469 €/ha*a would be needed.

<u>GM 3 – Value Chain Opportunities</u>

The guaranteed purchase of the cut grass would reduce monetary compensations even more by 67 €/ha*a for a fixed price; or 77 €/ha*a for market prices, resulting in an average payment of 445 €/ha*a.

6.5.5.2 Optimal mix of Governance Mechanisms (GMs)

As a result, under an optimal contract design, **combining all three GMs 1) incentive, 2) support for cooperation and 3) value chain opportunities**, farmers would be willing to participate in the scheme for an average compensation of 385 €/ha*a. Hence, **the optimal governance strategy** is a mix of these three GMs leading to the **most cost efficient** provision of PGs in agriculturally used peatland areas.

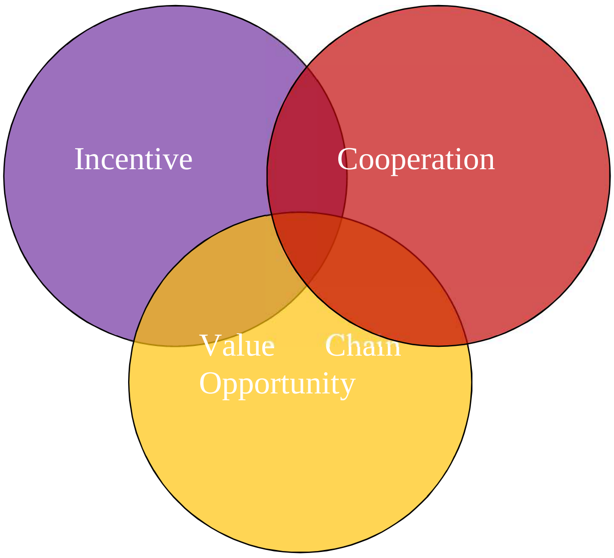

Figure 3. Optimal mix of Governance Mechanisms for climate friendly peatland management.

6.5.5.3 Impact on PG Climate Stability

Considering the above mentioned costs of the climate friendly peatland management and combine it with the avoided GHG emissions, we can estimate the price of metric tonnes CO_2 equivalent avoided through the measure. Through the change from drained medium-intensive grassland management to extensive wet grassland management about 15 t CO_2-Eq/ha*a emissions could be avoided (see Figure 4 based on e.g. Couwenberg et al., 2011; Drösler et al., 2013; Tiemeyer et al., 2016). Hence, combining the costs of 522 €/ha*a and the 15 t CO_2-Eq/ha*a avoided GHG emissions, the **price for saved carbon is calculated as 35 €/t CO_2-Eq under the AEM as incentive only**.

With the **optimal governance mix** with the additional support for cooperation and access to local value chains, the price per ton of avoided GHG emissions would be **26 €/t CO_2-Eq** based on 385 €/ha*a as necessary payment to the farmers.

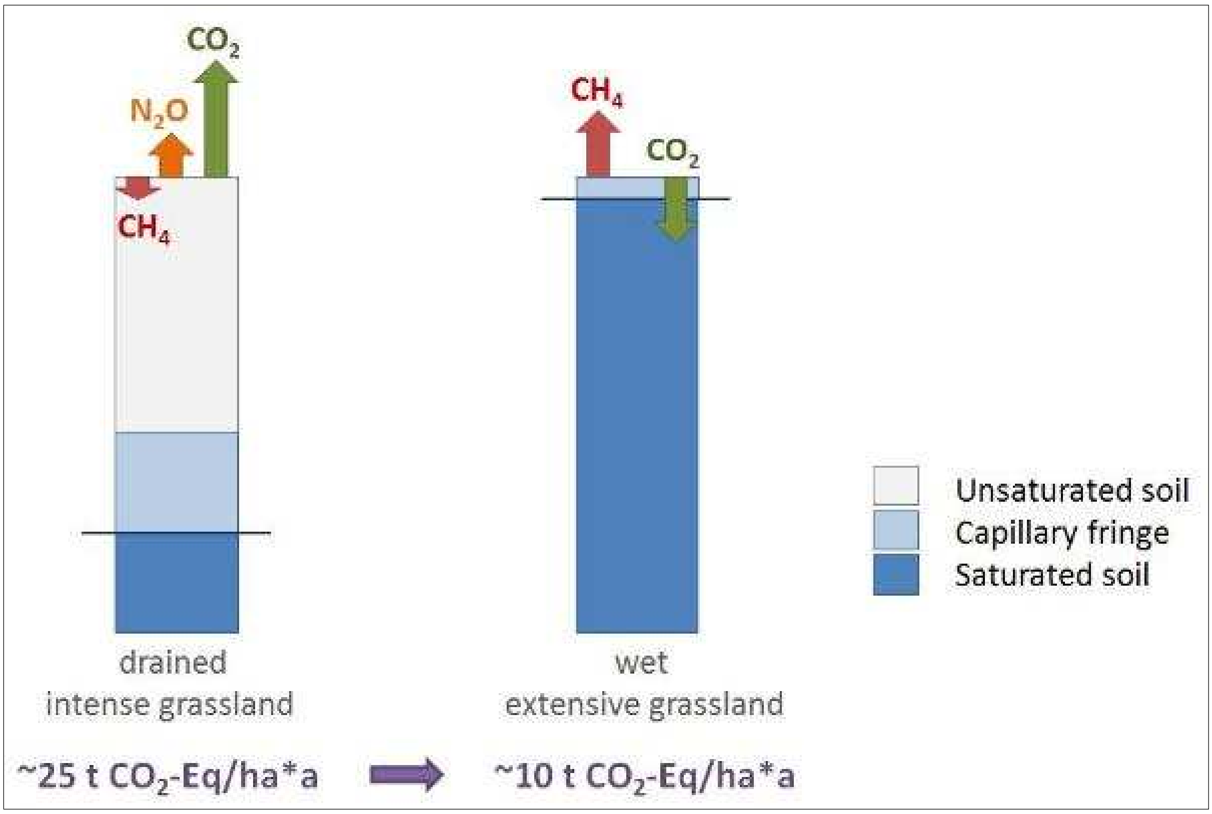

Figure 4. Possible GHG reduction through agri-environmental measure (AEM) according to Couwenberg et al., 2011; Drösler et al., 2013; Tiemeyer et al., 2016) .

The target level of GHG emissions that have to be mitigated per year in the agricultural sector until 2030 is 12 Mio t CO_2-Eq (Bundesregierung, 2016). Considering the 15 t CO_2-Eq/ha*a emissions that could be avoided with climate friendly peatland management, 800,000 ha of agriculturally used peatland need to be rewetted to reach the targeted GHG mitigation (if climate friendly peatland management is the only measure that contributes to the mitigation). Rewetting 800,000 ha for the price of 522 €/ha*a will result in **total payment per year of 417.6 Mio €/a to reach the targeted GHG mitigation of Germany. Under the optimal governance mix the total price could be reduced to 308.0 Mio €/a.**

6.5.5.4 Scenario exercise

In a second step of the scenario exercise, participants assessed the impact of the three scenarios, which have been regionalized in a first step (business as usual, sustainability-oriented, market-oriented). Therefore we asked the participants:

(i) To which extent will the participation of farmers in the agri-environmental measure (AEM) for peatland conservation change?

(ii) To which extent will the cooperation of neighbouring farmers concerning the peatland management change?
(iii) To which extent will opportunities for (regional) value-creation related to peatland management change?

Using a Likert-scale assessment scheme (-2 “strong decrease”, -1 “moderate decrease”, 0 “no change”, 1 “moderate increase”, 2 “strong increase”), participants could assess the impact of each of the scenarios on each of the governance / market mechanisms to encourage a peatland management, which is providing public goods). In total 15 stakeholders (7 farmers, 4 administration and research, 4 other, including NGOs, associations, private business) participated in this step. One additional person refused to participate due to difficulties of understanding the task. Only very few of the participants used the option to comment on the own choice.

Results of the exercise show that participants are relatively optimistic regarding the future performance of the governance / market mechanisms, as in most of the scenario-mechanism combinations, increasing tendencies are estimated, such as +0.51 for farm cooperation, +0.29 for the participation in AEM and +0.21 for regional value chain.

The by far largest increase is seen for the sustainability-oriented scenario as in average moderate increases are foreseen for the participation in AEM (1.0), cooperation (1.23) and regional value chains (0.79). In comparison, the market-driven scenario is seen only marginally optimistic concerning the performance of the three GMs. Interestingly, only the business-as-usual scenario is seen mainly negatively, especially for value chain opportunities (-0.36). Regardless of the scenario, an increasing extent of cooperation between farmers is expected.

There is large consensus also between the participant groups about the positive effects of the sustainability-scenario for the governance / market mechanism. Administration and research are much more optimistic about the role of the regional value chains, especially in the market scenario, compared to farmers and others. Disagreement can also be found between farmers and other participants about the future perspective of the implementation success of the AEM. Whereas farmers have a more optimistic outlook also in the market-driven scenario (+0.43), other assume a decreasing uptake (-0.50 / -0.25).

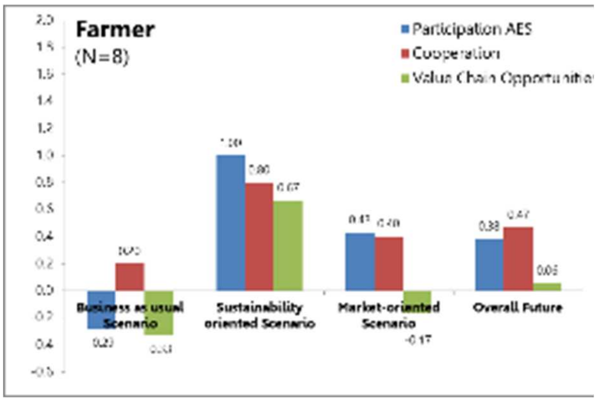

Figure 5. Average impacts assessment values for farmers.

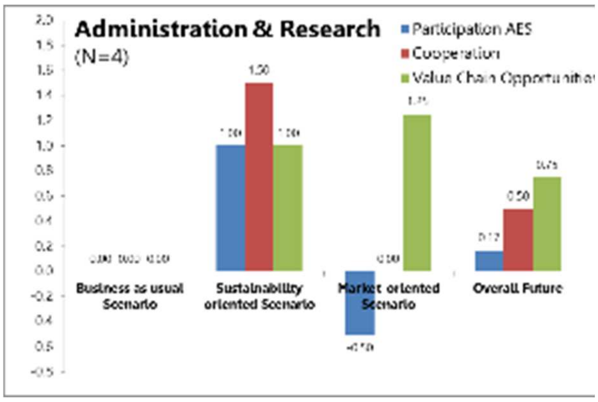

Figure 6. Average impacts assessment values for administration and research.

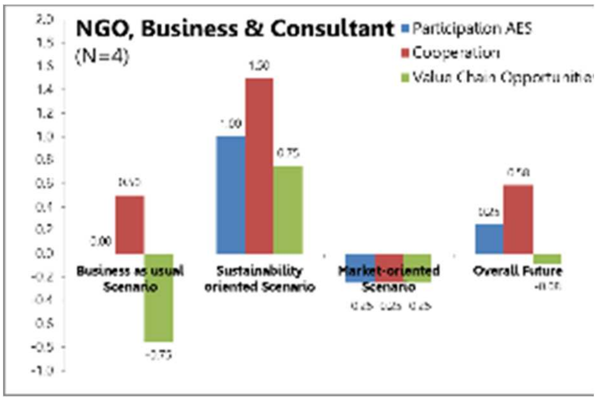

Figure 7. Average impacts assessment values for NGO, businesses and consultancies.

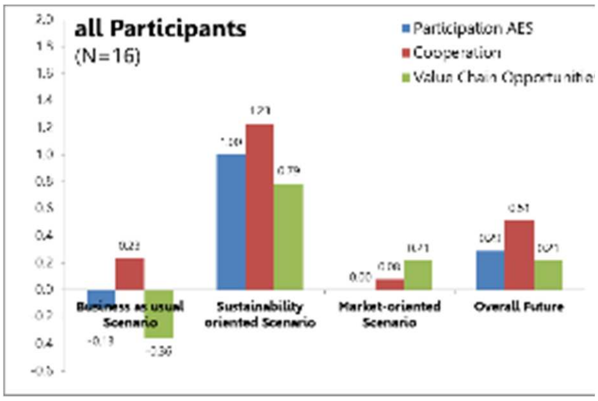

Figure 8. Average impacts assessment values for all participants.

More participation in the AEM, more cooperation and more value chain opportunities will lead to a higher provision of PGs (see chapter 3.1). Considering this cause-effect we can qualitatively deduce that especially a sustainability-oriented scenario will lead to a higher provision of PGs.

Table 2. Effect of future scenarios 1) Business as usual (BAU), 2) Sustainability-oriented, and 3) Market-oriented, one the provision of PGs.

Public Good	BAU	Sustainability-oriented	Market-oriented
Climate Stability	--	++	o
Biodiversity	-	++	o
Water Quantity	-	++	o

6.5.5.5 From current to future policy mechanisms

Focusing on the implications, the three scenarios would have on the policy mechanisms in force, and their anticipated or desired adaptation, open in-depth interviews have been carried out with three farmers individually. Their specialization was on:

(i) Large scale beef production based on extensive grassland management and short supply chain marketing;

(ii) Special, adapted livestock breeds, incl. water buffalo and heck cattle husbandry for landscape management

(iii) Water-adapted wood production (alder) or reed grass for energy and building material production.

The discussion evolved towards the distinction of mechanisms in BAU and sustainability orientation. For the development of policy mechanisms, the assumption of progress in CAP, environmental policies and related monitoring, mainly through ICT and data access and processing progress, were taken. Partially, mechanisms have been discussed from a farm strategic perspective.

Mechanism 1: Regulations and direct payments

- Direct payments are phasing out. The budgets of pillar I and II are integrated.
- Intervention logic consequently follows a new paradigm: If a good of societally demanded value is delivered through omitted land use, a payment is justified.
- Regulations regarding landscape elements are reduced and simplified. A lot of maintenance is required, e. g. pruning hedges, therefore more flexibilisation is introduced to meet the (payment related) definition of landscape elements.
- New regulations are defined under the target "high biodiversity". Management practice benefits from target- oriented scope in regulation. If something goes wrong in management, the farmer must be able to react quickly.
- Temporal flexibilisation is achieved. Long-term regulations can be permanently corrected. No 10-year contracts.
- In contrast, infrastructure regulations are oriented towards more long-term investments (e. g. stables: m2/animal. Stables are built according to specifications. Cannot be adapted quickly)
- Payment levels relate to regional objectives: Upper limits of payments/ha --> set by EU, grading: national or federal state level (e. g. alpine meadow=100% (Bavaria) or rewetted peatland =100% (Brandenburg)). Within programme further regional level adjustment of payment level according to land use system.
- Gradual zoning determines the level of payment. Highest level relates to land use type, e.g. grasslands – wetlands and peatlands, subzone to management, e.g. high water retention. Data are continuously monitored by LPIS/IACS.

Mechanism 2: Greening/ Incentivation of biodiversity cropping diversification

- Biodiversity rich field margins underlie the same payments as cropped area.
- Farmers voluntarily set aside field margins and take up examples from other farmers, as the benefits are obvious (higher crop yields, more bees).
- Establishment of connected margins/ strips along water bodies is a result of networking of neighbours

Mechanism 3: Incentivation of cooperation

- Incentivation of cooperation is not reasonable.
- Cooperation with personally known neighbours takes place on individual initiative, in case of capacity gaps within the own farm
- Strong entrepreneurial profile and high degree of professionalization is reflected in farm strategic planning and management. This connects product quality, landscape management and biodiversity targets in an individual optimization set-up.
- Farmers own skills to steering all farm internal processes well.

Mechanism 4: Marketing

- Farm economic viability primarily results from management measures that pay off. Marketing generates a surplus on top.
- Product marketing works via story-telling. It aims at building emotional ties of the consumer to the product (example water buffalo beef, not tasty but the taste of freedom)
- Willingness to pay more and durable short food supply connections result because farm identity is integrated into the product (transparency, traceability, personal connection)
- Risk reduction at farm level works via niche products with alone standing character
- Valorisation of landscape via product quality does not work, because it is too brainy
- Circular economy elements however work as a marketing element, mainly via food waste avoidance. E.g. better valorisation of carcass (slaughtered animal) through reintroduced high variety of meat sorting
- Direct marketing and short chain retail expand in addition to discounters.

6.5.6 Discussion

6.5.6.1 Discussion of results

The overall average willingness to accept under the current contract conditions (five years; no support for cooperation; medium effort; no acceptance of cut grass assured) is calculated as 522 €/ha*a, which is above the current payment of the scheme of 387 €/ha*a. This difference of 135 €/ha*a could arise due to the farmers' perceived transaction costs, such as search, decision making, negotiation, and coordination costs (Mettepenningen, Verspecht, & Van Huylenbroeck, 2009) and equal about 25 % of the calculated payment.

Compared to other market mechanisms to reduce GHG emission, the AEM is rather expensive. GHG emission trading schemes (ETSs) for instance are operational in several countries and range between 0 and 24 $A (Talberg & Swoboda, 2013), of which the EU ETS is the biggest with currently almost 8 € per metric tonne CO_2 (14.01.2018). But if we compare our results to private payments for ecosystem services (PES), such as atmosfair (www.atmosfair.de/en) that compensates GHG emissions from traveling, or the world's first carbon credit scheme from peatland rewetting, MoorFutures® (www.moorfutures.de), we see that there is a high willingness to pay of private persons for carbon saving. The certificates are sold for 23€ (www.atmosfair.de/en) and 35 – 67 € per unit (Günther, Böther, Couwenberg, Hüttel, & Jurasinski, 2017), respectively.

6.5.6.2 Discussion of methodological approach

It needs to be considered, that the result of the cost calculations based on the results of WP4 only represents an average estimate. In practice, farming conditions, required management efforts and yield potentials vary tremendously between different locations, which would influence farmer's decision making. Whereas in regions with less favoured conditions and lower yield expectations, such as in Brandenburg (for which the original measure was designed), lower monetary compensation levels might be sufficient, highly intensively managed and high-yield grasslands, such as in Northwest Germany, even the 522 €/ha*a would be insufficient to encourage farmers to participate in the AEM. Farm type and regional differences thus have to be considered more closely in further modelling.

Also the particular biophysical characteristics of locations are not reflected, which would needed to be taken into consideration for the GHG emission estimates.

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6.6 NL-1: Habitat, biodiversity, aesthetic quality and agricultural production in the "Kromme Rijn" area, the Netherlands

6.6.1 Introduction

6.6.1.1 Description of Case study region

The Dutch case study region - the Kromme Rijn area - is located in the Central Netherlands (Fig.1). This dynamic area (219 km^2, 86.090 inhabitants) is characterized by a rich cultural landscape with differences in scale, openness and relief, attracting around 1.8 million recreationists yearly (Provincie Utrecht, 2016). Its location adjacent to the city of Utrecht adds to the popularity of this peri-urban area as a leisure-time destination (Fig 2). The main recreation areas are defined by diverse landscapes, offering a variety of landscape elements, including riversides, small forests, and cultural heritage sites such as estates and forts belonging to the monumental 'Nieuwe Hollandse Waterlinie' (Will, 2002).

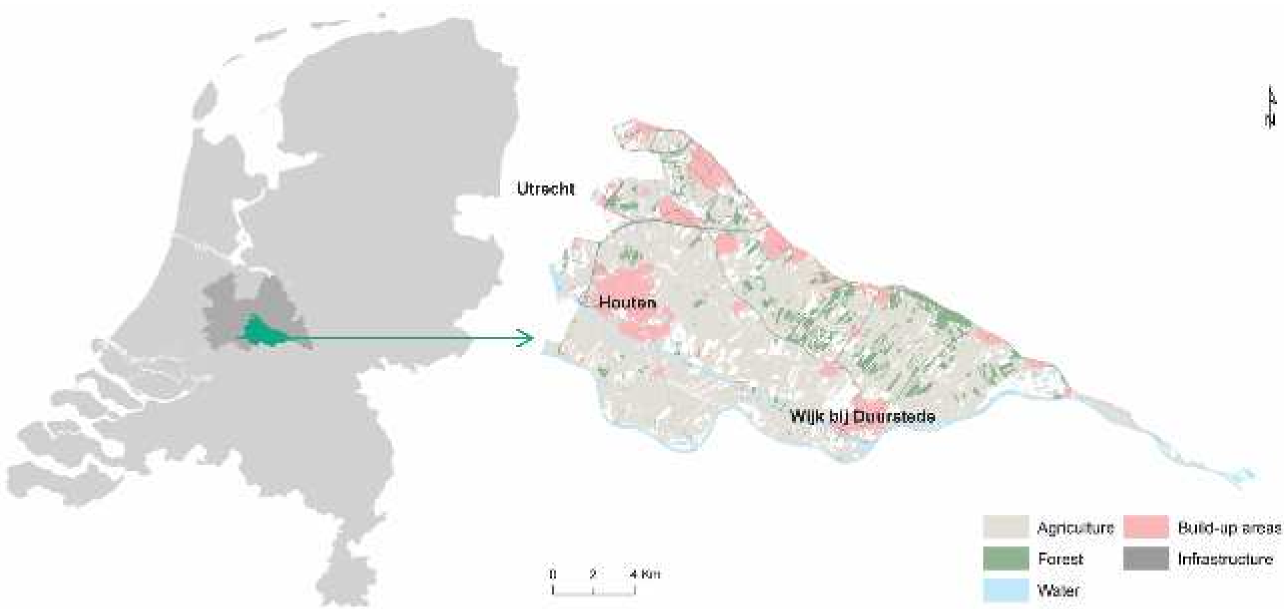

Figure 1. Map of the location of the case study area in Central Netherlands. In green the study area outline, in dark grey the outline of Utrecht province (Komossa et al, draft)

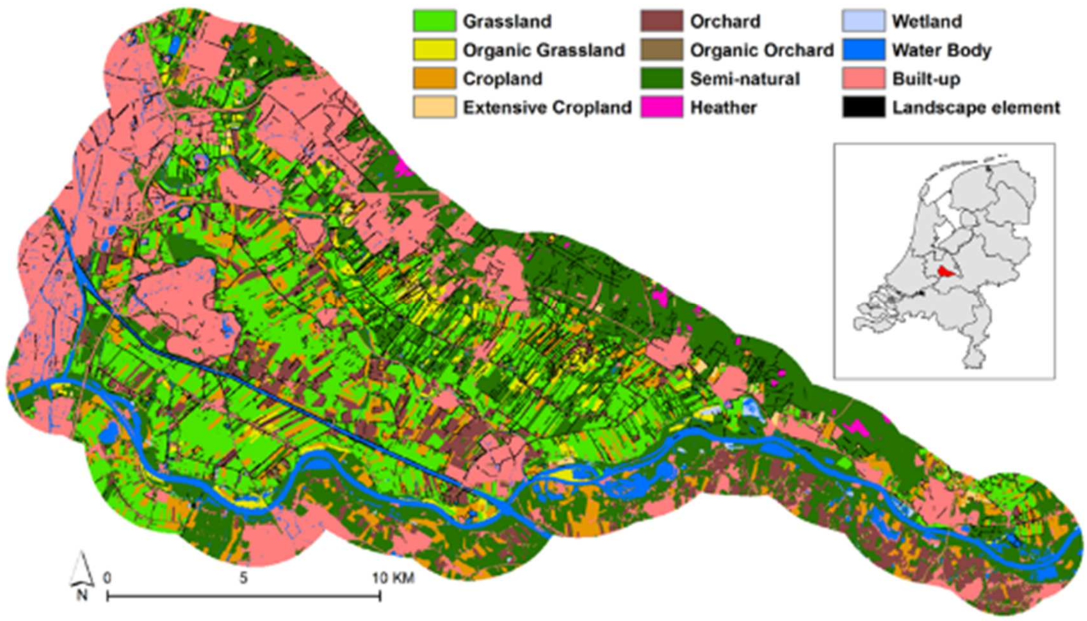

Figure 2. Land use land management map of the study area depicting the main agricultural land systems. The inset of the map shows the location of the Kromme Rijn area (in red) within The Netherlands. The land system map is depicted with a 2-km buffer. The number of classes (41) in the actual map is simplified for visualization purposes. Map taken from Verhagen et al. (under review)

The name 'Kromme Rijn' refers to a 28-km long river that flows through the area, a former branch of the river Rhine. The fluvial deposits of the river have strongly influenced the current land use pattern (Fig.3), as fruit orchards are established on the sandy and clay levee deposits of the former riverbed. Fruit cultivation (e.g. apples, pears and cherry) is a financially important sector and is currently expanding. Fruit cultivation takes place in both high-stem and modern orchards and the sector currently consists of 109 farms (1200 ha). A second important agricultural sector is dairy farming, which mainly takes place on lower lying grassland areas. The area has 234 dairy farms (7496 ha), with an unknown area of grassland also used for feeds. Arable land plays a minor role, with cereals (27 ha) and vegetables (1 ha) (CBS, 2016; Provincie Utrecht, 2011).

6.6.1.2 Description of public good issue

The main sources of tension related to PG/PB's within the case study region – as stated by stakeholders during stakeholder workshops or personal interviews (March 2016 and December 2017) – concern tensions between different landscape functions. These functions relate to the agricultural character of the area, the natural environment and an increasing demand for outdoor recreation. The higher demand for outdoor recreation – here mainly short-term recreation such as daily hikes, biking, picnicking - potentially leads to various effects, including environmental pressure (e.g. tranquility, biodiversity), residents' fear of losing rural identity, increased traffic on the road network etc. Simultaneously, agricultural land use (dairy farming, fruit cultivation and arable farming) - especially agricultural intensification without sufficient agrobiodiversity measures - is likely to negatively influence the natural environment in terms of the supply of biodiversity in the case study region.

The aforementioned tensions call for well-designed management strategies for the preservation and maintenance of the multi-functionality of the area.

6.6.1.3 Description of governance-strategy

In WP4, we investigated a potential future location advantage tax charged on recreational facilities as a means to finance landscape management and maintenance through the demand for outdoor recreation. However, the results of our analysis and the input of various stakeholders brought us to consider landscape management and maintenance within the broader framework of existing governmental policies, thus drawing other landscape functions than just outdoor recreation into the equation.

Landscape management and maintenance are regulated through the Dutch nature management plan (NBP). Our aim is to analyze how the current NBP can be optimized to meet the various objectives at play. The NBP includes regionally specific goals. For the Kromme Rijn area, the NBP focuses on the restoration of habitat for a set of focal species (Utrecht Province 2017). Agricultural land is assigned to be taken out of production and most commonly converted to natural grassland. The NBP also promotes the restoration of green linear elements (e.g. hedges and tree lines) on agricultural land. Conform to EU policy (Bird and Habitat Directive and Rural Development Programme), restoration of these elements is voluntary but eligible for subsidy. The transition to organic management is - based on several stakeholder workshops (March 2016 and December 2017) - viewed as an important alternative for farmers. This transition is not addressed in the NBP, nor is it eligible for subsidy. Additional environmental objectives such as aesthetic quality or orchard production that are relevant for the Kromme Rijn area are also not addressed in the NBP. Adding those environmental objectives will help spatial planners by designing future plans that can simultaneously meet multiple competing demands.

6.6.2 Methodological approach

6.6.2.1 Theoretical background

Tools that can both identify trade-offs between different environmental objectives and assist in navigating these through planning are needed. One tool that can assist in doing so are landscape optimization algorithms. We employed an optimization model for the Kromme Rijn area in order to 1) optimize land use/land management, and 2) assess the trade-offs among different objectives. We thereby maximized orchard production, endangered species habitat and landscape aesthetics while minimizing losses in grassland production. Moreover, to achieve these objectives we allocated on-farm measures (organic management and restoration of linear elements), off-farm measures (by taking land out of production) and a combination of both.

6.6.2.2 Model implementation

In the optimization model we included four objectives based on relevance to the study area, namely orchard production, aesthetic value, habitat suitability for the great crested newt (Triturus cristatus), as well as the loss in pasture production, which is incited by the restoration of natural habitat. The models used to quantify each objective are described in Verhagen et al. (under review). Below we give a short summary of the main characteristics:

- *Pasture production for dairy cows:* The model of pasture production for dairy cows (euro/ha/year) was based on a look-up table approach for which we calculated the profit per cell. These are based on average production values per ha pasture, the costs of milk production and market prices for the Netherlands.
- *Orchard production:* Orchard production (euro/ha/year) was modelled based on the level of pollination per orchard and was then coupled with a look-up table approach to quantify costs and benefits.
- *Aesthetic quality:* We quantified the aesthetic quality of the landscape as a proxy for outdoor recreation demand using a model by Tieskens et al. (under review) specifically designed for the Kromme Rijn area, linking the amount of unique user uploads of landscape photos on social media platforms to the location of a set of structural landscape features (Panoramio and Flickr).
- *Great Crested newt occurrence:* As a biodiversity indicator, we therefore chose to use a model on the habitat suitability (number of individuals/pond) for the great crested

newt (van Teeffelen et al. 2015). We chose this species as the Kromme Rijn area is a focal area for its habitat protection (Utrecht Province 2017).

6.6.2.3 Optimization experiments

Three optimization experiments were conducted, which differed in the type of agri-environment measures implemented. Each grassland and orchard farm can choose between several management options, namely conventional production, conventional production with restoration of hedges and tree lines, organic production, and organic production with restoration of hedges and tree lines. In addition, pasture farms can choose to take land out of production, i.e. restoring pasture land to natural grasslands. Below a short summary of each experiment. For more information, see Verhagen et al. (under review).

- *On-farm:* pastures and orchards can only be assigned a change in farm management and/or restoration of linear elements. This experiment quantified the optimal trade-off for agri-environment measures with a sole focus on changing farm practices.
- *Off-farm:* pastures can only be taken out of production, with no change in orchards. This experiment quantified the optimal trade-off if agri-environment measures would only focus on taking land out of production.
- *All options:* pastures and orchards can be assigned to all land use and land management (LULM) categories, combining *on-farm* and *off-farm* agri-environment measures. This experiment quantified the optimal trade-off if planners would combine all LULM options.

We used a multi-objective optimization algorithm, NSGA-II (Strauch et al., in prep). The optimization algorithm generates a set of alternative LULMs and quantifies the four objectives for each new LULM allocation. In the end, the result is a set of non-dominated LULM allocations, or alternative landscapes, that perform a maximization of the four objectives. We compared the different LULMs in two ways:

First, for each cell we calculated the frequency with which a cell was assigned a certain LULM across all alternative landscapes. For this we use an approach by Karakostas et al. (2017). The higher the frequency of a cell for a particular LULM alternative the more often that LULM alternative is assigned to that cell across all dominant solutions. We limited the extent of change in allocation of LULM per category. For pastures, we calculated the amount of land taken out of production as proposed in the nature plan. We additionally limited the amount of change from conventional management to another LULM allocation where we limited the loss in pasture production by the expected loss incurred in the nature management plan. For orchards, no land is taken out of production. To calculate the allowed change from conventional orchards to orchards with agri-environment measures, we used yearly transition rates of conventional to organic orchards.

Secondly, we compared the alternative landscapes to the current nature management plan with reference to the performance on all four objectives. This comparison provides insight into the extent to which a landscape optimization approach can improve the current nature management plan.

6.6.3 Participative approach

The involvement of relevant stakeholders before (*a priori*), during (*interactive*) or after (*a posteriori*) the optimization process was vital to understand the local decision making context, as well as provide a suitable fit with local interests and ecosystem services demand (e.g. Bryan et al. 2010; Cord et al. 2017). Based on several stakeholder workshops (March 2016 and December 2017), we decided to widen our focus from a single landscape function (recreation) and a related governance strategy (location advantage tax) to an analysis of the current Dutch policy on nature management as anchored in the NBP. Moreover, during the process, we were able to define additional environmental objectives relevant for the Kromme Rijn area that are not addressed in the current NBP. More specifically, we among others learned that the transition to organic management is viewed as an important alternative for farmers. An *a posteriori* discussion of our results with the stakeholders will take place in the near future.

6.6.4 Results and interpretation

Spatial priorities were identified for all LULM allocations (Fig. 3), yet here we only visualize the results for the *all options* experiment given the fact that this measure shows the highest potential for optimizing all the objectives. Figure 3A shows that only a few locations are assigned an agri-environment measure across all optimal LULM allocations and are mainly concentrated around orchards in the heart of the Kromme Rijn area. Here, we encounter a striking mismatch with the areas identified in the nature plan, which by contrast are to be found at the edges of the area, for instance along the riverside and close to existing natural environments (Fig. 3D). This difference can partly be explained from the fact that the nature plan is developed for the sole purpose of species protection, not taking the additional objectives and agri-environment measures into consideration.

The cells with a high frequency of agri-environment measures can now be identified. However, it cannot yet be detected which type of agri-environment measure is assigned. Therefore, we separately identified the frequency of *on-farm* (Fig. 3B) and *off-farm* restoration per cell (Fig 3C). We can spot cells with a high frequency of on-farm measures mostly located in the center of the Kromme Rijn Area (Fig 3B). These cells commonly align with cells having a high frequency for agri-environment measures. There are no locations with a high frequency for off-farm restoration. This indicates that no cell has a high priority to be taken out of production. With this approach we can thus identify both priority locations for agri-environment measures and, more specifically, priority locations for on-farm restoration.

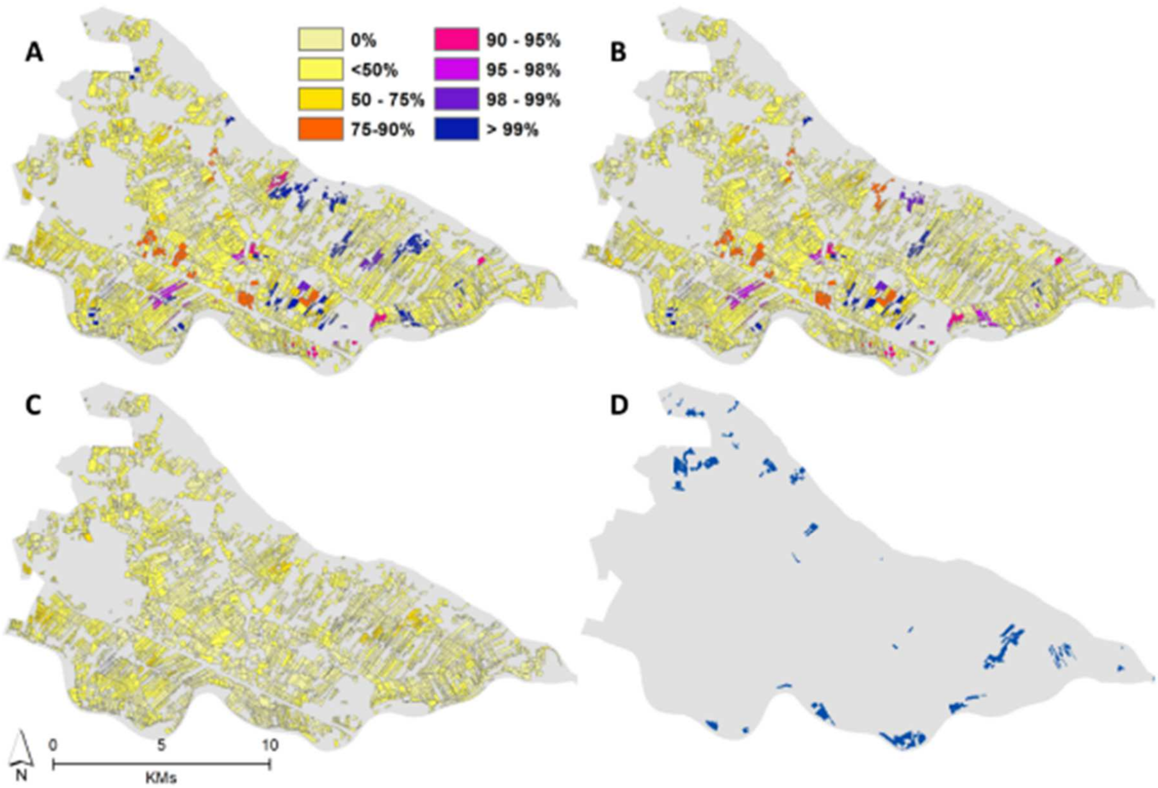

Figure 3: Priority map for nature restoration in the Kromme Rijn area. The higher the priority the more often a field is assigned to a restoration alternative. The maps depict priorities for (A) conventional versus all other agri-environment measures, (B) *on-farm measures* versus all other, (C)*off-farm* measures versus all other and (D) the areas targeted in the nature management plan to be taken out of production (blue areas in D). Figure taken from Verhagen et al. (under review).

In a next step, we compared the results from our optimization analysis to the measures envisaged in the nature plan. It should be noted here that there is a discrepancy in landscape understanding between the two as the nature plan assigns management measures at the cell level, while the optimization analysis concerns homogeneous LULM allocation at the farm level. The analysis nevertheless shows that the nature plan can be further optimized for the four set objectives (Fig. 4). The results show that a land allocation different from the one envisioned in the nature plan would not only induce a smaller loss in pasture production, but also boost the other three environmental objectives (orchard: +21.55%, aesthetics: +0.40%, newt: + 1.29%). This means that a combination of *on-farm* and *off-farm* measures *compared to the nature plan* has the double advantage of limiting the loss of pasture production and increasing newt habitat, while also orchard production and landscape aesthetics can be stimulated.

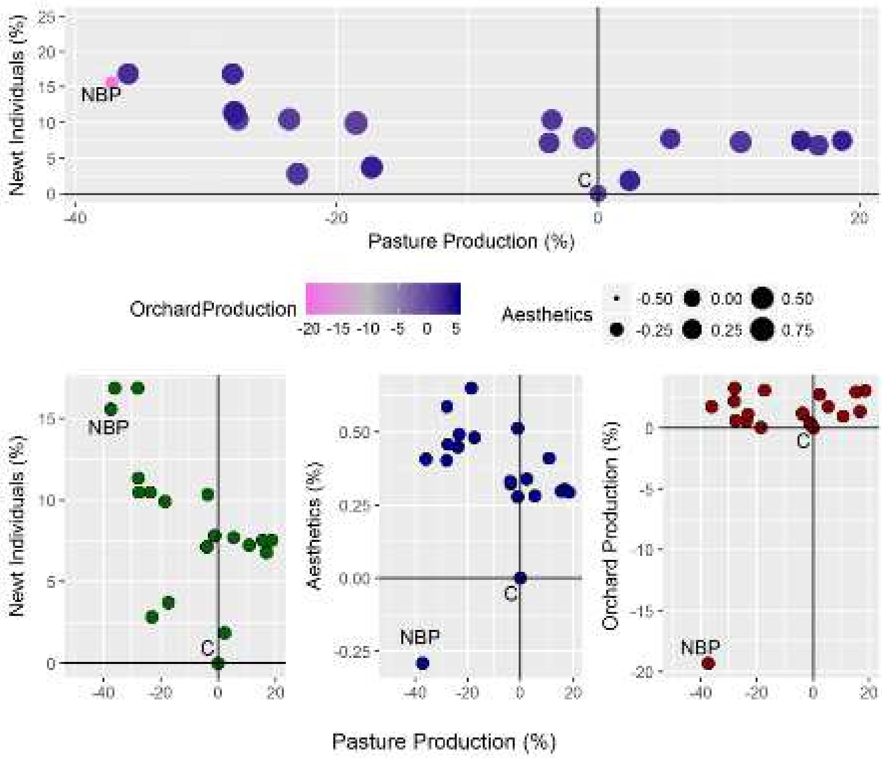

Figure 4. Set of Pareto dominated solutions from the optimization analysis. All changes are calculated relative to the current landscape. The five solutions to the top right of the current landscape (C) are Pareto dominant, i.e. score better on all objectives compared to the current landscape. The NBP is Pareto dominated, scores better on all objectives, by two solutions to the top right. The results depicted are the outcomes of the "all options" experiment. Figure taken from Verhagen et al. (under review).

6.6.5 Discussion

6.6.5.1 Discussion of results

Our results aim to optimize the landscape configuration of different agri-environment measures for a set of environmental objectives. All our three environmental objectives are sensitive to landscape configuration, including functions related to the surrounding landscape (distance decay), edge effects and linear elements. The importance of landscape configuration for ecosystem services has been previously addressed using a conceptual model (Mitchell et al. 2015) or model comparisons (Lautenbach et al. 2011; Verhagen, Van Teeffelen, et al. 2016). The Pareto frontier in any optimization analysis can be interpreted as the set of optimal landscape configurations for increasing opportunity costs. It highlights what can be optimally achieved when combining the effect of the area of interventions (composition) with the spatial allocation (configuration). However, most ecosystem service models do not account for landscape configuration (Verhagen, Van Teeffelen, et al. 2016; Seppelt et al., 2011). The outcome of any restoration plan, then, purely depends on the amount of land being restored irrespective of the location. Thus not accounting for landscape configuration in ecosystem service models means that restoration plans cannot be optimized in terms of spatial allocation.

In addition, our results highlight the importance of linear elements in agricultural landscapes for ecosystem service supply. Previous research linked these elements to a diverse set of ecosystem services and argued for the inclusion of elements in landscape optimization approaches (Verhagen et al. 2016; Jones et al. 2013). To our knowledge this is the first application of linear elements in landscape optimization. We highlighted that a landscape optimization without these elements would result in a less optimal outcome, thus providing evidence for the importance of accounting for configuration and linear elements in landscape planning.

The optimization analysis shows that the implementation of all agri-environment measures has a positive impact on all three environmental objectives together. However, the improvement of each objective differed depending on the choice for *on-farm* or *off-farm* measures. Choosing only one of the measures induces a notable trade-off between orchard production and newt habitat. This trade-off can be largely prevented when all measures are combined. Yet, when doing so, the maximum values for both objectives turn out lower in comparison to the individual management strategies. Given that none of the agri-environment experiments is better than the others, the ultimate trade-off chosen depends fully on the preferences of stakeholders and/or landscape planners.

Our results show that the NBP can be improved by different LULM allocations, even when including a wider set of environmental objectives. This can serve as a starting point for further developing the NBP by potentially including more objectives. More importantly, these results can be used as a discussion tool with local stakeholders to conjointly develop an improved NBP that can meet more environmental objectives an also reduce costs for farmers. A next step in the project is to present and discuss our results with local stakeholders.

6.6.5.2 Discussion of methodological approach

One limitation of our approach is the necessity to implement LULM alternatives at the farm level, assuming a uniform LULM across all cells in a farm. In reality, many agri-environment measures can be implemented below the farm level which is why the resolution of LULM's allocation is not aligned. The restoration of linear elements offers an evident example in this respect, as this does not necessarily apply to all fields of a farm. In order to – at least partly – account for this, we only allowed allocation of linear elements at the edges of fields.

Another limitation relates to the definition of the objective function for which we used four objectives and optimized the outcome for each objective. For this we used the concept of Pareto-dominated solutions meaning that alternative landscape allocations, in which one objective increases but in doing so decreases another is not considered Pareto optimal. What the optimization tool in other words aims to achieve is a full or strong trade-off between all given objectives. However, not every objective is likely to be considered equally important when such a diverse set of objectives is at play. Gourevitch et al. (2016) has aimed to resolve this issue by assigning variable weights to each individual objective. But here another obstacle arises: the set of possible combinations increases exponentially when attributing weights to more than two objectives, with which the data would become inconceivable. In addition, applying a single objective function to a multidimensional problem such as this one would partly obscure the trade-offs between environmental objectives. Therefore, the stakeholders and planners should always be involved when making decisions on the appropriate value of each objective. In other words, this method can quantitatively identify optimal trade-offs but the actual restoration plan designed, should be a combination of the quantitative trade-offs in combination with stakeholders' values and preferences.

6.6.5.3 Discussion of participative elements in the modelling approach

Our research aims to combine targeted spatial planning with multi-objective optimization. Visualizing optimization – showing, as we have done, numerous possible land allocations – offers an effective tool for the discussion of policy targets (Verburg et al. 2016). Previous research has likewise used visualized example landscapes for the provision of landscape management advice (Pennington et al. 2017; Gourevitch et al. 2016; Kennedy et al. 2016; Nelson et al. 2009). A single optimal LULM allocation could accordingly be achieved after discussions with the stakeholders. This approach has however been under scrutiny for its lack of transparancy: it does not provide stakeholders with insight into the method leading to the results (Verburg et al. 2016). To counteract this shortcoming, we based our research on an approach used by Karakostas (2017) and aggregated all optimization outcomes to identify the priority areas most suitable for policy implementation, while we could simultaneously assess the impact from different policy mixes on the landscape configuration. In this way, our approach offers a very direct instrument for informing policy design. This of course requires due knowledge of the local decision-making context and calls for the involvement and direct engagement of relevant stakeholders, either before (*a priori*), during (interactive) or after (*a posteriori*) the optimization period. Only then can the optimization tool be effectively connected to local interests and the demand for ecosystem services (e.g. Bryan et al. 2010; Cord et al. 2017) and accordingly support successful policy implementation (e.g. McIntosh et al. 2011; Albert et al. 2014).

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7 Extensive agricultural land use systems

CSR	Topic	Model	Authors
CZ-1	Water availability in Northern Bohemia in Czech Republic – Evaluation of a collective action based on the local action group (LAG)	Qualitative assessment following Ostrom; Fuzzy cognitive mapping and Participatory Method for Impact Assessment	T. Ratinger I. Vancurova
BG-1	Water quality, food security and scenery and recreation in the Bulgarian South central planning region – Investigating a mechanisms mix of collective action, AES and quality product certification	Principal component method	D. Nikolov I. Boevsky P. Borisov T. Radev M.Anastasova
RO-1	Natural landscape quality in the Dorna valley, Romanian North East region – Evaluating a mix of targeted AES and education/information measures	Sensitivity analysis based on scenarios	C. Mihai A. Maxim M.C. Apostoaie

7.1 CZ-1: Water availability in Northern Bohemia in Czech Republic

7.1.1 Introduction

7.1.1.1 Description of case study region

The case study region (CSR) „Northern Bohemia“ consists of two districts (LAU1): CZ0421Decin and CZ0511 Ceska Lipa. The area of the case study region accounts for 1982 km^2 and there live 235 thousand inhabitants. The average income (in PPS GDP per capita) amounts €11500 in 2012 which is 40% below the EU average and 25% below the national average.

The share of agriculture on the case study region GDP is 2% and the share on the labour force is even lower - only 1.5%. The characteristic feature of the CSR "Northern Bohemia" is its turbulent demographic and socio-economic development. The majority of population in this region were Germans who were expelled after 1945. The new settlement were unstable, people migrated in and out of the region frequently. Because of the lack of people agriculture and manufacturing industry collapsed after WW2, later they both recovered. However, the infrastructure remained fairly underdeveloped comparing the other parts of the country. Agriculture and textile industry experienced a further shock during the transition period in the 1990s. People moved out again.

The CSR population density of 118 inhabitants per km^2 is 12% below the national average (135 inhab./km^2), the HS area "CZ1" (Sluknov area) is on the frontier between Predominantly Rural and Intermediate regions according to the OECD methodology. Due to lack of labour force, most of the arable land was turned in grassland. The conversion was accelerated to large extent by the investors who envisaged extensive agriculture as a mean for collecting income supports (direct payments, LFA payments). The conversion went hand by hand with the introduction of beef cattle. The livestock density is however low around 0.2 LU per hectare.

7.1.1.2 Description of public good issue

The participants in the first stakeholder workshop identified water availability as a critical PG issue in the north-west part of the CSR – we marked it as the hot spot CZ1. The CZ1 region exhibits the level of rainfalls usually above the national average. In addition, the share of grasslands on agricultural lands exceeds 80% there. It assured sufficient supply of surface and underground water in the past. However, with the climate change temperature increase and weather irregularities local people, agriculture and forestry are exposed to dry seasons with which the current land management system and practices cope only with difficulties. Drought resilience requires coordination among stakeholders like farmers, foresters, water management bodies and environmental administrations (and perhaps also some NGOs).

We consider two public good – the primary one "water availability" (rather intangible) and the secondary one – a tangible face of the primary PG "high water retention capacity of cultural landscape". Supplying water retention means

- carrying agro-technical practices (operational measures) allowing water to leak deeper in the soil and to stay there (underground water);
- establishing technical measures like barrier, polders and ponds to prevent water run-off after rains or when snow melts.

Obviously, low retention capacity of the landscape results in floods if rains are heavy - often with damages on private and public properties which can be classified as public "bad" (the other side of the coin). Since arable land has already been converted in grasslands in the case study region, we put more emphasis on water retention technical measures (WRTM).

Farmers and foresters also pursue adjustment measures e.g. a selection of crops and trees which are less sensitive to water shortages in upper layers of the soil as alpha-alpha or broad leaf trees. Adjustment practices are deemed to reduce the need for mitigation measures i.e. introduction of TM and OM.

Improved water availability (retention capacity of the landscape) can only be achieved if technical and operational measures are taken on most of the territory. The establishment of TM and introduction of operational measures brings costs (investment and maintenance) which are unevenly distributed among actors: absolutely and also in relation to the benefits.

7.1.1.3 Description of governance-strategy

The current governance of landscape water management is divided in a number of overlapping structures and institutions. The area belongs administratively to the River Basin Authority (RBA) of the river Ohre [actually (geo-morphologically) it is the river basin of Oder/Nisa which however mostly spreads in Germany]. But RBA concerns only about bigger river Mandava, the small streams, springs and wetlands are under the supervision of the Forests of the Czech Republic, the state company and its Water Catchment Unit (WCA).

There is no local office of these two water management bodies located in the Sluknov area. The nearest local office (of the RBA) is in Ceska Lípa, about one hour drive from the HS area.

The local Water Management Office is managed by the Municipality of Extended Authority (MEA) Rumburk (most of the Hots Spot area – North-West) and the Municipality of Extended Authority Varnsdorf (East-South). The responsibility of WMO concerns dinking and sewerage water infrastructure. Water retention in the landscape belongs under the environmental and territorial planning departments of MEAs. Individual Municipalities have also some authority over water management (at least a passive one in terms that any change affecting the life in the site must be approved by them).

The Regional Government (REG) in Usti nad Labem has also some authority over water management in the HS area. The concerns of REG (expressed in interviews) are drinking water supply in terms of availability and quality.

And finally, the State Land Office is authorized to take measures for improving water management in the landscape during the land consolidation project. Actually, the need for improving water management can be a reason for initiating the land consolidation project in a municipality.

The lack of coordination and clear distribution of responsibilities over landscape water retention seems to be the first critical weakness of the current system. Probably, the most concerned are officers of the MEA Rumburk, however finding it difficult to take responsibility for the areas behind the border of the municipality.

Since there are no signals that ground water and water retention in the landscape will receive a national or at least regional (NUTS3) top down coordination or we concentrate on the option that local actors will take a collective action.

The Land Consolidation Programme, the Rural Development Programme with the support to non-productive investment, Operational Programme Environment etc. are good opportunities to get financial support to the implementation of water retention measures.

Map 1 Hot Spot CZ1 within the Case Study Region (Source: own illustration)

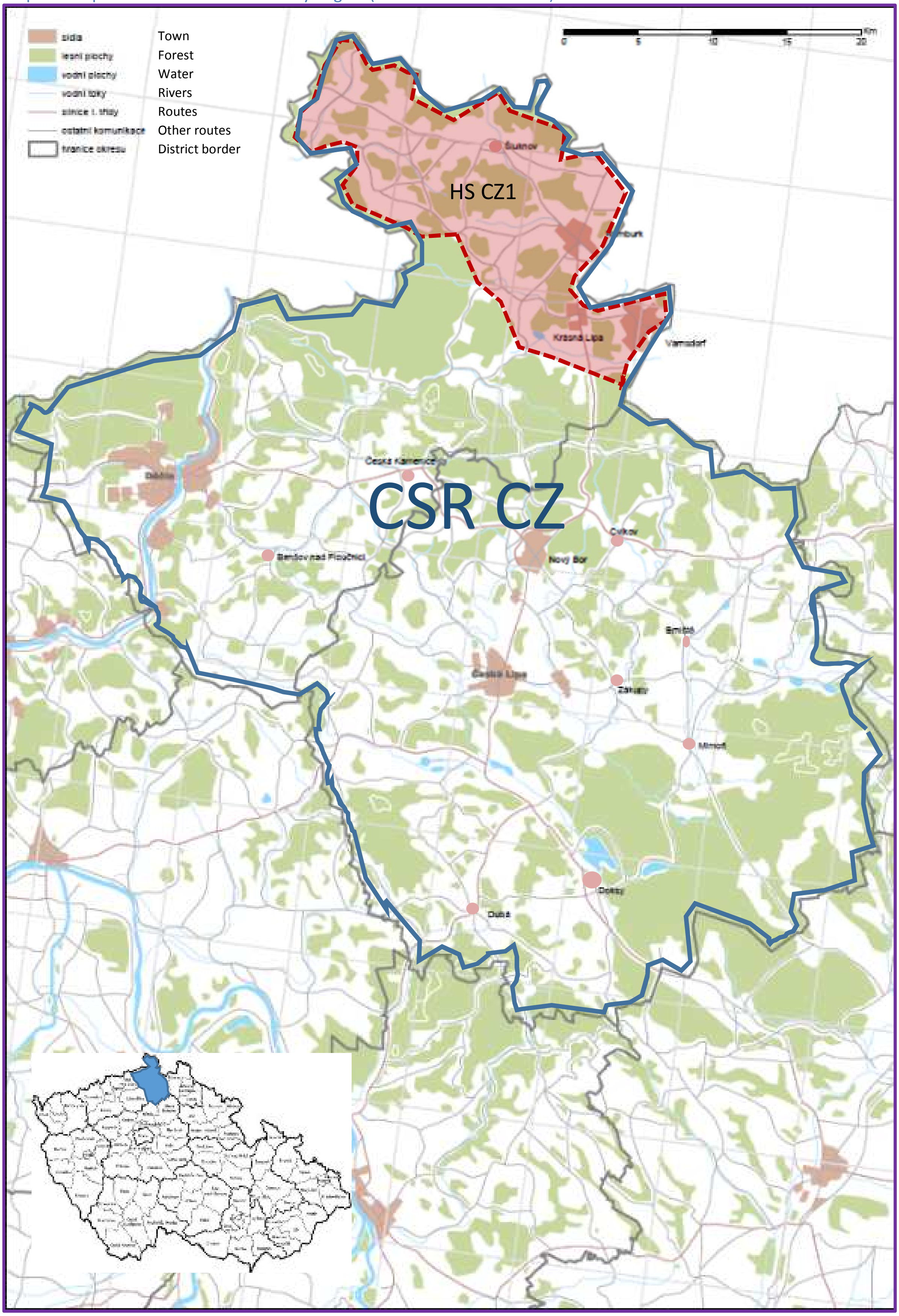



Figure 1. Typical landscape in the HS area (Sluknov area) (Photo: Boskova, 2016)

The participants of the last workshop agreed that the best platform for a water retention collective action will be the existing LAG – the Czech North (MAS Český sever).

The advantage of the LAG based collective action is that it already involves all important local stakeholders (farmers, municipalities, local businesses) in the HS area. Over the years of its existence the LAG has also received recognition and credit among many outside stakeholders (authorities). LAG has its internal (democratic) governance structure and some experience with resolving/mediating conflicts among members. LAG has also experience in creating strategies and development plans, their financing and monitoring and evaluation.

A certain weakness might be that LAG role in possible coordination of water management activities have not been envisaged in the definition of LEADER programme and thus it might be difficult to incorporate them in the revised LAG strategy. Also, the outside investors in farming might find difficult to accept the authority of LAG.

In cooperation with the two MEAs (Rumburk and Varnsdorf) the LAG might address the needs for TM and OM in the HS area and develop a plan of their gradual implementation. LAG will then coordinate activities of individual municipalities and other actors and help to resolve conflicts among land owners/managers as well as water users.

According to the old records there were about 300 ponds in the HS area. Collective action using external funds (Land consolidation programme, RDP, OP Environment etc.) will renew most of them or replace them by other effective TM, promote adoption of relevant operational measures and organize the maintenance of the TM. This will presumably improve the retention capacity of the landscape which will increase water reserves in the soil.

7.1.2 Methodological approach

7.1.2.1 Theoretical background

First of all we adopt the assumption that an introduction of technical measures like ponds, dams, polders, water run-off barriers, wetlands etc. improve retention capacity of landscape creating ground and surface water deposits. Similarly, operational measures like land cover (best by grass), regular renewal of grasslands, maintenance of meliorations, etc. support the water retention of landscape. The effects of TM and OM can be substantially amplified by coordinated activities. It is because a collective action delivers benefits to all individual members while single activities might produce more benefits to neighbor farmers or inhabitants than to the investor (members share benefits of joint activities).

Second we review fulfilment of the 8 conditions enabling a collective action for governing commons proposed by Ostrom (1990)

Our approach is qualitative deploying knowledge of experts and local stakeholders. This knowledge is mapped and classified using "fuzzy cognitive mapping" approach (Grey et al, 2013). Using fuzzy logic we can then assess responds to changes in the weight of internal or external drivers (Grey, et al. 2012, Henly-Shepard, 2015).

We created own routines in Excel Visual Basic, following closely the web application "mentalmodeler.org" (Gray et al. 2012)

7.1.2.2 Model implementation

Old documents show that there were about 300 (predominantly small) ponds in the HS area before collectivization in the 1950s. Currently there are less than a quarter of them. The target of the proposed changes will be gradually approximate the "retention value" of these 300 ponds by introducing TM and OM.

Another criterion will be timing. It is assumed that the process will be delayed or accelerated depending on the level of cooperation of land owners and operators.

From the survey on the willingness of farmers to give land and to invest in TM we know the propensity of farmers (by their characteristics) to support and introduce TM and OM and also their propensity to participate in a collective action. These figures will be in an input in the model.

Similarly, we have calculations on the annual costs of maintenance of TM.

7.1.3 Scenarios

We consider two options of climate change (CC): current and progressive weather extremes. Under weather extremes we mean sudden heavy rains resulting in flash floods (as in the Sluknov region in 2010) and droughts (as in 2015). Against climate change scenarios we would like to test three governance mechanism (GM) options:

i) The current atomized structure with overlapping competences;
ii) Base on LAG as a form of a collective action with full participation of local actors;
iii) Similar to ii) but with the absence of investor farms (with owners outside the Sluknov region) - marked as “incomplete collective” GM

A combination of the two criteria (CC and GM) would lead to 6 scenarios. However, we will concentrate only on 4 of them (**Errore. L'origine riferimento non è stata trovata.**, the middle column).

Table 1. Criteria for the definition of scenarios

	Climate change		**CAP support**	
GM	Current trend	Higher variability of weather extremes	Current	Reduction 50%
Current (atomised)	1		1	
Based on LAG (collective action)	2	3	2	3
Incomplete collective		4	4	

Source: own illustration

For the expert group we considered in addition two CAP options: Status Quo and Reduction of Direct Payments and Payments for Natural Constraints by 50% (**Errore. L'origine riferimento non è stata trovata.**, the right column). Scenarios are specified in Box 1.

Box 1 Scenario definitions (Source: own definition)

- **Baseline**: current GM , CAP Status Quo, current CC trends
- **Scenario 2:** Full participation of farmers on LAG platform, current CC trends; (Status Quo)
- **Scenario 3:** Full participation of farmers on LAG platform, progressing CC, (Reduction of direct payments)
- **Scenario 4:** Investor farms decline taking part in the collective action, progressing CC, (Status Quo)

Full and partial participation is explained in Paragraph 3.1.

7.1.4 Participative approach

7.1.4.1 Stakeholders' input to the development of governance mechanisms

The workshop in May 2017 delivered important information on the coordination capacity of MEAs, the ongoing activities of stakeholders (study on the landscape environmental stability, starting land consolidation, …). Also the participants of the workshop suggested the LAG Czech North to be considered as a possible coordination platform (collective action) for improving water retention in the HS area.

In the additional interview with the SLO office in the district centre (Decin) we learned about its constraint to take a lead in the Sluknov stakeholders' effort to improve water retention of the hot spot area. SLO only rarely initiates land consolidation projects. The initiative should come from stakeholders (municipalities, groups of land owners, etc.). If the initiative approved as relevant and plausible, the respective regional/district office of the SLO will launch a project. The project usually covers a cadaster (or a couple of cadasters if the municipality is big; however; never an area as large as a region or sub-region). The project is elaborated by an external contractor. The project is implemented also by an external provider who also conducts all negotiations with stakeholders. The identified investment needs in re-parceling and environmental facilities can be covered from the Rural Development Programme (M04.31) or from the national funds.

7.1.4.2 Stakeholders‘ input to the modelling exercise

As pointed out earlier, from the survey we learned about farmers' opinions on the need for improving water retention as well as about their willingness to introduce and maintain TM and OM and also about their propensity to participate in a collective action.

We used an expert focus group to help to define scenarios and to assess their effects (Expert Workshop – held in TC on December 13, 2017; for the composition of the expert group see Appendix 6.3).

There is also an additional survey among farmers (conducted in January 2018) to get notion about their likely responses to various incentives and circumstances defined in the scenarios. The respective questionnaire deployed the knowledge obtained from the Expert Workshop.

We used fuzzy logic cognitive mapping for summarizing outcomes of workshops and other discussions and interviews together with modified Method for Assessing Impact of Programmes and Projects (MAPP) for the group of experts and a questionnaire for local stakeholder (a simplified MAPP). See Appendix 6.1. for the description of MAPP.

The knowledge about the system guiding (currently or optionally) the provision of PG "Water Availability" is summarized in **Errore. L'origine riferimento non è stata trovata.** in Appendix 6.2.

7.1.5 Results and interpretation

In the first step we concentrate on the evaluation of the effectiveness of proposed GM. For this purpose, we adopted the scheme of the intervention logic. The general objective of changing GM is to improve supply of the PG "water availability" in the hot spot area. The corresponding specific and operational objectives aim at improving farming practices, reducing soil degradation, enhancing water retention facilities and improving small streams and surface water in the landscape in general. The related output/result indicators are listed in the right column of **Errore. L'origine riferimento non è stata trovata.**. Note that a commonly used output indicator referring to the response of actors to the intervention/change of the GM – the participation rate is actually an assumption of the scenarios.

Indicators of the impact – long term effects of the considered GM options (listed in the left column of Table 2) include changes in the capacity of landscape to retain (rainfall and snow) water and thus its availability for use in agriculture and forestry and in households.

Table 2. List of Indicators for evaluation scenarios (Source: own proposal)

Output/Result indicators	Impact indicators
The share of organic farming	The share of water kept in the landscape
Intensity of livestock production	The groundwater level (- decline, + increase)
The state of water in the landscape (number frogs, extent of wetlands, …)	Water availability for agriculture (+ reduced shortage)
The state of soil (-degradation, + improvement)	Water availability for households (- dry wells and pipes, + never dry wells)
The state of meliorations	Flood damages
The state of technical measures for water retention	
The extent of technical measures for water retention	
The state of small streams	

Indicators "The share of organic farming" and "The state of water in the landscape" were added by the experts. The former to indicate the environmental concern of farmers in the HS CZ01, while the latter is to indicate the related role of water in the landscape for biodiversity.

All indicators are qualitative valued on the 5 level Likert scale (Table 3).

Table 3. Description of the values in the Likert scale (Source: The judgement agreed at the Expert Workshop (December 2017))

Value	Explanation
1	Marginal short term effect
2	Small effect in long term
3	Important, short term or partial effect
4	Important, medium term effect on most territory
5	Important, long term effect on entire territory

Note, please, that the scale reflects first of all the importance of the investigated factor (driver) for the change of the output/result and impact indicators, while the added terms of time and coverage serve as a supporting explanation of the referred importance level.

7.1.5.1 Scenarios

Our assumption is that under the absence of clear responsible public manager of the PG "water availability"/"water retention in the landscape" on the top of a hierarchical governance structure, the second best alternative is a collective action (i.e. self-governing group) of stakeholders. We also regard "water availability"/"water retention in the landscape" as common good for which members have critical interest in its maintenance since the good is of limited supply (must be renewed). To examine the potential for a collective management of the common good we first examine actual and potential fulfilment of the Eight Principles for Governing Commons proposed by Elionor Ostrom (1990). This is presented in Table 4.

Table 4. Examination of the Ostroms' Eight Principles for Governing Commons (Source: own elaboration base on Ostrom(1990) and interviews with stakeholders.)

#	Condition	LAG platform
1	Define clear group boundaries.	Only stakeholders form the Sluknov area can participate. A subgroup has to be established within the LAG.
2	Match rules governing use of common goods to local needs and conditions.	Challenge:
3	Ensure that those affected by the rules can participate in modifying the rules.	Fulfilled, individuals (households) participate through municipalities)
4	Make sure the rule-making rights of community members are respected by outside authorities.	It is an issue: on one hand LAG has been recognised for their management/ coordination of local development. However, the representative of the LAG pointed out that water retention of the landscape is not an envisaged area of LAG competencies.
5	Develop a system, carried out by community members, for monitoring members' behaviour.	Challenge
6	Use graduated sanctions for rule violators.	Challenge
7	Provide accessible, low-cost means for dispute resolution.	Conflict resolution exists, however should be strengthened
8	Build responsibility for governing the common resource in nested tiers from the lowest level up to the entire interconnected system.	This will be a challenge, nevertheless the LAG showed its competence in this respect in the other areas.

While four of the principles are already fulfilled or easy to introduce (1, 3, 4, and 7), the other four will be a challenge. It concerns those points where internal rules have to be developed and obeyed. In the particular case of the technical measures it means that members are ready to negotiate location of these measures on their land which suits best the common interest of maximizing retention of water. From the survey conducted in WP4, however we have learned that some farmers are not in favour to it (either declining participation it or claiming too high compensations).

In the case of operational measure, all members will need to commit themselves to maintain technical measures, to provide maintenance and renewal of grasslands, to assure adequate soil coverage in the case of arable land or permanent crops, to recycle sewerage water, to use water efficiently, etc.

While this correct behaviour will need to be encoded in the internal rules and the sanctions for not complying are to be formulated consequently, it will be critical that the collective will succeed to create individual responsibilities of members in this respect. The group of experts suggested formulating in a positive way: i.e. instead of sanctions the members will collect positive points (tokens) for which they can earn some benefits. Non-compliers will not access these benefits.

Results of the expert group

Depending on the scenarios, the commitment (in the above respect) of land owners and operators is imputed in the model. Generally, we are optimistic based on the previous successes in other matters that LAG has capacity to fulfil all the challenging conditions. However, we assume different participation rates in scenarios: if it includes all (vast majority) of land owners and operators or only a group which expressed their interest in the collective action in the survey (i.e. excluding investor farms with owners outside the hot spot area).

Scenarios 2, 3 and 4 are evaluated against the baseline (Scenario 1) which refers to the current atomised GM with overlapping authorities and responsibilities. This scenario was defined as an assessment of trends in the second step of MAPP (see Appendix 6.4). Below we present three ways of scenario evaluation:

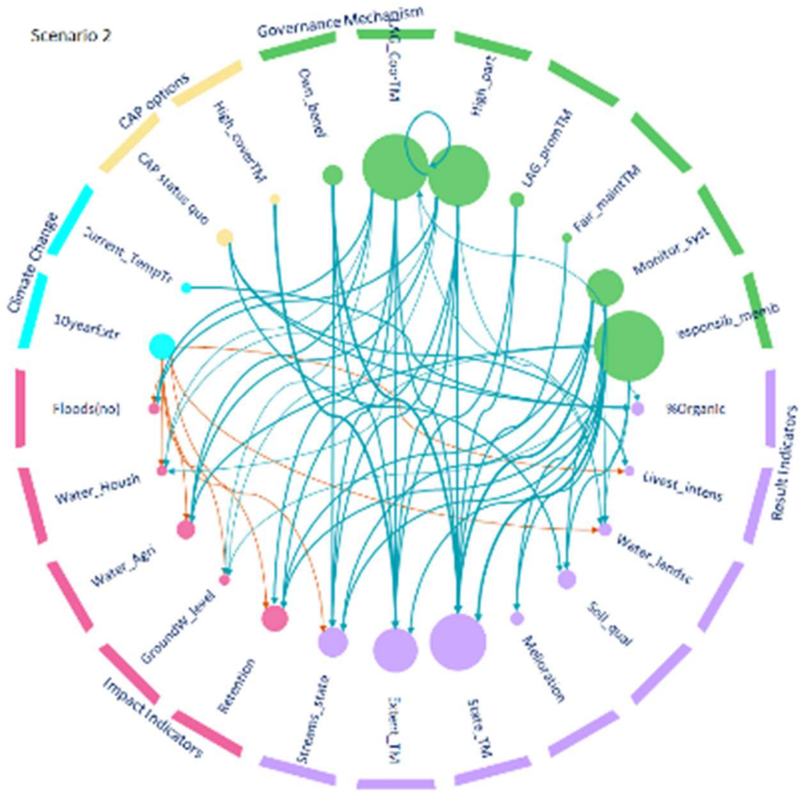
i) the impact of scenarios' individual attributes on the selected indicators of effects (**Errore. L'origine riferimento non è stata trovata.**):
   a. the upper hemisphere of the scenario charts represents the attributes of scenarios, while the lower one refers to the indicators of effects;
   b. the size of nodes refers to the sum of the appraisals of the influence of a scenario attribute on the selected indicators; the bigger nodes the bigger influence or impact;
   c. the thickness of edges [oriented curves connecting nodes – mostly scenario attributes with impacts (incl. outputs and results)] refers to the appraisal of experts on the level of influence between nodes in the direction of the arrow;
   d. the colour of edges indicates if the influence is negative (orange) or positive (green blue)

e. the most important factors affecting the provision of water availability are "the progress of climate change", "the LAG coordination", "the level of participation in collective action", "the responsible approach of members"

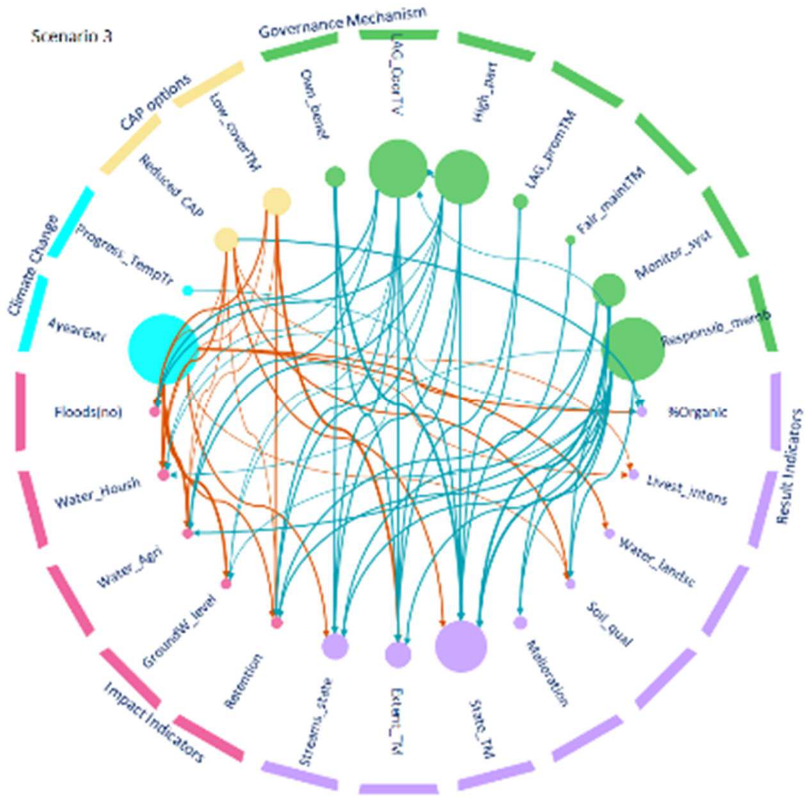
f. the most affected indicators are "the state and the extent of technical measures", "the state of small streams", "water retention of the landscape" and "water availability in agriculture";

g. The establishment a collective action under the LAG (Scenario 2) enlarges technical measures for water retention and improves the state of the existing ones. Consequently, it improves water retention and availability of water for agricultural production. The effect on water availability on households is regarded as small (and in long term).

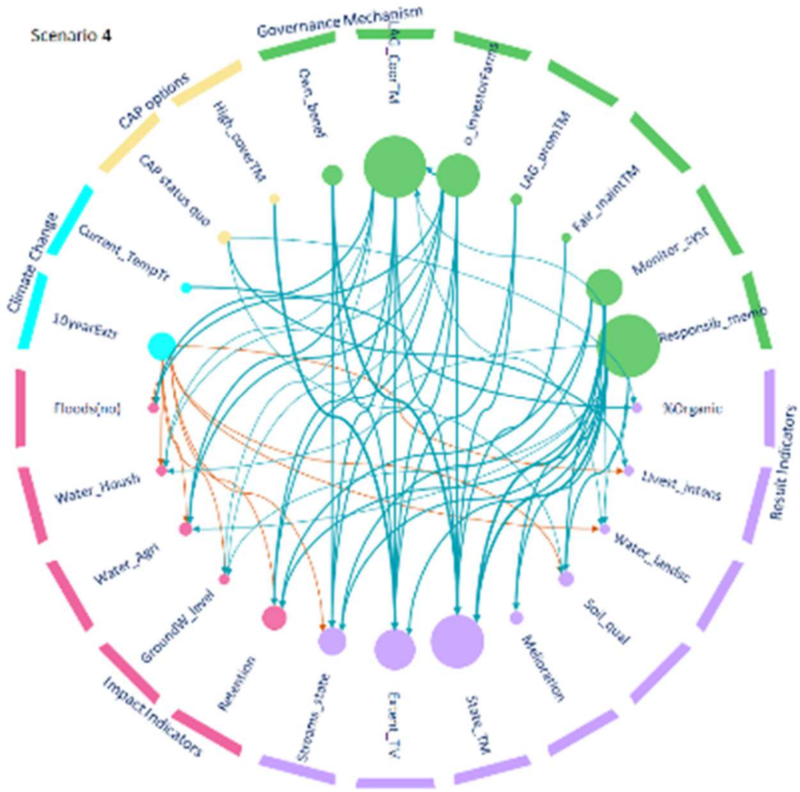
Figure 2. Scenario results



SC2 Full participation of farmers on LAG platform, current CC trends; (Status Quo)



SC3 Full participation of farmers on LAG platform, progressing CC, (Reduction of direct payments)



SC4: Investor farms decline taking part in the collective action, progressing CC, (Status Quo)

Abbreviation	Definition	Abbreviation	Definition
%Organic	The share of organic farming	Floods(no)	Floods (rarely)
Livest_intens	Intensity of livestock production	10yearExtr	Ten year cycles of weather extremes
Water_landsc	The state of water in the landscape	Current_TempTr	Current trend in temperature increase
Soil_qual	The state of the soil (- degradation, + improvement)	CAP status quo	CAP status quo
Melioration	The state of meliorations	High_coverTM	High coverage of investment costs
State_TM	The state of technical measures for water retention	Own_benef	Possibility to get direct benefit of TM (water for livestock)
Extent_TM	The extent of technical measures for water retention	LAG_CoorTM	LAG coordination of activities improving water retention
Streams_state	The state of small streams	No_InvestorFarms	Investor farms do not take part in the collective action
Retention	The share of water kept in the landscape	LAG_promTM	The assistance of LAG in negotiation land consolidation
GroundW_level	The groundwater level	Fair_maintTM	Spread of maintenance costs among members
Water_Agri	Water availability for agriculture (almost no shortages)	Monitor_syst	Creation of the system of monitoring behaviour of members
Water_Housh	Water availability for households (never dry wells and pipes)	Responsib_memb	Responsible approach of members

Source: own visualization

h. obviously, the change in the progress of climate change (Scenario 3) produces number of effects (it affects all impact and some result indicators). Together with the reduction of CAP supports they generate pressure on "water availability" and thus threatens agricultural production and welfare of households.

i. the experts do not think that a substantial reduction of CAP supports (Scenario 3) will affect the production (livestock intensity much)

j. a failure in attracting investor farms to take part in the collective action (Scenario 4) will produce only marginal effects. It is expected that the water retention of the landscape anyhow improves while the excluded farms might still lack water (they might not have access to water facilities providing water for animals, while they might benefit in terms of higher grass yields).

ii) the overall impacts of scenarios on the selected indicators of effects

The overall evaluation of scenarios is summarised in **Errore. L'origine riferimento non è stata trovata.**. Because it is difficult to sum positive and negative effects together we report them separately if they are of serious importance (high scores). Only in the case of minor importance (low scores) we bring them jointly under the sign "-/+".

In all scenarios, there are very important effects of the GM parameters on the extent and the state of water retention facilities and consequently on water retention. It definitely results in substantially better availability of water for agricultural production. On the other hand, the effect on water availability for households is limited. It is mainly because we considered that most of water for households comes from ground water which is marginally affected by water retention measures. Please, note that in this respect there was rather disagreement among experts. This rested in the time perspective: the sceptical position obviously referred to short and medium period, while the optimistic one emphasized long term benefit of more water in the landscape which eventually leak in the lower layers of the soil.

More progressive climate change i.e. most frequent weather extremes with droughts and flash floods is a challenge for the water management system (Scenario 3). It however seems that collective action can improve resilience of the cultural landscape to the adverse effects (mitigate these effects).

iii) the comparison of the individual effects of scenarios

In this part we sum together the negative and positive effects but also provided the aggregated negative and positive values. It improves our insight in the effects allowing somehow better overall judgement.

We illustrate it on the case of agricultural production. Most of the farms raise cattle (predominantly beef cattle) in the region. Thus we look at livestock intensity as the first indicator. It was farmers who claimed that water availability is critical PG in the Sluknov area. Farmers as well as municipalities suggested that rainfall water is insufficiently retained in the landscape. Thus we will concentrate on the effect of scenarios on the indicator of the retention capacity of the landscape.

Table 5. Summary of the Scenario assessment

	profil Scenario 2					profil Scenario 3					profil Scenario4					Scenario characteristics with highest impact		
Indicator /Valuation	--	-	-/+	+	++	--	-	-/+	+	++	--	-	-/+	+	++	Clim Ch	CAP opt	GM
The share of organic farming				+														
Intensity of livestock production			-/+					-/+					-/+				+	
The state of water in the landscape				+				-/+						+				
The state of the soil (- degradation, + improvement)							-		+					+				
The state of meliorations				+					+					+				
The state of technical measures for water retention					++					++					++			++
The extent of technical measures for water retention					++		-			++					++			++
The state of small streams					++					++					++			++
The share of water kept in the landscape					++	--				++					++			++
The groundwater level				+			-	-/+					-/+			-		
Water availability for agriculture (almost no shortages)					++		-			++				+		-		++
Water availability for households (never dry wells and pipes)				+			-						-/+			-		
Floods (occurence)				+		--			+					+		--		

The retained water creates reservoirs for water for animals on one hand and if absorbed in soil it is a precondition for sufficiently high yields of grass (or other fodder crops). The latter assumes application of operational measures for maintaining high water absorption capacity of grasslands. These effects are covered by the indicator of water availability for agriculture. Figure 3 shows that Scenario 3 will have (according to experts) substantial negative effect on livestock production at least in short time, while the other two scenarios have rather positive impact since negative effects of the CC are marginal, and positive effects of Current CAP are moderate.

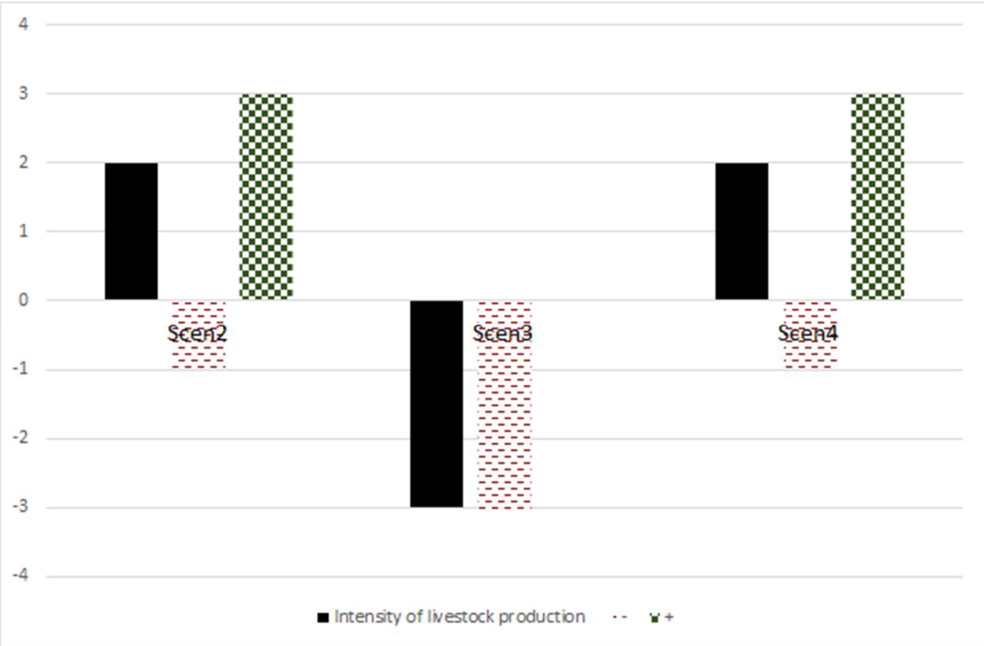


Figure 3: The effect of scenarios on the Intensity of livestock production (Source: Expert workshop (December 13, 2017))

We can read fromFigure 4 that the positive effects of scenarios parameters on water retention capacity have a similar extent in all scenarios; mostly referring to the benefit of LAG coordination. The negative impacts of mainly CC (and CAP in Scenario 3) on water retention vary; the magnitude of the negative extent might be as big as those positive of the improved GM. Or turning it over, the LAG based on GM can cope with progressing CC and a withdrawal of the CAP supports to the extent that the situation will not worsen even the periods of weather extremes shorten to four ear cycles.

As a consequence, water availability is expected to improve or definitely not to worsen thanks the improvement of the GM.

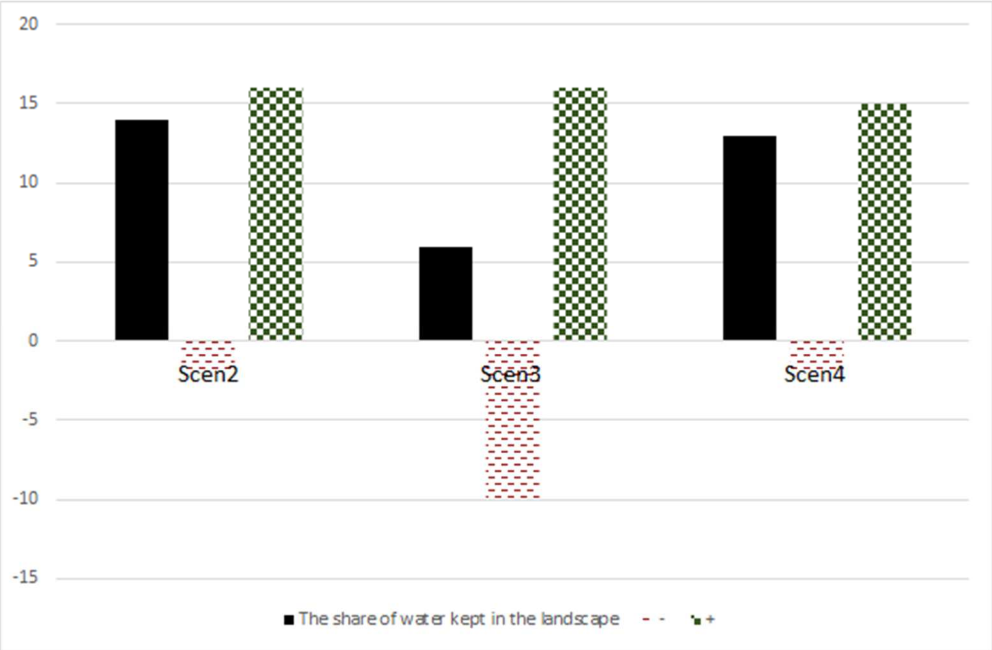


Figure 4. The effect of the scenarios on the share of rainfall kept in the landscape (Source: Expert workshop (December 13, 2017))

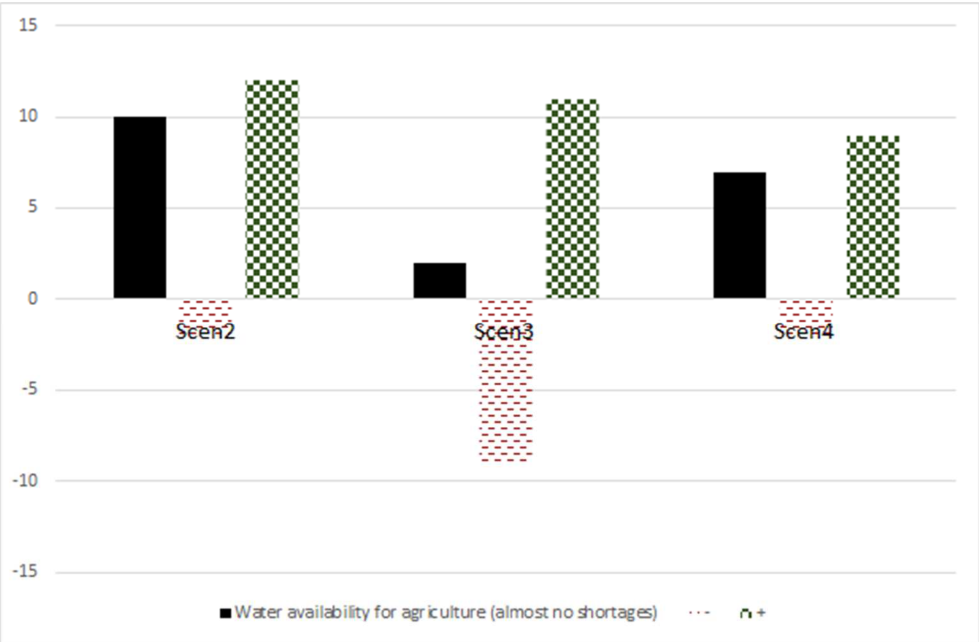


Figure 5. The effect of scenarios on Water availability for agriculture (Source: Expert workshop (December 13, 2017))

Results of the survey

Twenty two local stakeholders participated in the survey of which 17 were men and 15 were younger than 55 years. The composition of the participants in the survey (in terms of their roles in the local action arena) is given in Table 6. Half of the participants were farmers, while the other stakeholders are represented between one and three people only.

Table 6 The composition of the sample

Repondent typology	freq	
Expert	2	9%
Farmer	11	50%
Local activist	2	9%
Municipal Officer	1	5%
Non-agric Entr	3	14%
Reg Gov Offic	1	5%
SLO Officer	2	9%

Source: The survey of stakeholders, February 2018

Before we introduced the scenarios and asked about stakeholders' preferences we raised three questions on the position of the stakeholders towards water retention improvements. The respondents agree that water retention is in the interest of all stakeholders in the Sluknov area and that technical and operational measures for its improvement are important. Only two of them have strong reservation to the responsibility of farmers for the renovation of grasslands, and one is not sure about this statement validity

Table 7 Perception of the water retention improvement aspects by stakeholders

	Fully agree	Agree with some small reservation	Agree with the need, but does not with the farmers' responsibility for it	Do not know
Water retention is in the interest of all stakeholders	15	7		
TM are important	8	14		
Grassland renovation is necessary, and farmers are responsible for it.	9	10	2	1

Source: The survey of stakeholders, February 2018

In the following table (Table 7) we present evaluation of Scenarios 2 to 4 on three questions (indicators): about cost efficiency, effects on farming and outmigration and farmers commitment. Most of the respondents took neutral positions that positive effects will be achieved only partly. However, the responses to the questions on farming continuation and stability of population, and on members commitment to retain water in landscape exhibit some logical adverse reaction to more profound climate change (Scenario 3) or incomplete participation (Scenario 4) in terms of lower number of positive responses (Expected effects) than under Scenario 2. Actually, one third of the respondents stressed positive effects of Scenario 2 on these two indicators.

Table 7 Perception of the water retention improvement aspects by stakeholders

Question		Expected effect	Expected partially	Not expected
Costs are lower than the effects of weather extremes	SC2 full particip.	1	21	0
	SC3 progress. CC	2	20	0
	SC4 partial part.	5	17	0
Farmers keep on, people stay	SC2 full particip.	7	15	0
	SC3 progress. CC	6	16	0
	SC4 partial part.	5	17	0
Members committed to retain water	SC2 full particip..	7	15	0
	SC3 progress. CC	3	19	0
	SC4 partial part.	3	19	0

Source: The survey of stakeholders, February 2018

Concerning the first indicator on cost efficiency in Table 7, it is evident that the costs were understood as transaction costs by some respondents. The cost efficiency is regarded being achieved more frequently in Scenario 4 when investor farms do not participate in the collective action than in the other scenarios likely because these farms will cause less trouble.

Generally, we can say that the survey among the stakeholders yield much less insight in the issue of governance than the consultation with experts. The most relevant result of the survey rests in the confirmation that measures on the improvement of the retention capacity of the landscape in the Sluknov region are considered as important.

7.1.6 Discussion

7.1.6.1 Discussion of results

Our analysis has showed that LAG based governance mechanism can improve the provision of the public good "Water Availability" in a robust way, i.e. it will help to cope with a climate change progress as well as with CAP changes. The experts emphasized that an essential condition for such robustness of the collective GM rest in achieving members' commitment for responsible management of water retention. And thus that it is necessary that the LAG pay great attention to it.

We also assume that an essential attribute of the proposed GM is that the costs of maintaining the water retention facilities are distributed fairly among the members of the LAG. However, the experts were skeptical on this and therefore this attribute actually played a minor role in the effects of scenarios.

According to the experts the absence of investor farms in the collective action will reduce the effects rather marginally, even if it might concern a half of the agricultural land. Obviously, the experts thought that free riding will be limited to some benefits from water deposited in soils, while the non-participants will exclude themselves from the access to water for animals. Also one has to take into account that retaining water in soil assumes rather operational measures than technical measures and providing operational measures (e.g. renewal of grassland) will be of the responsibility of farmers.

7.1.6.2 Discussion of methodological approach

For evaluation scenarios we chose a qualitative approach based on the knowledge of experts and stakeholders. We combined the Fuzzy Logic Cognitive Mapping (to summarise pre modelling knowledge) with MAPP (for assessing scenarios). We put some emphasis on visualisation of connections between concepts (drivers and impacts) and their relative importance in terms of frequencies of interactions their importance and certainty. It has added on the transparency of the evaluation at least to some extent. Because we found the assessment of expert/stakeholders opinions from the point of view of certainty (fuzzy set membership) as problematic, we decided for the much more straightforward MAPP. However, we found the scoring of the importance problematic too. It is not easy to state ordinary set of scores capturing more than one dimension; e.g. period of the effects (short to long terms) and territorial coverage (marginal coverage to the entire territory) – while multi-criteria judgement would be absolutely desirable. In addition, it is difficult to assure consistency of judgements. A further problem with scores rests in the limited possibility to judge on the compensation between the positive and negative effects.

Nevertheless, we tried to address these issues by presenting three different partial evaluations of the scenarios. We hope that such a “triangulation” allows producing convincing results on scenario evaluation.

7.1.6.3 Discussion of the participative elements in the modelling approaches

Two approaches to dealing with stakeholders and experts were largely used in the case study on the HS CZ1: i) individual interview (structured and semi structured) and ii) facilitated group discussions. The individual interviews with stakeholders allowed obtaining certain factual details and a precise position of a stakeholder regarding the investigated subject. On the other hand, it provided narrow perception of the problem. In contrast, group discussion first of all enlarged the perception of the stakeholders and experts of the dimensions emphasized by the other participants – it forced the participants to think in broader contexts. A good example of it is that hydrologists presented their skeptical attitude to the impact of the technical and operational measures for water retention measures on rising groundwater level in the interviews, while in the group discussion with environmentalists and practitioners they admitted that there would be long term benefits and that the extent of the measures (territorial coverage) would matter.

The participatory research method yielded additional effect in terms that stakeholders or experts met for first time and regarded this opportunity as exceptional for establishing contacts which otherwise would last longtime to emerge. Actually it was the LAG which suggested to invite additional stakeholder to our third workshop in June 2016 and all participants found it as beneficial. While the representative of the LAG appreciated te opportunity to get in touch with experts in our scenario evaluation workshop. Also experts found the input from the practitioner as important for their further work on the climate change/drought mitigation policy.

An obvious disadvantage of the participatory approach is the difficulty to engage the right experts and key stakeholders and to find suitable time for group work. Dependence on expert and stakeholder involvement might hinder the progress of the research while putting great load on the researchers during the workshops - to facilitate the discussion and to keep detail notes of the discussion. Consequently, there is limited possibility to get further clarifications or specifications after the workshop which might leave some gaps in the consistency of judgements uncovered.

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APPENDIX

MAPP

MAPP is a participatory Method for Impact Assessment of Programmes and Projects developed by the German Development Institute (Dr SUsanne Neubert) (EC, 2014). It is a methodological framework combining a qualitative approach with participatory assessment instruments, but it includes also a quantification step. It orients itself towards principles such as:

Triangulation: the collection of distinct data with different tools in order to proof or raise the validity of the data;

Optimal ignorance: the capability to select relevant data and to avoid an information overkill;

Communal learning: the findings of an assessment are the result of a communication process among relevant stakeholders and/or experts.

MAPP is an evaluation approach that allows the inclusion of experts, people affected by an intervention and other stakeholders in the evaluation of impacts following a logical structure (4 steps)

<u>Life Curve:</u> This shows the overall development trends in the community/region along a certain time frame ending at the horizon of the investigation.

<u>Trend Analysis (Baseline):</u> In this step, detailed development trends of the effect indicators are evaluated over the period of interest (of the scenario assessment). These trends do not reflect scenario assumptions (changes in external conditions, intervention and institutions/ e.g. GM) for ex-ante evaluation or the investigated policy implementation for ex-post evaluation.

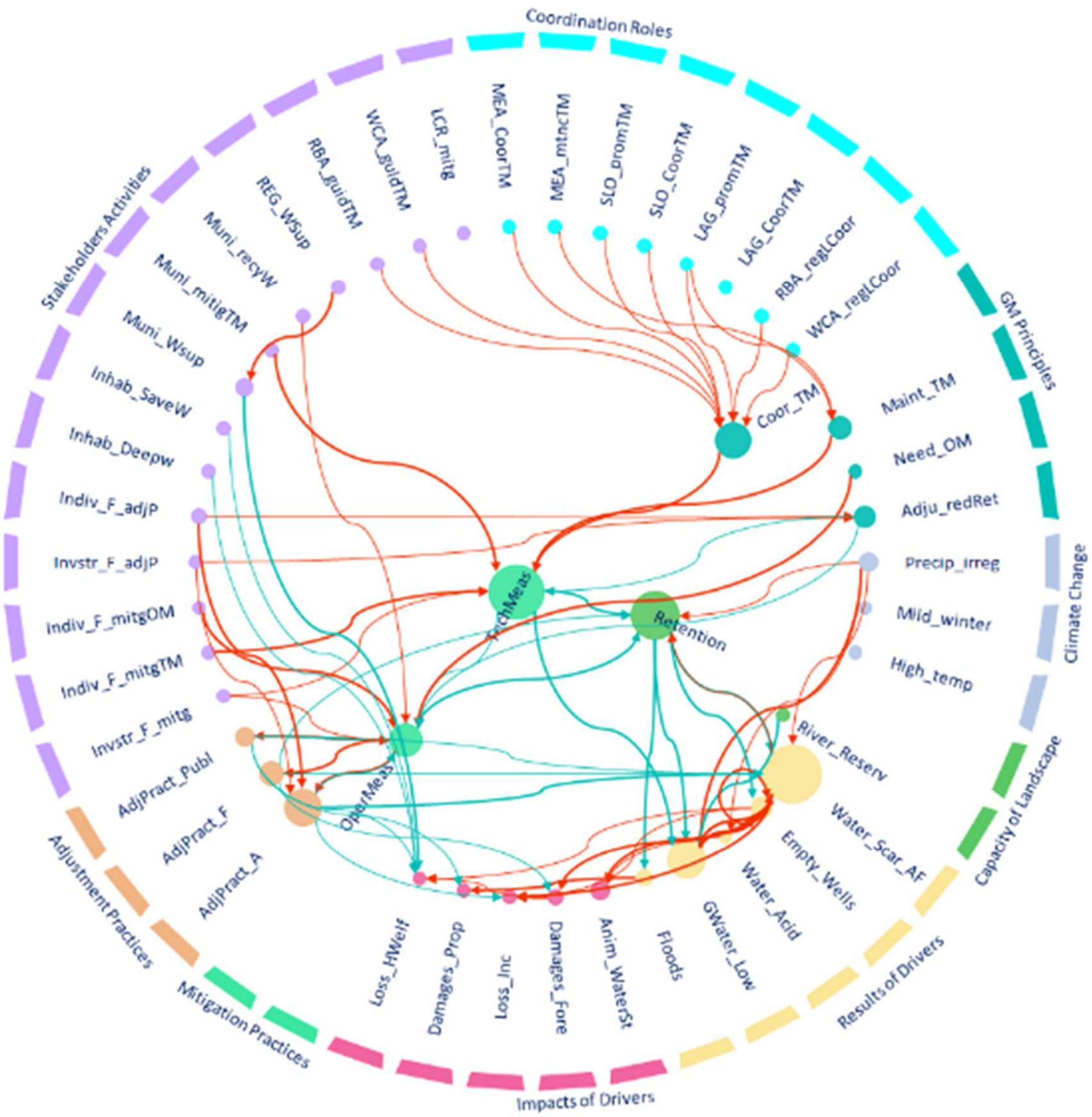
<u>Influence Matrix:</u> This matrix shows the influence of drivers (external conditions, policy intervention institutional changes) on each effect (result and impact) indicator. Afterwards, the passive and active sums are calculated. The active sum shows which driver has impacts on the most effect indicators, whereas the passive sum shows which effect indicators is affected most.

Scenario Impact Profile: It is a table with graphical interpretation of effects of scenarios. It summarizes results of MAPP. A comparison of Scenario Impact Profiles gives an impression of the robustness or vulnerability of some effects (indicators) in respect to changes in drivers.

Please, note that scenarios are evaluated against the baseline. (for more details see EC (2014))

The system of the provision of the PG "Water Availability".

Figure 6. System of "Water Availability" provision in the HS CZ1: Sluknov Area



Note: The list of used abbreviations/acronyms is in Table 6.

Source: The summary of investigation among stakeholders (The survey among farmers on their willingness to participate in water provision; Stakeholders workshops 1 and 3; interviews with stakeholders.

Table 6. The list of Abbreviations used in **Errore. L'origine riferimento non è stata trovata.**

#	Abbreviation	Definition
1	Precip_irreg	Irregular precipitation
2	Mild_winter	Mild winter (less snow)
3	High_temp	High temperature -> high evaporation
4	Retention	Retention capacity of cultural landscape (low, medium, high) - agric and forest land, small stream
5	River_Reserv	Big water reservoirs (dams), river channels and other river constructions affectiing ground water level
6	Water_Scar_AF	Water scarcity in agriculture and forestry
7	Empty_Wells	Water scarcity in human settlements
8	Water_Acid	Water acidity
9	GWater_Low	Low ground water level
10	Floods	Floods
11	Anim_WaterSt	Lack of water for animals
12	Damages_Fore	Damages on forests
13	Loss_Inc	Income loss due to the loss of yield
14	Damages_Prop	Damages on private and public properties
15	Loss_HWelf	Human welfare loss
16	TechMeas	Technical measures for increasing water retention
17	OperMeas	Operational measures: farming, forestry measure for improving water retention
18	AdjPract_A	Agricultural adjustment practices to cope with water scarcity
19	AdjPract_F	Forestry adjustment practices to cope with water scarcity
20	AdjPract_Publ	Adjustment practices to cope with water scarcity at public administration level
21	Invstr_F_mitg	Investors farms are keen on engaging in CC mitigation (technical and operational measures)
22	Indiv_F_mitgTM	Individual farmers are ready to invest in TM for CC mitigation
23	Indiv_F_mitgOM	Individual farmers are ready to introduce OM for CC mitigation
24	Invstr_F_adjP	Investors farms will adopt adjustment practices (e.g. increasing extensity, change of crops)
25	Indiv_F_adjP	Individual farms will adopt adjustment practices (e.g. increasing extensity, change of crops)
26	Inhab_Deepw	Inhabitants will dig/drill deeper wells.
27	Inhab_SaveW	Inhabitants will reduce water consumption
28	Muni_Wsup	Municipalities will invest in new water supply pipelines
29	Muni_mitigTM	Municipalities will invest in TM for CC mitigation
30	Muni_recyW	Municipalities will investe in water recycling
31	REG_WSup	Regional Government will invest in new water supply pipeline
32	RBA_guidTM	RBA will guide investment in TM for CC mitigation
33	WCA_guidTM	WCA will guide investment in TM for CC mitigation
34	LCR_mitg	LCR is keen on engaging in CC mitigation (technical and operational measures)
35	MEA_CoorTM	Municipality with Extended Authority will coordinate TM
36	MEA_mtncTM	Municipality with Extended Authority will take care of maintenance of TM
37	SLO_promTM	SLO will promote investment in TM
38	SLO_CoorTM	SLO will coordinate investment TM
39	LAG_promTM	LAG will promote investment and maintenance of TM
40	LAG_CoorTM	SLO will coordinate investment and maintenance of TM
41	RBA_reglCoor	RBA recognises local coordination of TM and OM
42	WCA_reglCoor	WCA recognises local coordination of TM and OM
43	Coor_TM	Coordination of TM in the landscape improves retention
44	Maint_TM	Maintenance of TM is essential for sustaining water retention capacity of the landscape
45	Need_OM	OM are needed to improve water retention capacity of the landscape
46	Adju_redRet	Adjustment measures reduce interest in TM a OM

The composition of the Expert Group

Ten experts of different disciplines and organisations related to the water availability problem. Finally, five of them managed to arrive. Thus the group of experts included

- a hydrologist from the Water Research Institute; member of the Taskforce on Draught Mitigation Policy of the Czech Government
- an environmentalist from the Nature Conservation Agency of the Czech Republic
- an environmentalist from the Technology Centre of the Czech Academy of Sciences
- a crop scientist and agricultural economist from the Czech University of Life Sciences
- a member of the management of the LAG (MAS Cesky sever) and agricultural advisor

The workshop was held in the Technology Centre of the Czech Academy of Sciences, Prague on December 13, 2017.

Baseline

Table 7. Trend analysis (Baseline) (Source: Results of the Expert Workshop (December 13, 2017))

Baseline

Indikátor	Rok 1960-1990	2001-2020	2020 - 2050	Trend
The share of organic farming		0.2LU ->0.3	0.4	-
Intensity of livestock production	High share of arable land	85%	85%	+-
The state of water in the landscape				
Soil erosion	high	low	low	+-
Other soil degradation (compaction, poor state of grass)		compaction, poor state of grass	compaction, poor state of grass	-
The state of meliorations		poor	poor	-
The state and extent of technical measures for water retention		slow pace of introducing them	slow pace of introducing them	-+
The state of small streams		generally, improving	depending on weather extremes	-+
The share of water kept in the landscape		Improving	Decrease	-
The groundwater level		Declining	Declining	--
Water availability for agriculture (almost no shortages)			Worsening	-
Water availability for households (never dry wells and pipes)			Worsening	-
Floods (rare occurrence)	Moderate danger of floods	Increasing danger of flash floods	High danger of flash floods	-

The list of abbreviations

Abbreviation/ Acronym	Explanation
CC	Climate Change
CSR	Case Study Region
CZ1	Hot Spot of the Sluknov area
GM	Governance mechanism
HS	Hot Spot (in this report referring to the Sluknov area),
LAG	Local Action Group (in the study “MAS Cesky Sever”)
MEA	Municipality with Extended Authority (in terms of state administration)
OM or WROM	Operational Measures for improving water retention in the landscape (e.g. grassland renewal, maintenance of water streams)
RBA	River Basin Authority (it is a state company, in this report RBA of the river Ohre with its local office in Ceska Lipa)
SLO	State Land Office (in this report the district office in Decin)
TM or WRTM	Technical Measures for improving water retention in the landscape (ponds, dams, polders, wetlands, …)
WCA	Water Catchment Authority - a unit of the state company “Forests of the Czech Republic” (the corresponding office for the HS CZ1 [Sluknov area] is in Teplice)
WMO	Water Management Office (provided by the MEA Rumburk)

7.2 BG-1: Water quality, food security and scenery and recreation in the Bulgarian South Central Planning Region

7.2.1 Introduction

7.2.1.1 Description of case study region

- Name – South Central Planning Region (SCPR)
- Location – southern part of Bulgaria
- Size – 22 365 km² or 20.1% of the country
- inhabitants/km² - 66
- share of agricultural area – 46.3 %

Soil and climatic conditions in the region favors the cultivation of all crops. The crop system is predominated by wheat, corn and sunflower. Cereals have the largest share - 56.5%. Besides major grain-producing the region has 30.8% of the areas of vegetable crops at national level, 28.1% of the areas of fruits and 26.7% areas of vineyards. There is a small proportion of forage crops. Although cotton occupies only 1.5 percent of arable land in the region, the region is the main national cotton producer because 89.5% of the areas of this crop.

More than half of national tobacco production is from the region.

In the region are located more than half of the country land under apples and one third of table grapes. The most distributed vegetable crops are green pepper, potatoes and tomatoes. The region provides more than half of the production of oriental tobacco, pepper and apples at the national production. Yields of most crops are higher than average crop yields obtained in Bulgaria.

The livestock is well developed in the region and includes various animal productions – cow, sheep, goats, birds, pigs. The region produces more than one third of the total quantity of milk in the country - 34.8 percent.

The terrain is extremely diverse. The area covers a large part of Rhodope Mountains, Sredna Gora (mountain) and Sakar Mountain. Lower parts of the area covering the Upper Tracian Valley it is formed around the catchment areas of the River Maritsa. Kardzhali and Smolyan districts are located in the mountains, while others combine mountains with valleys. The **landscape** suggests significant differences in the climate of parts of the region. Agriculture in mountain areas has a secondary function which is determined by the specific soil and climatic conditions of the area and the relief, which creates difficulties in processing the land. Until recently, the main crop in mountainous areas was tobacco. But there is a tendency to reduce its share in the structure of the agriculture. **Soil** cover in SCR is closely related to the specific combination of bedrock, the peculiarities of the relief, the direction of the radial movements of the earth crust, climatic conditions and human activities that determine the considerable diversity of soils in the region. They can be characterized as: deep soils in lowland areas with soil types: typical cinnamon forest soils, leached cinnamon forest soils, leached vertisols, pseudopodzolic soils, alluvial meadow soils, swamp soils, saline soil ; and shallow soils in the hilly and mountainous areas with soil types, humus carbonate soil, shallow cinnamon forest soils, brown forest soils, brown soils with humus-carbonate soils.

The landscape of the territory is defined as very pastoral - with small and well-managed fields and meadows processed in the traditional way. Mountain pastures and hay meadows are inherent for the territory. In the territory under pastures it is breading sheep and cows. Some pastures and meadows are underutilized and they slowly turning into forest. Agriculture in the region is defined as "self" production mainly for its own needs and sells the surplus. Main productions are potatoes, tobacco and Smilyan beans and animals for milk and meat. Mountain farming in combination with unspoiled nature and the lack of polluting enterprises guarantee the high quality and purity of the produced agricultural products. There is potential for registration of geographical marks.. Over the past three years many organic farms have been certified - organically grown mainly herbs, chokeberry and raspberries. Livestock is presented primarily by individual animal owners and can be attributed to the so-called "small farming" - on individual holdings. It covers the predominant share in the statistical data. There are only few large farms.

After a brief decline in the registered number of farmers in the area in the last year is noticeable again their increase, which is a prerequisite for a real increase in investment in agriculture through the opportunities offered by European funds through the Programme for Rural Development. Prospects for the development of Agriculture concluded in overcoming fragmentation, land consolidation, creation of agricultural associations, cultivation of new crops, improving quality of the nursery and finding new markets.

7.2.1.2 Description of public good issue

The area is notorious with its public goods – water quality and availability, food production and security, wood production, scenery and recreation. Although they are available in good levels there are some negative trends in their developments. They need to be governed by proper mechanisms in order to be maintained and developed in future.

The existing mechanisms don't stimulate locals to perform actions assuring supply of public goods. Governance mechanism do not reach small farmers. There is lack of Association or producers groups. Local food security is weak because of not enough regional brands of food. There is no developed short chain distribution. The agricultural management is already good and the relevant changes are the following: Financial incentives (subsidies, local development programmes) and Advisory services and information. They must provide interactions between PGs and PBs – mainly for Food and Wood Production, Water quality and Landscape.

There is a need of creating initiatives among farmers and forest owners to apply sustainable management practices. Adequate public financial support will be crucial for implementation of such activities. After the discussion the final PGs which need to be improved governance mechanism and should be investigated in the context of the hotspot BG-1 are: Water quality (PG1), Food security (PG2) and Scenery and recreation (PG3).

7.2.1.3 Description of governance-strategy

The PGs are designed by the policy makers (Organic farming, Natura 2000) and from the market are logging and food production. The PGs are defined by the policy makers through the public programmes based on the budget funds (regional and municipality level). Also exist regional water management plans. Private governance mechanisms are dominated by local brands, agricultural and credit cooperatives and private investors. Connected with agriculture system in the region is the direct marketing as private governance. Access to credit is limited for the small farms. The financial support is for preserving the local variety of livestock and plant production. Existing certification and labelling mechanism for Food and Forest products (Smilan been, Rodopi bull, “Mursal herb tea and organic farming). Existing knowledge about the network supporting mechanism are: local collective actions, producers groups, advisory and information services (NAAS and information centres), and local action group (LEADER approach), knowledge transfer and innovation organisation (Research Institutes and Universities for agriculture and forest). Others governance mechanisms are based on the environmental clubs and society (Hunting and Fishing Union, carrying about the biodiversity).

We investigated a mix of 3 governance mechanisms - collective action, AES and quality product certification.

The main advantages of the proposed Governance Mechanism from the stakeholders' point of view are:

- Protection on local small producers.
- Guarantee for consumers
- Development of local communities

The main criteria for good governance strategy are:

- Market price volatility
- Consumption patterns
- Depopulation of the region

After the implementation of the governance strategy in terms of public good provision and in terms of land management/public good provision the following is to be expected:

- Better image of the region and more opportunities of investments in other sectors.
- Small farms must be core of this mechanism. They can be supported by LAGs.
- Landscape aesthetic will somewhat decrease due to abandonment of land.
- Soil functionality will increase due to low intensive production.
- Improvement of life quality in the region and welfare.

7.2.2 Methodological approach

7.2.2.1 Theoretical background

We used a quantitative approach: we used logic models including interactions with the attributes of PGBs and the constant (ASC) with socioeconomic variables to identify significant relationships between these variables and benefits of PGBs provided by the HS under study. We run one model per variable (i.e. potential determinant) including interactions between it and the two attributes representing PGBs (water quality and food security) provided by the HS Mountain in the CSR BG (an example of this model for the variable representing if any individual's relative MOTIVIPLF (How much are motivated the respondents to pay more for local foods). Also, we include interactions between the variable and the ASC, which can be interpreted as relationships between the 2 PGBs.

7.2.2.2 Model implementation

Target levels of public good provision are addressed in the model

1. annual rate of fertilization with manure - 170 kg per ha
2. share of local farms apply practice of water protection – 66%
3. number of farms in AES – 80 farms /30%/
4. Share of farms in AES – 33%
5. Number of new rural tourism objects – 5
6. Investment in eco infrastructure – 150 Euro/citizen

Modified partial equilibrium model of demand and supply of public goods

The main idea of the study

The main research objective is to produce quantitative assessments separately for the supply and demand of public goods and on this basis to analyze their compliance. The study involves the three public goods PBG1 - the provision of Quality Water; PBG2 - Food Security and PBG3 - Landscape and Recreation Conditions The Gross Margin (GM) is involved in the calculation of the total measure of the supply of public goods, and any change of GM is followed by corresponding changes in the level of supply. Since the different types of subsidies are involved in the value of the gross margin, when they increase, the gross margin will increase and hence the supply level will also increase. Under unchanged other conditions, variations in gross margin values can be simulated under the influence of changes in the agricultural product prices and compensation payments under different agri-environment measures and other schemes. In this way, the effects of the separate compensatory payments on the various measures on the supply of public goods can be assessed. The main subsidies are under the Nitrates Directive, the Certification of Agricultural Products, the subsidies under Measure 10 "Agroecology and Climate" in the "Recovery and Maintenance of High Nature Value Grassland (HNV)" and the "Soil Erosion Control" etc.

The idea of quantification of supply and demand levels is realized based on the vector length calculated from the results obtained of the application of Principal Component Method (PCM). Input variables for the PCM have used the answers to a large number of questions in the questionnaire for users of public goods. These issues relate to the different types of economic, social and environmental costs, the economic, social and environmental benefits of potential tourists and rural populations, economic, social and environmental opportunities for improving the environment and the economic, social and environmental risks of air pollution, the lack of qualified personnel for introducing eco-standards, soil erosion, and so on. Together with this type of inquiry questionnaire, answers to the questions related to the amount that respondents would pay for moderate or significant improvement of the public goods offered. Each of the original variables has a certain extent to the supply of public goods.

Basic theoretical principles of the PCM

The analytical expression of the main components has the following general appearance:

(2) $PCjkl = \sum Wjkl * Vjk$, where:

Wjkl represent the factor weights in front of the k variable of the 1st major component for the economy;

Vjkl are the values of k initial variable for the holding;

k = 1, ...n / number of initial variables /;
j = 1, ... m / number of agricultural holdings /;
l = 1, ... p / number of main components /.

Each farm can be presented separately in the four resulting spaces as points in a coordinate system with coordinates resulting in the corresponding major components. Thus, on each holding corresponds one vector (KVj) in the resulting four spaces and the length of this vector can be calculated by the formula:

(3) Length j = SQRT (ΣPCj1 ^ 2), where:

j corresponds to the jth potential consumer of public goods / j holding;

l = 1, ... p / number of main components /

The magnitude of the length of the vector is focused on the aggregate influence of the initial variables. As they express the manifold aspects of supply and demand factors for public goods, Length represents a quantitative measure of their level. This approach is applied in the quantitative measurement of a number of phenomena in the social and economic sciences [Mihailov, D., S. Tzvertarski, M.Anastasova and others. (2004) The municipal human development index in the context of the typology of municipalities, In: Rural Regions: Overcome Development Disparities, United Nations Development Program (UNDP), p. Rakadjiiska, T., M. Molhol. (1995) Modeling the Social Subject of Labor, In: Journal Sociological

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Key features of the modified partial equilibrium model

The general appearance of the modified partial equilibrium model can be described by the following equation:

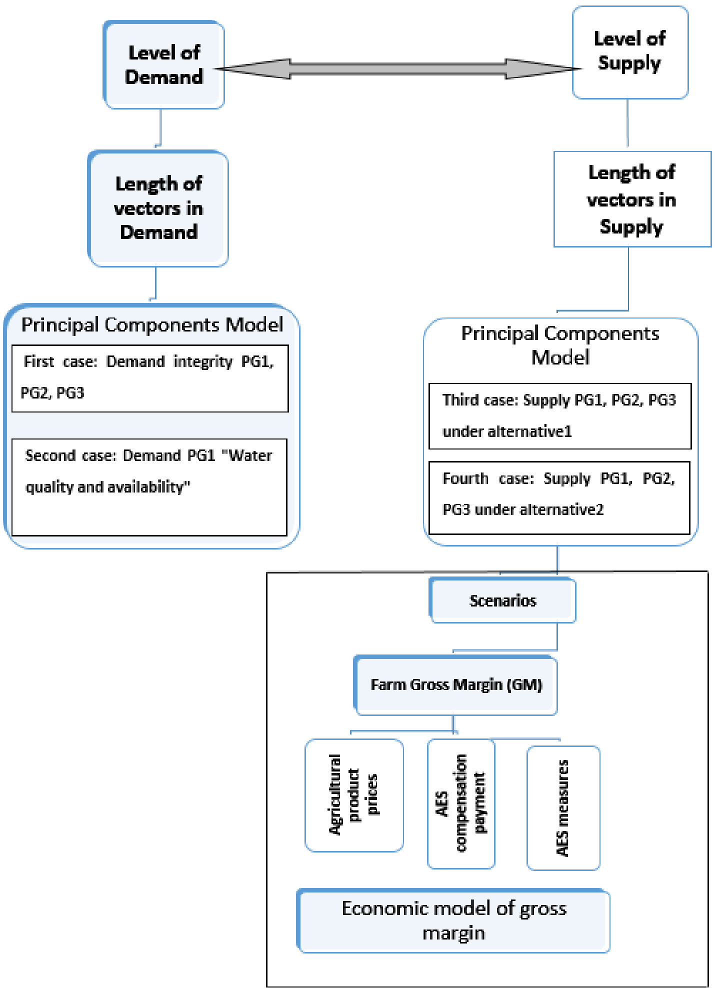
LengthSPL|01 = Length Dm|01, where the two dimensions to the left and to the right express the supply level and the demand level presented on the single measurement scale. Once the respective vector lengths have been obtained, each of them is aligned to the classic single scale for greater clarity. (The maximum vector length is 1, the minimum is 0).

It should be emphasized that models of supply and demand equilibrium do not have that classical form expressed through the prices and the respective quantities of the offered goods and services (Georgieva, K. (1991), Microeconomics, University of National and World Economy, Pp. 182). The received quantitative measures of demand and supply of public goods are considered as basic models. Futher, on the base of these models, has been explored the effect of different policies (measures) actions in order to promote greater degree of public goods provision, intending the reaching of their demand level. In this way, from the basic models of the demand - supply ratio, we move to partial equilibrium models targeting the three public goods.

The impact of the price simulation on the supply of good PBG 2 "Food Security" does not manifest in direct form but indirectly through the gross margin. Simulated changes in agricultural product prices affect the value of the gross margin. And since the gross margin is involved in determining the length of the vector to measure the level of supply of this public good, then the price with its respective changes has a definite effect on it.

For the other two goods (PBG1 and PBG3), the effect of the subsidies amount under the various measures on the level of their supply is also investigated through the corresponding changes occurring in the value of the gross margin as it includes all possible subsidies. The reasoning is the same as for PBG 2. The gross margin is involved in the calculation of the respective length of the supply vector and any change therein (the gross margin), including as a result of subsidy changes, affects the supply level. Here too, the effect of separate measures to assist farmers on the level of supply of PBG1 and PBG3 is indirectly reflected through the gross margin.

The modified partial equilibrium model of public goods can be illustrated in the following way.



Graphic presentation of the modified equilibrium model

Methodological tools for applying the PCM to the demand and supply of the three public goods

The assessment of the supply and demand of public goods and their length has no particular physical meaning due to the nature of the principal components. Once the respective vector lengths have been obtained, each of them is aligned to the classic single scale for greater clarity. (The maximum vector length is 1, the minimum is 0).

The principal components' method is applied sequentially in four cases. In each case, reduced space is represented by corresponding linearly independent vectors.

In the **first case**, the answers to a large number of questions in the questionnaire for users of public goods were used as an input variables. This is a model for applying the **PCM to the demand of the three public goods in their integrity.** These issues relate to the different types of economic, social and environmental costs, the economic, social and environmental benefits of potential tourists and rural populations, economic, social and environmental opportunities for improving the environment and the economic, social and environmental risks of air pollution, the lack of qualified personnel for introducing eco-standards, soil erosion, and so on. Together with this type of questions, the answers of the questions related to the amount that the respondents would pay for moderate or significant improvement of public goods are included.

Each of the original variables has relation to a certain degree to the supply of public goods. More specific view of the primary variables used is derived from the list of questions, the replies of which are in the capacity of the initial variables (Annex 1).

In essence, the three goods are interconnected, so both the supply and demand of each one contributes to the supply of the other two goods. For this reason, the study was conducted in a complex way, at the same time for the three goods. Another reason for this decision is also given by the fact that the respondents put the three goods in an equal position in terms of their priority in relation to the allocation of additional funds for their provision. To the question, "What do you think is the public good that you want to see more money allocated to?" 32% of farmers responded that this is the availability of quality water, 33% refer to the viability of the countryside (landscape) and recreation and 34% of food security. There are other answers in the two questionnaires, which give us enough reason to believe that at the time of the survey, the two categories of respondents (farmers and potential consumers of public goods) have almost the same attitude towards the provision of all three public goods.

However, it was further attempted to apply the main components model separately for each of the three goods.

In the second case there is a model for the application of the PCM to the demand of the Public Welfare PGB1 "Water quality and availability". The questions were taken into account are include in Annex 2.

In the third case, a model for the application of the PCM in supply the three public goods as a whole at Alternative 1 (Farmers produce goods without clear identification of their origin). The answers to the following questions in the questionnaire for farmers are used: "How do you assess the contribution of agriculture and forestry to securing public goods?" and "To what extent does the production of products without a clear identification of origin (alternative1) affect the different types of benefits, opportunities, costs and risks?" The gross margin is included. The list of responses includes the questions (Annex 3)

The fourth case differs from the third one only in that instead of alternative1 an alternative2 is used-, a model for the application of the PCM in supply the three public goods as a whole at Alternative 2 (the production of goods with a clear identification of origin). The used variables one can see in Annex 4.

7.2.3 Scenarios

7.2.3.1 Overall scenario narratives

Overall narrative of Business as usual scenario:

- Climate change: two degree increase will be missed
- Moderate world population increase
- Given consumption patterns/low willingness to pay for public goods
- Moderate prices of natural resources, in particular oil
- High market price volatility
- Technical progress without fundamental breakthroughs

Overall narrative of Sustainability driven scenario:

- Climate change: max two degree increase
- Low world population increase
- Significant willingness to pay for public goods
- High prices of natural resources, clearly reflecting scarcity
- Moderate market price volatility
- Significant, clearly environmental oriented technical progress

7.2.3.2 Specific scenarios for each public good

The scenarios for PG1: (water quality and availability) :

- Basic - no change in fertilization level of 400 kg per ha of potatoes and 200 kg per ha of beans; no change in the yield level;
- Scenario 1 - no change in the level of bean fertilization and reduction of potatoes' fertilization to 260 kilos per ha and respective reduction of the yield by 20%;
- Scenario 2- The same conditions as for Scenario 1 plus 50 Euros per ha under Measure 12.3 (Nitrates Directive);
- Scenario 3 - Same conditions as for Scenario 1 plus 500 Euros per ha under Measure 12.3 (Nitrates Directive);
- Scenario 4 - The same conditions as for scenario 3 plus EUR 130 per ha under Measure M.13.1.

The scenarios for PG2 (food security):

- Basic - level of fertilization in potatoes - 400 kg. per ha; fertilizer level for beans - 200 kg; without a product quality certificate.
- Scenario 1 - level of potato fertilization - 400 kg. of ha; fertilizer level for beans - 200 kg; with a product quality certificate that increases costs by 10.26 euro per ha and an increase of the product price by 5%;
- Scenario 2 - Potato fertilization level - 400 kg. per ha; fertilizer level for beans - 200 kg; with a product quality certificate that increases costs by 10.26 euro per ha and an increase of the product price by 10%;
- Scenario 3 - level of potato fertilization - 400 kg. per ha; fertilizer level for beans - 200 kg; with a product quality certificate that increases costs by 10.26 euro per ha and an increase of product price by 15%;
- Scenario 4 - Potato fertilization level - 400 kg. per ha; fertilizer level for beans - 200 kg; with a product quality certificate that increases costs by 10.26 euro per ha and an increase of the product price by 25%;
- Scenario 5 - level of potato fertilization - 400 kg. per ha; fertilizer level for beans - 200 kg; with a product quality certificate that increases costs 10.26 euro per ha and an increase of the product price by 50%.

The scenarios for PG3 (scenery and recreation):

- Basic - level of fertilization for potatoes - 400 kg. per ha; fertilizer level for beans - 200 kg; without taking into account the subsidies under the agri-environment schemes under M.13.1 and the support for investments in the environmental infrastructure.
- Scenario 1 - no change in fertilizer level taking into account payments under Agri-environment and Climate (M.10);
- Scenario 2 - no change in fertilization level, taking into account payments under Agri-environment and Climate (M.10) plus compensatory subsidies for mountain areas under M.13.1;
- Scenario 3 - no change in fertilization level plus payment of EUR 150 per farm for investments in environmental structure;
- Scenario 4 - no change in fertilizer level taking into account payments under Agri-environment and Climate (M.10) plus payment of EUR 150 per farm for investments in environmental structure;
- Scenario 5 - no change in fertilization level, taking into account payments under Agri-environment and climate (M.10) plus compensatory subsidies for mountain areas under M.13.1 and plus 500 Euros per ha under the Nitrates Directive.

As can be seen, the described scenarios contain, on the one hand, the main elements of support schemes for farmers which are directly related to the landscape and, on the other, the financial support for investments in environmental infrastructure.

7.2.4 Participative approach

Following stakeholders' answered the questionnaires:

- Small farms
- LAGs
- Ministry of agriculture and foods
- Advisory services
- Farms' organizations
- Agricultural credit cooperatives

There was group decision for modelling exercise. The evaluation exercise aims at assessing how a mix of collective action, AES and quality product certification a can safeguard the provision of PGs in a low intensive agriculture area. Water quality is typically the subject of a variety of policy instruments in Europe, being affected by different regulations (ND, WFD). Quality product certification encourage membership by farmers who can help build consumer confidence and gain new market opportunities for produce through required standards. Maintaining the landscape provide added value of scenery and recreation.

7.2.5 Results and interpretation

7.2.5.1 Results from the application of the PCM to a complex assessment of the supply and demand of public goods

A sufficiently high degree of the explained variance (nearly 80%) was obtained in the PGB1 good demand model "Water quality and availability". In other cases, the variance explained is below 70%. This fact warrants the common model for the other two public goods (PGB2 and PGB3).

I. PCM Assessment of the demand for the three public goods in their integrity

The results show that a five-dimensional space consisting of five linearly independent components (PC1, PC2, PC3, PC4 and PC5) has been obtained. The first component PC1 explains more than a half of the dispersion (53.1%); the second PC2 - 8.4%; PC3, PC4 and PC5 - by 5.2%, 4.3% and 4.2% respectively.

As can be seen from the data in the above tables, the main components explain a significant portion (over 75%) of the total dispersion in the integral measure (Table 1.1).

Table 1.1: Results from the application of the principal components method (PCM) to the overall demand level of the three public goods. Characteristic of the total dispersion.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	12,753	53,137	53,137	12,753	53,137	53,137
2	1,785	8,437	61,574	1,785	8,437	61,574
3	1,244	5,183	66,757	1,244	5,183	66,757
4	1,038	4,324	71,062	1,038	4,324	71,062
5	1,015	4,228	75,290	1,015	4,228	75,290
6	,799	3,129	78,192			
7	,727	2,927	81,118			
8	,658	2,542	83,660			
9	,548	2,032	85,692			
10	,475	1,979	87,671			
11	,413	1,719	89,390			
12	,386	1,609	90,999			
13	,308	1,284	92,282			
14	,268	1,119	93,401			
15	,251	1,047	94,448			
16	,230	,960	95,408			
17	,209	,870	96,278			
18	,181	,754	97,032			
19	,160	,666	97,699			
20	,150	,624	98,323			
21	,125	,522	98,845			
22	,123	,511	99,356			
23	,097	,403	99,759			
24	,058	,241	100,000			

Extraction Method: Principal Component Analysis.

The results obtained so far are presented in Figure 1.

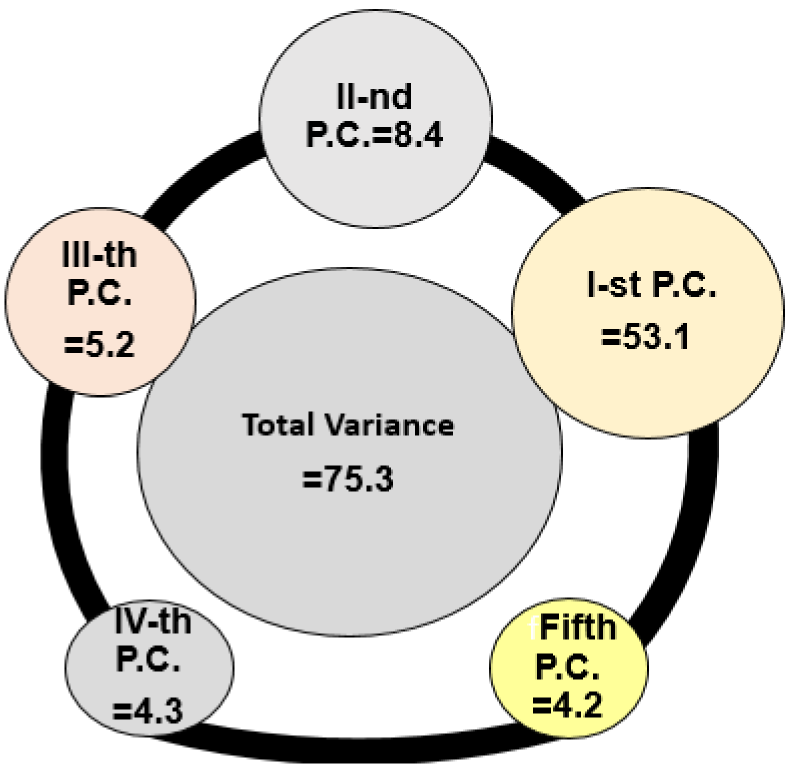


Fig. 1. Distribution of the total variance for the three public goods between the principal components (%) Source: Own figure with calculations from SPSS

The analytical expression of the main components is presented as follows:

PCj1 =∑ Wk1* Vjk
PCj2 =∑ Wk2* Vjk
PCj3 =∑ Wk3* Vjk
PCj4 =∑ Wk4* Vjk
PCj5 =∑ Wk5* Vjk
k defines the sequence number of the primary variable for which the factor weight Wk is greater than or equal to 0.3;
j = 1,.....87, means the serial number of the potential consumer of public goods.

The specific values of the Wk multipliers are contained in Table 1.2, and the Vj multipliers in the responses of potential consumers of public goods.

Table 1.2. Factor weights (Wkl) of the variables in the principal components of the three public goods

Component Matrix [a]

	Component				
	1	2	3	4	5
Q12	,746	-,011	-,131	-,362	,030
Q13	,715	,065	-,019	-,408	-,242
Q20	,833	,016	-,305	,006	-,125
Q21	,788	-,074	-,129	,187	-,126
Q22	,767	,136	-,066	,227	,241
Q24	,800	,092	-,334	,152	,053
Q25	,657	-,047	,069	,416	-,209
Q26	,866	,054	-,235	,021	-,029
Q27	,687	,020	,264	,029	-,447
Q29	,806	,023	-,290	,146	,122
Q30	,792	-,043	,356	,115	-,198
Q31	,703	-,063	,201	-,177	,474
Q32	,395	-,048	,506	,390	,211
Q33	,800	-,116	,116	-,219	-,192
Q34	,681	,011	,100	-,189	,369
Q35	,801	-,161	,095	-,135	,073
Q36	,801	,025	,164	,082	,194
Q37	,787	,114	-,287	,195	,080
Q39	,812	-,080	,280	,013	-,085
Q41	,809	,143	,082	-,253	,145
Q42	,756	,024	,199	-,080	-,111
Q19	,815	-,033	-,250	,006	-,131
Q44	-,012	,930	-,007	,093	,045
Q43	-,052	,887	,186	-,110	-,111

Extraction Method: Principal Component Analysis.
a. 5 components extracted.

Based on the linear equations obtained above, the vector lengths (Lentgh) for each potential consumer, represented by the coordinates (PCj1, PCj2, PCj3, PCj4, PCj5), were calculated according to a formula 3. The data are given in Annex 5.1. After switching to the single scale, it was found that, on average, for the surveyed sample of potential consumers, the demand for public goods was slightly above the average. (Length Dm | $_0{}^1$ = 0.54)PCM Assessment of demand for public good PGB1 "Water quality and availability"

A four-dimensional space consisting of four linearly independent components (PC1, PC2, PC3 and PC4) was obtained. As can be seen (Table 2.1), the principal components explain a significant part (over 78%) of the total dispersion in the integral measure.

Table 2.1 Results from the application of the principal components method (PCM) to the demand level of the PGB1 „Water quality and availability". Characteristic of the total dispersion

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2,436	30,450	30,450	2,436	30,450	30,450
2	1,703	21,284	51,734	1,703	21,284	51,734
3	1,118	13,973	65,706	1,118	13,973	65,706
4	1,061	13,261	78,967	1,061	13,261	78,967
5	,594	7,422	86,389			
6	,478	5,973	92,362			
7	,368	4,603	96,965			
8	,243	3,035	100,000			

Extraction Method: Principal Component Analysis.

The obtained results are presented in Figure 2.

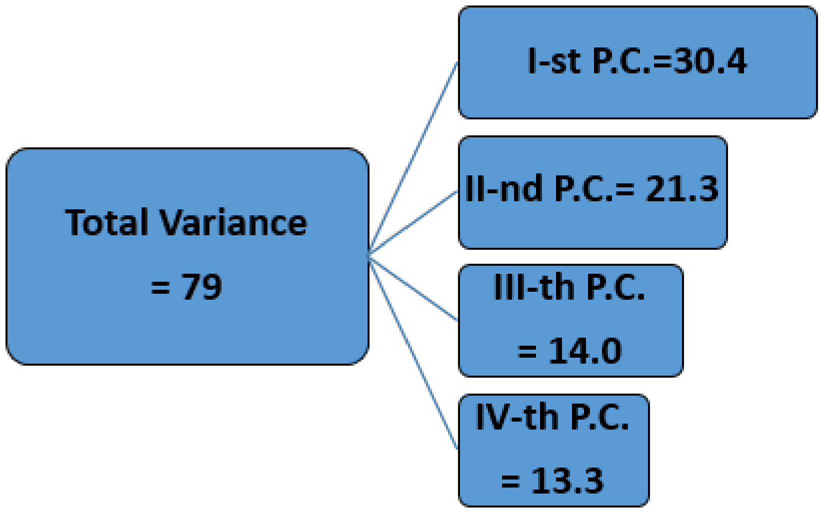


Fig 2.Distribution of the total variance for the PGB1"Water qualitative and availability" between the main components (%) (Source: Own figure with calculations from SPSS)

The analytical expression of the main components is presented as follows:

PCj1 =∑ Wk1* Vjk

PCj2 =∑ Wk2* Vjk

PCj3 =∑ Wk3* Vjk

PCj4 =∑ Wk4* Vjk

k defines the sequence number of the primary variable for which the factor weight Wk is greater than or equal to 0.3;

j = 1,.....87, means the successive number of the public good consumer PGB1.

The specific values of the Wk multipliers are contained in Table 2.2, and the Vj multipliers in the responses of potential PGB1 consumers.

Table 2.2. Factor weights (Wkl) of the variables in the principal components of the PGB1

Component Matrix [a]

	Component			
	1	2	3	4
Q6	-,036	,182	,841	,406
Q14W	,569	-,061	-,132	,644
Q19W	,709	,006	,243	-,391
Q29W	,765	-,076	-,322	-,136
Q34W	,731	-,026	-,085	,389
Q41W	,692	,160	,377	-,382
Q43	-,061	,926	,002	-,062
Q44	,068	,881	-,285	,097

Extraction Method: Principal Component Analysis.

a. 4 components extracted.

In a similar way, as in the first case, the lengths of PGB1 searches for each of its sample consumers were calculated in accordance with a formula 3. (Anex 5.1) The obtained result shows that the average value of the PGB1 search level represented on the single scale is slightly below the average (LengthDmPGB1|01 = 0.44)

PCM Assessment of the supply of the three public goods as a whole under Alternative 1

A three dimensional space consisting of three linearly independent components (PC1, PC2 and PC3) is obtained. As can be seen from the data in the above tables, the major components account for nearly 76% of the total dispersion in the integral measure (Table 3.1).

The first component PC1 explains more than half of the dispersion (47.4%); the second PC2 - 15.5% and PC3 - 12.8%.

Table 3.1 Results from the application of the principal components method (PCM) to the overall supply level of the three public goods- ALTR1. Characteristic of the total dispersion

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5,220	47,450	47,450	5,220	47,450	47,450
2	1,701	15,466	62,916	1,701	15,466	62,916
3	1,403	12,756	75,673	1,403	12,756	75,673
4	,842	7,654	83,327			
5	,485	4,411	87,738			
6	,435	3,956	91,694			
7	,259	2,358	94,052			
8	,230	2,089	96,141			
9	,164	1,494	97,635			
10	,150	1,359	98,995			
11	,111	1,005	100,000			

Extraction Method: Principal Component Analysis.

The PCM results are presented in Figure 3.

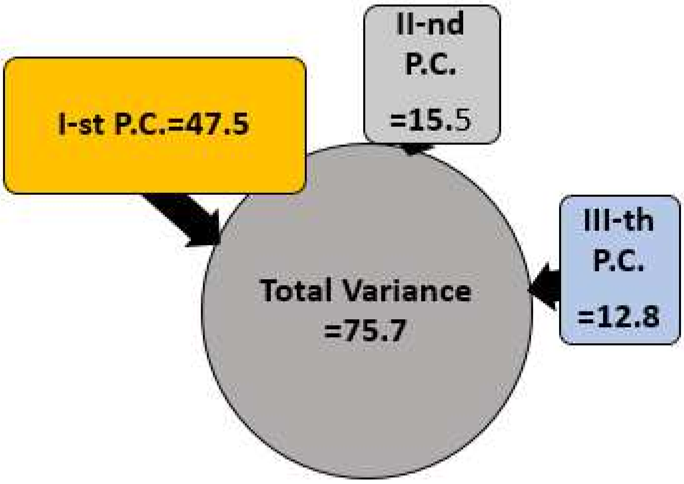


Fig 3.Distribution of the total variance for the overall supply of three public goods (ALTR1) between the main components (%) Source: Own figure with calculations from SPSS

The analytical expression of the main components is presented as follows:

PCj1 =∑ Wk1* Vjk

PCj2 =∑ Wk2* Vjk

PCj3 =∑ Wk3* Vjk

k defines the sequence number of the primary variable for which the factor weight Wk is greater than or equal to 0.3;

j = 1,.....30 and means the serial number of the agricultural holding in the surveyed sample from the district of Smolyan.

The specific values of the Wk multipliers are contained in Table 3.2 and the Vj multipliers in the answers of the farms from Smolyan region.

Table 3.2. Factor weights (Wkl) of the variables in the principal components of the overall supply for three public goods- ALTR1.

Component Matrix [a]

	Component		
	1	2	3
BFSAF1	,602	,550	-,019
BFRES1	,809	-,264	,140
OPORTR1	,519	,497	,578
OPORLS1	,778	,128	,157
COSTINT1	,841	-,290	-,295
COSTTR1	,877	,022	-,180
COSTEC1	,833	-,316	-,242
RISKECON1	,808	,010	-,318
RISKSOL1	,541	,594	-,008
Q12	,295	-,258	,812
BRMARJNOV	-,355	,680	-,295

Extraction Method: Principal Component Analysis.

a. 3 components extracted.

The result obtained after the calculation procedure for determining the length of the vector regarding the level of supply of public goods under Alternative 1 shows that it is lower than the average demand level (LengthSPL.ALTR1 $|_0^1$ = 0.41). The length is calculated by using a formula 3 (Annex 5.2).

Assessment of the supply of the three public goods as a whole under Alternative 2

In the last case four-dimensional space is composed of four linearly independent components - PC1, PC2, PC3 and PC4 (Table 4.1).

Table 4.1.Results from the application of the principal components method (PCM) to the overall supply level of the three public goods- ALTR2. Characteristic of the total dispersion

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4,221	32,471	32,471	4,221	32,471	32,471
2	2,899	22,298	54,769	2,899	22,298	54,769
3	1,613	12,406	67,175	1,613	12,406	67,175
4	1,022	7,861	75,035	1,022	7,861	75,035
5	,770	5,922	80,958			
6	,657	5,057	86,015			
7	,404	3,105	89,120			
8	,338	2,597	91,717			
9	,302	2,321	94,039			
10	,252	1,938	95,977			
11	,234	1,800	97,777			
12	,162	1,246	99,023			
13	,127	,977	100,000			

Extraction Method: Principal Component Analysis.

As can be seen from the data in the above tables, the main components account for 75% of the total dispersion in the complex measurer.

The first component of PC1 explains approximately one-third of the dispersion (32.5%); the second PC2 - 22.3%; third PC3 - 12.4% and PC4 - 7.9%.

The PCM results can be seen in Figure 4.

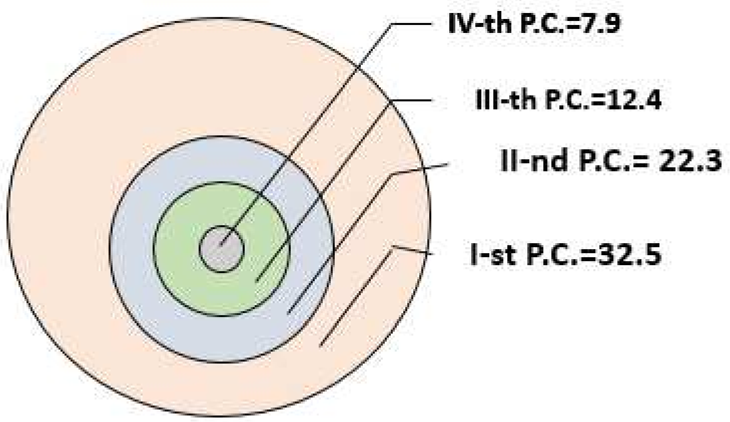


Fig 4. Distribution of the total variance for the overall supply of three public goods (ALTR2) between the main components (%) *Source:* Own figure with calculations from SPSS

The analytical expression of the main components is represented by the following system of equations:

PCj1 =∑ Wk1* Vjk

PCj2 =∑ Wk2* Vjk

PCj3 =∑ Wk3* Vjk

PCj4 =∑ Wk4* Vjk

k defines the sequence number of the primary variable for which the factor weight Wk is greater than or equal to 0.3;

j = 1,.....30, means the serial number of the agricultural holding in the surveyed sample from the district of Smolyan.

The specific values of the Wk multipliers are contained in Table 4.2, and the Vj multipliers in the answers of the farms from Smolyan region.

Table 4.2.Factor weights (Wkl) of the variables in the principal components of the overall supply for three public goods-ALTR2.

Component Matrix [a]

	Component			
	1	2	3	4
Q12	-,478	-,451	,255	,135
BRMARJNOV	,027	,883	,033	-,198
BFSAF2	,370	,477	-,098	,687
BFRES2	,620	-,606	,115	-,067
OPORT2	,614	-,024	-,427	-,165
OPORLS2	,797	-,414	,143	,036
COSTINT2	,694	,337	-,351	-,228
COSTTR2	,615	-,592	,227	-,182
COSTEC2	,800	,187	-,197	,015
RISKECON2	,590	,545	,133	,125
RISKSOL2	,246	,239	,805	,269
RISKEECOL2	,614	,191	,578	-,246
BFPRF2	,419	-,508	-,327	,475

Extraction Method: Principal Component Analysis.
a. 4 components extracted.

The result of the length of the vector that determines the level of public supply of Alternative 2 shows that it is higher than the search level (LengthSPL.ALTR2 $|_0^1$ = 0.56). In this case the length is calculated also by using a formula 3,

7.2.5.2 Results for expected effects of the measures (policies) to promote the supply of public goods. Comparative analysis between different scenarios

7.2.5.2.1 Results for public good PBG1 (Water quality and availability)

Before the actual analysis of the modified equilibrium models, the changes in GM (Gross margin) are briefly presented under different scenarios. Annex 6.1 lists the results obtained for each farm for the GM value at the different scenarios. These results are presented here (fig. 5)

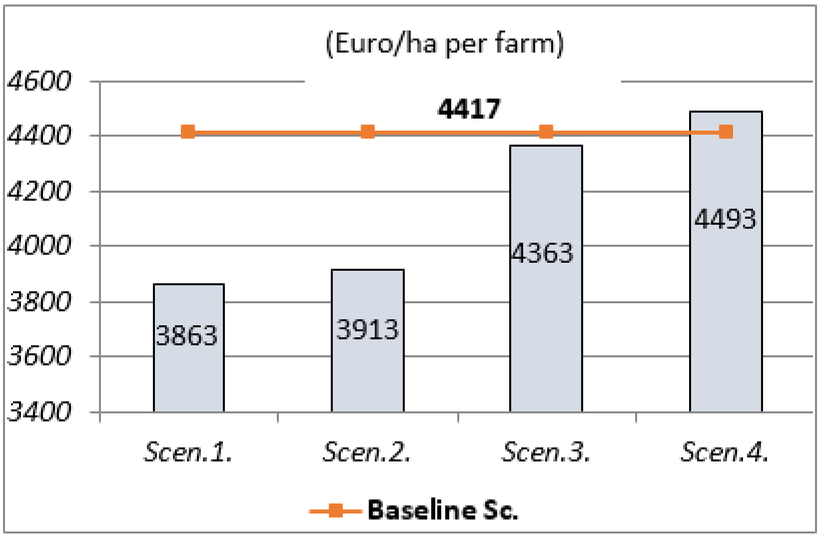


Fig 5. Gross margin values under different scenarios to promote PBG1 (Water quality and availability) (*Source:* Own Calculation)

From the data in the above graph it is clear that the gross margin in the first three scenarios is lower than the basic variant by 12%; by 11% and by 1.3%. The worst scenario is when there is a reduction of potato fertilizer amount and a corresponding drop in yield is allowed without any subsidies under the Nitrates Directive. In each of the following scenarios where payments under this Directive are received and their amount is increased, there is a growth in the gross margin, but it remains below the gross margin under the baseline scenario. It is only in the last option, where the maximum allowable amount of the subsidy under the Water Directive is envisaged, and at the same time the payments under M.13.1 have also been taken into account, the gross margin increases significantly and exceeds that of the basic option, albeit very poorly (by 1.7%).

The comparative analysis between the modified equilibrium models of the different scenarios is carried out on the one hand by comparing changes in the supply level of PBG1 from scenarios 1 to 4 against the supply scenario in the baseline scenario. On the other hand, the level of supply is compared with the demand level in each scenario. The results obtained are set forth in Table 5 and can be clearly seen in Figure 6.

Table 5.Modified equilibrium models between demand and supply of PBG1 in different scenarios Source: Own Calculation

Scenarios	**Models of equilibrium**
Baseline Sc.	LengthSPL$\|_0^1$ < Length Dm$\|_0^1$
Scen.1.	LengthSPL$\|_0^1$ < Length Dm$\|_0^1$
Scen.2.	LengthSPL$\|_0^1$ < Length Dm$\|_0^1$
Scen.3.	LengthSPL$\|_0^1$ < Length Dm$\|_0^1$
Scen.4.	LengthSPL$\|_0^1$ = Length Dm$\|_0^1$

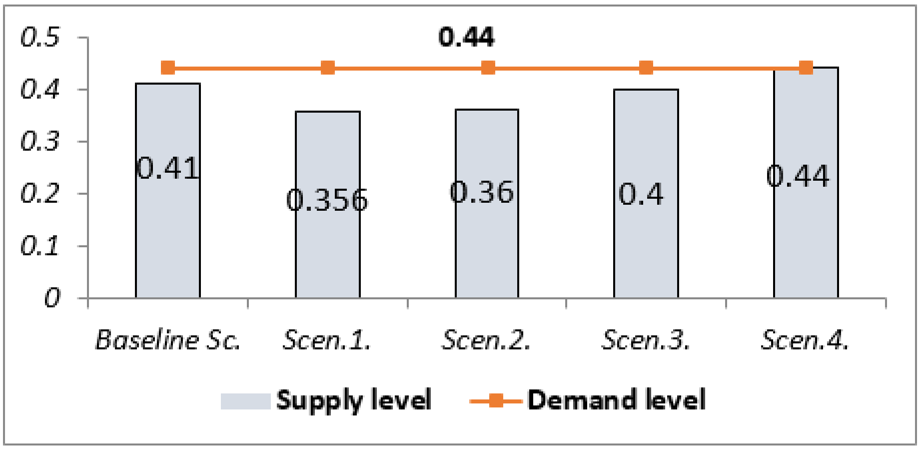


Fig 6. Modified equilibrium models between demand and supply of PBG1 in different scenarios (Source: Own Calculation)

Data analysis in the above graph shows that with the transition from the first to the last scenario, the supply level of PBG1 is gradually increasing. Under the latest scenario only the necessary balance between demand and supply levels is achieved. When fertilizing potatoes of 400 kg. per ha and without change in yield, the level of supply of the good "Quality Water" is slightly below the demand level. When fertilizing potatoes of 260 kg. per ha and a 20% reduction in yield, the supply level for PBG1 drops from 0.41 to 0.36 and is already significantly lagging behind demand.

When fertilizing potatoes with 260 kg. and a reduction in yield of 20% plus 50 EUR per ha from the Nitrates Directive, the supply level remains the same as in the scenario 1, namely at 0.36.

At 260 kg./ha fertilization and a reduction in yield of 20% plus EUR 500 per hectare of the Nitrates Directive, the supply is rising to 0.40, but it is still below the level of demand.

7.2.5.2.2 Results for public good PBG2 (Food security)

In this case, (as in the case of PBG1 water quality and availability), the change in the level of the gross margin was first examined in the successive transition from the baseline to the other scenarios. The results obtained are set out in Annex 6.2 and can be traced back to Figure 7.

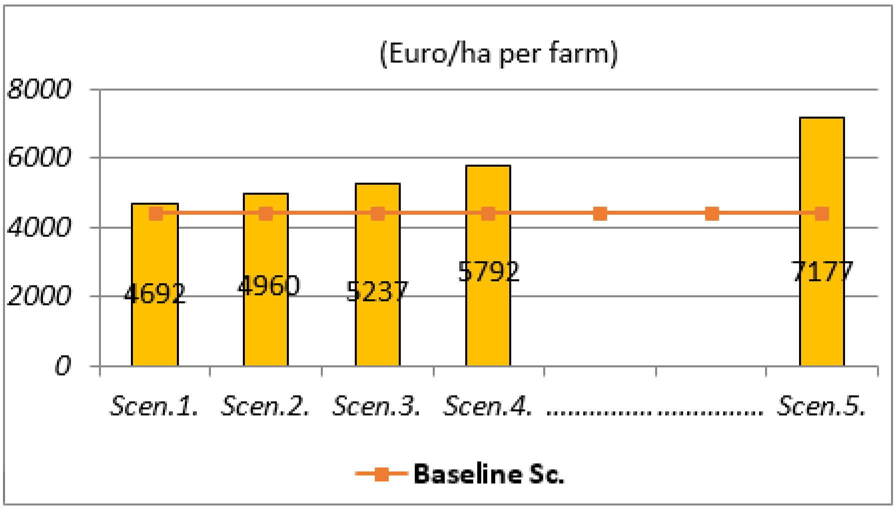


Fig 7.Gross margin values under different scenarios to promote PBG2 (food security) (*Source:* Own Calculation)

The analysis of the above data shows that with the obtainment of a production quality certificate, at each increase of the agricultural products price by 5% and under the same other conditions, the gross margin increases by an average of 5.7%.

The analysis of modified equilibrium models assesses the effect of changes in the price of agricultural products on the supply of good PBG2. The condition that the farmer receives a product quality certificate is observed against which he increases the total cost of the same product.

Since for the provision of this good is important whether the production of agricultural products is without a clear identification of origin (Alternative 1) or with such identification (Alternative 2), the food security study has been conducted separately for both alternatives.

Results about modified partial demand and supply equilibrium models of PBG2 for Alternative 1 are presented analytically in Table 6 and can be clearly seen on Figure 8.

Table 6. Modified equilibrium models between demand and supply of PBG2 (food security) in different scenarios in case of Alternative 1. (Source: Own Calculation)

Scenarios	Models of equilibrium
Baseline Sc.	$LengthSPL\|_0^1 < Length\ Dm\|_0^1$
Scen.1.	$LengthSPL\|_0^1 < Length\ Dm\|_0^1$
Scen.2.	$LengthSPL\|_0^1 < Length\ Dm\|_0^1$
Scen.3.	$LengthSPL\|_0^1 < Length\ Dm\|_0^1$
Scen.4.	$LengthSPL\|_0^1 = Length\ Dm\|_0^1$
Scen.5.	$LengthSPL\|_0^1 > Length\ Dm\|_0^1$

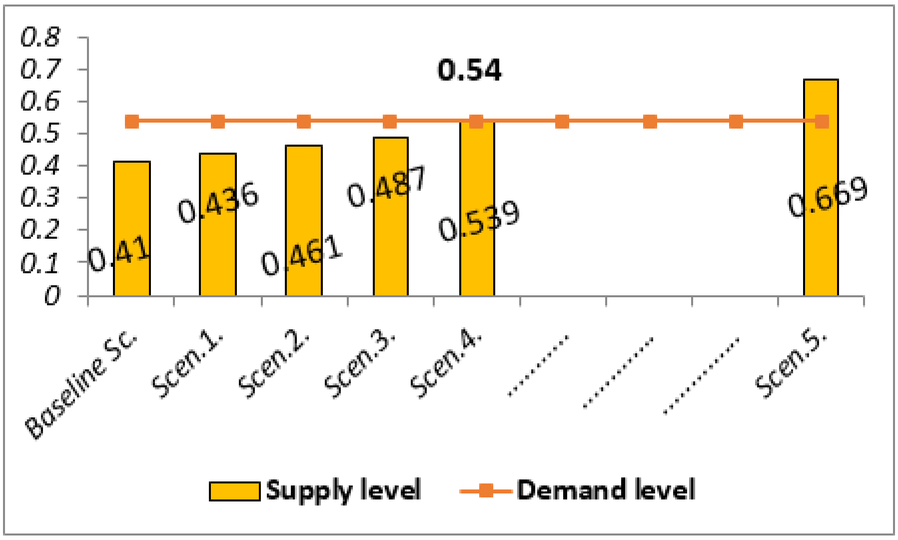


Fig 8. Modified equilibrium models between demand and supply of PBG2 (food security) in different scenarios in case of Alternative 1. (Source: Own Calculation)

The above graph prove very convincingly how the rise in the price of agricultural products, at equal other conditions, leads to an evenly increasing level of supply of PBG2. Before the introduction of a product quality certificate and before the corresponding price increase, the gap between supply and demand is greatest. The supply is lagging behind demand by nearly 24% in the baseline scenario. For each subsequent price increase as a consequence of the introduction of a product quality certificate, the supply level increases and gradually approaches the demand level (the equilibrium point). This situation is reached with a price increase of 25% (Scenario 4), compared to the Baseline scenario.

Then, any new rise in the price of agricultural products, under unaltered other conditions, lead to a distortion of the equilibrium and the supply outweigh the demand. For illustration we chose a 50% price increase (Scenario 5).

For farmers producing goods with a clear identification of origin (alternative 2), the introduction of a quality certificate will have no impact on the level of PBG2 supply. It will remain almost invariable (from 0.567 will be reduced to 0.566). By comparing the level of demand with the supply level, it appears that under these conditions the supply slightly outstrips the demand level. The supply of the public good "Food security" from farms under Alternative 2 has reached the level of demand.

7.2.5.2.3 Results for public good PBG3 (Scenery and recreation)

The value of the gross margin in the different scenarios changes in the way shown in Figure 9. The results obtained in detail are set out in Annex 6.3. Mostly GM is increasing in scenarios that provide for a payment of 150 EUR per household (farm) for investment in environmental infrastructure. This increase is 34% and 36% for Scenario 3 and Scenario 4 against the baseline scenario. This leap is very large but, as is clear from the subsequent PBG3 supply-demand matching analysis, only in these cases the desired equilibrium can be achieved.

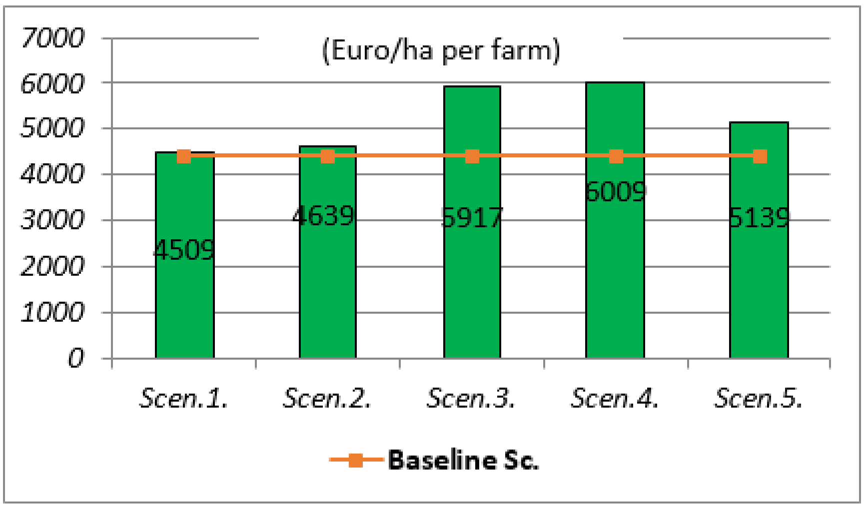


Fig 9. Gross margin values under different scenarios to promote PBG3 (scenery and recreation) (Source: Own Calculation)

The modified equilibrium models of demand and supply of the public good PBG3 are shown in Table 7 and are presented graphically in Figure 10.

Table 7. Modified equilibrium models between demand and supply of PBG3 (scenery and recreation)in different scenarios (Source: Own Calculation)

Scenarios	*Models of equilibrium*
Baseline Sc.	LengthSPL$\|_0^1$ < Length Dm$\|_0^1$
Scen.1.	LengthSPL$\|_0^1$ < Length Dm$\|_0^1$
Scen.2.	LengthSPL$\|_0^1$ < Length Dm$\|_0^1$
Scen.3.	LengthSPL$\|_0^1$ ≈ Length Dm$\|_0^1$
Scen.4.	LengthSPL$\|_0^1$ > Length Dm$\|_0^1$
Scen.5.	LengthSPL$\|_0^1$ < Length Dm$\|_0^1$

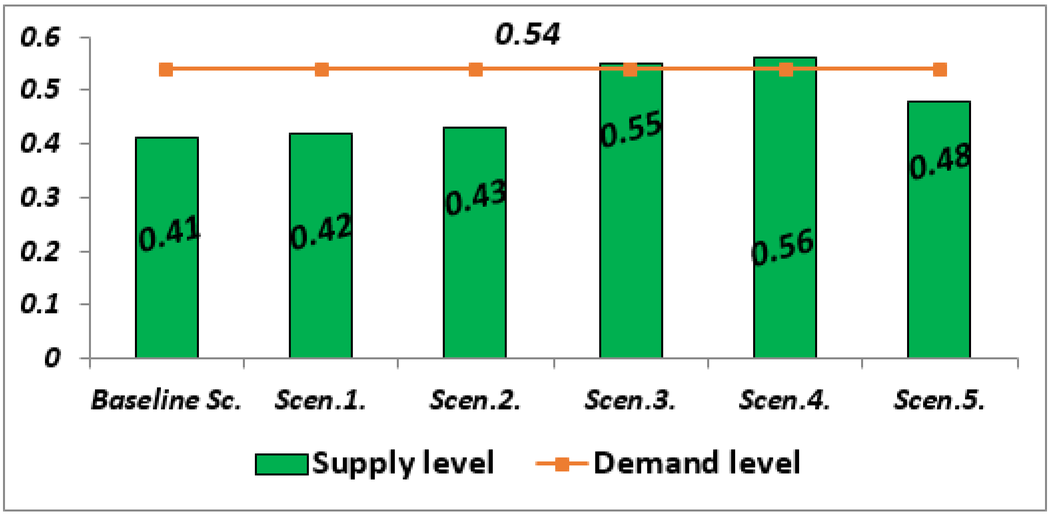


Fig 10. Modified equilibrium models between demand and supply of PBG3 (scenery and recreation)in different scenarios (Source: Own Calculation)

The analysis of the data in the above graph shows that only under scenarios 3 and 4, which include support for investments in improving environmental infrastructure, the level of supply equals, even slightly exceeds the demand level. For the other scenarios, supply is insufficient to meet the demand line. For payments only under M.10 for agri-environment and climate, supply has increased only slightly from 0.41 to 0.42. For both M10 agri-environment and climate payments and M.13.1, supply also increased scarcely (at 0.43), with lagging behind the demand still high - more than 20%. Only in scenario 5 (payments under M.10 for agri-environment and climate, under M.13.1 and EUR 500 per hectare of the Nitrates Directive), supply is rising to 0.48, but still below the demand level by 12%.

7.2.6 Discussion

7.2.6.1 Discussion of results

For public good PG 1

The subsidy of € 50 per ha under the Nitrates Directive does not have any positive impact on the supply increase. Even at the maximum possible value of the Nitrate Directive subsidy, supply is still lagging behind demand. It is concluded that only with this instrument (through the Nitrates Directive), while meeting the requirement to reduce the amount of fertilizer, the demand level cannot be reached.

When subsidies are added to those that farmers can receive in the form of compensatory payments for mountainous areas (scenario 4), then the necessary balance between supply and demand for PBG1 is already achieved.

For public good PG 2

The obtaining a certificate for a certain quality of the agricultural product in alternative 1 is inevitably linked to the need to increase its price accordingly. The results show that this increase should be about ¼, which we think is a very high jump. For this reason, other sources and instruments could be sought to compensate for additional costs for the certification of agricultural products, not just through the price mechanism.

For farmers with a clear identification of their origin (alternative 2) any increase in the cost of agricultural products produced by them will lead to a situation where the supply level significantly exceeds the demand level. If we accept a price reduction instead of an increase in order to fully align supply and demand, it will lead to economic losses for producers and they would not agree with such a strategy. For this reason, it is not necessary to develop different scenarios relating to the change in the price of agricultural products, irrespective of the direction of this amendment. Rather, opportunities should be sought to increase the demand for such products, which in turn involves an income policy aimed at increasing the number of solvent people.

For public good PG 3

Landscape and recreational conditions can hardly be seen as a separate good, without taking into account the link with the other two goods - providing healthy food and quality water. This is because the potential tourist chooses the resting place not only by the beauty and greatness of natural sight, but also to a lesser extent he is also interested in the quality of the food and drinking water offered. Therefore, besides the measures for investment in environmental infrastructure, other subsidies related to agro-ecological and climate measures, water purity protection and agricultural production compensations in mountain areas are involved in models.

The main reserve for achieving the necessary supply in order to match it to the demand is the financial support of EUR 150 per farm to improve the environmental infrastructure. The separate effect of the other measures is quite symbolic and extremely insufficient to achieve the desired balance between supply and demand.

Conclusions

In the baseline scenarios and in the production of goods without a clear identification of origin (Alternative 1) there is a higher demand for the three types of public goods compared to the level of their supply. This supply / demand gap is 24% for PBG2 and PBG3 and 12% for PBG1 for the benefit of demand. Under each of the following scenarios, for all three goods, the level of supply gradually increases.

Under the baseline scenario and at the production of goods with a clear identification of origin (Alternative 2) there is a greater supply of "food security" than its level of demand. In order to achieve the equilibrium between demand and supply, reserves are sought in the various mechanisms for securing more public goods. They are related to compensatory payments for reduced yields due to reduced fertilization, raising the price of agricultural products with a certain quality and origin certificate, agri-environment payments, etc. In order to achieve a balance between supply and demand for the good “quality water”, while complying with the requirements for reduction of the quantity of fertilizers, it is necessary both to activate the schemes under both the Water Purity Directive and the agri-environment payments and compensations for the production of agricultural products in mountain areas. To reach the necessary supply of the good "food security" it was found that, with equal others, an approximately 25% increase in price is needed to match its supply to demand. The increase in this price may, to a certain extent, be reduced at the expense of Compensatory payments for mountainous areas or other mechanisms. In order to achieve a balance between supply and demand for the good “landscape and recreation”, the greatest positive impact will be the financial support for investments in order to improve the environmental infrastructure. The other measures have little impact.

Changes in the level of supply of public goods follow changes in the value of the gross margin. Under the same conditions, the bigger the increase in the gross margin, the higher the supply is, and the level of supply is getting closer to the level of demand.

The overall conclusion is that the measures to promote supply and align it with the demand level should be applied in a comprehensive manner. Each of them, if applied separately, would not produce the desired result. In addition, the amount of subsidies received should be the maximum allowable amount provided for under the relevant measures. Only in these circumstances can a balance be struck between the level of demand and the level of supply of public goods.

7.2.6.2 Discussion of methodological approach

The main positive side of the used methodological approach is to include the maximum possible number of variables that are related to the supply and demand of public goods. By using the gross margin as a measure of the economic performance of farms and its inclusion in the methodological approach it is possible to assess the impact of different measures in the RDP and other Directives on the modified partial equilibrium model. The applied methodical approach is quite abstract. Therefore, it is difficult to understand directly obtained results from its application without the necessary specific knowledge. For this reason, the obtained basic partial equilibrium model and the other subsequent models are not of the classical partial equilibrium models. The abstract indicator which compares levels of demand and supply of public goods is a synthesized expression of their economic, social and environmental aspects.

7.2.6.3 Discussion of the participative elements in the modelling approaches

Using the statistical method Hi-square we determined the interactions of the three public goods with the socio-economic variables of the local farmers (see Table 8). Maintaining the quality of water is part of the activity of farmers who are older, have more experience as farmers, carry out other economic activity and have someone to inherit their business. Obviously, the benefits of this public good are sought in the long run, with the aim of ensuring the sustainability of the business and living environment. The opportunities for agriculture to create conditions for complete recreation are valued by female farmers, older farmers and those using consultancy services. In this context, the link between agriculture and tourism can be interpreted and the synergic effects of their interaction can be achieved. What is interesting is the fact that, with regard to the third public good, "food security" does not relate to any of the surveyed characteristics of farmers. This gives grounds for seeking other motivating factors that influence the provision of this public good. We can assume that the market has a priority impact on the development of food security.

Table 8 A statistically significant relationship between the characteristics of farmers and public goods

	Water quality	**Food security**	**Scenery and recreation**
gender	no connection	no connection	**connection**
age	**connection**	no connection	**connection**
experience	**connection**	no connection	no connection
advices	no connection	no connection	**connection**
other activities	**connection**	no connection	no connection
education	no connection	no connection	no connection
sucsessor	**connection**	no connection	no connection

ANNEX 1.

A list of questions about the first case: **Demand integrity PG1, PG2, PG3**

Q12- When you think of the water you have available and the part of it to be consumed on the three below public goods, which is more costly?

Q13- When you think of the cost of complying with the eco-standards, which of the following is most expensive?

Q19- When you think of the SOCIAL BENEFITS (Social benefits for stakeholders have a cleaner environment. Cooperatives are sustainable and produce eco-products. Created favourable conditions for the development of various tourism related public goods) of RURAL POPULATION in the hotspot area what is more important?

Q20- When you think of the SOCIAL BENEFITS of POTENTIAL TOURIST what is more important?

Q21- When you think of the SOCIAL BENEFITS of COOPERATIVES what is more important?

Q22- When you think of the ECONOMIC BENEFITS (To create eco food clusters to produce new products and create new jobs and increase income.) of RURAL POPULATION IN THE HOTSPOT AREA what is more important?

Q24- When you think of the ENVIRONMENT BENEFITS (Improved living conditions and “better places to live”) of the LOCAL AUTHORITIES what is more important?

Q25- When you think of the ENVIRONMENT BENEFITS of COOPERATIVES what is more important?

Q26- When you think of the ENVIRONMENT BENEFITS of the POTENTIAL TOURIST what is more important?

Q27- When you think of the SOCIAL OPPORTUNITIES (Increase opportunities to increase social capital and opportunities in society) of SUBSIDIES what is more important?

Q29- When you think of the ECONOMIC OPPORTUNITIES POTENTIAL TOURIST what is more important?

Q30- When you think of the ECONOMIC OPPORTUNITIES of CROP ROTATION what is more important?

Q31- When you think of the ENVIRONMENT OPPORTUNITIES (Opportunity to improve the quality of the environment based on water use, the eco-standards and high natural value land) OF WATER what is more important?

Q32- When you think of the ENVIRONMENT OPPORTUNITIES of ECO-STANDARDS what is more important?

Q33- When you think of the ENVIRONMENT OPPORTUNITIES of HIGH NATURAL VALUE LAND what is more important?

Q34- When you think of the SOCIAL RISKS of (lacking) SKILLED WORKFORCE what (public good) is more vulnerable?

Q35- When you think of the SOCIAL RISKS of confronting with DISEASES AND PESTS what (public good) is more adversely affected?

Q36- When you think of the SOCIAL RISKS of a poor AIR-QUALITY what (public good) is more adversely affected?

Q37- When you think of the ECONOMIC RISKS of FLOODING what (public good) is more adversely affected?

Q39- When you think of the ECONOMIC RISKS of SOIL EROSION what (public good) is more adversely affected?

Q41- When you think of the ENVIRONMENT RISKS of facing DISEASES AND PESTS what (public good) is more adversely affected?

Q42- When you think of the ENVIRONMENT RISKS of (lacking) ROAD (infrastructure and maintenance) what (public good) is more adversely affected?

Q43- How much would you pay for a moderate improvement in the PGBs provided by the AFS in the selected HS?

Q44- How much would you pay for a significant improvement in the PGBs provided by the AFS in the selected HS?

ANNEX 2.

A list of questions about the second case: **Demand PG1 "Water quality and availability"**

Q6- How much you are interested in the quality of local water resources?

Q14- When you think of the economic costs induced by the ECO-STANDARDS on the Water quality, mark their costs with grades from 1 to 9.

Q19- When you think of the SOCIAL BENEFITS (Social benefits for stakeholders have a cleaner environment. Cooperatives are sustainable and produce eco-products. Created favourable conditions for the development of various tourism related Water quality) of RURAL POPULATION in the hotspot area what is more important?

Q29- When you think of the ECONOMIC OPPORTUNITIES POTENTIAL TOURIST, how much is important Water quality?

Q34- When you think of the SOCIAL RISKS of (lacking) SKILLED WORKFORCE, how much is vulnerable for Water quality?

Q41- When you think of the ENVIRONMENT RISKS of facing DISEASES AND PESTS, how much is adversely affected on Water quality?

Q43- How much would you pay for a moderate improvement in the PGBs provided by the AFS in the selected HS?

Q44- How much would you pay for a significant improvement in the PGBs provided by the AFS in the selected HS?

ANNEX 3.

A list of questions about the **third case: Supply PG1, PG2, PG3 under alternative1**

BFSAF1- To what extent do you think the alternative 1 will contribute to ensuring user safety?

BFRES1- To what extent do you think alternative 1 would contribute to the conservation of natural resources?

OPORTR1- To what extent do you think that alternative 1 will contribute to the preservation of local societies and traditions?

OPORLS1- To what extent do you think alternative 1 would contribute to improving the landscape?

COSTINT1- To what extent do you think the alternative 1 will contribute to higher costs of introducing the product?

COSTTR1- To what extent do you think that alternative 1 will require costs due to training?

COSTEC1- To what extent do you think that alternative 1 will contribute to higher costs of introducing environmental standards?

RISKECON1- To what extent do you think that alternative 1 will cause economic risk due to diversification (new products)?

RISKSOL1- To what extent do you think alternative 1 would cause social risk associated with traditions?

Q12- How do you assess the contribution of agriculture and forestry to provide the following 3 public benefits to society: quality and availability of water; food security; landscapes and recreation?

BRMARJNOV - Gross margin in EUR per 1 ha.

Annex 4

A list of questions about the **fourth case: Supply PG1, PG2, PG3 under alternative2**

Supply PG1, PG2, PG3

BFSAF2- To what extent do you think alternative 2 would contribute to ensuring consumer safety?

BFRES2- To what extent do you think alternative 2 would contribute to the conservation of natural resources?

OPORTR2- To what extent do you think that alternative 2 will contribute to the preservation of local societies and traditions?

OPORLS2- To what extent do you think alternative 2 would contribute to improving the landscape?

COSTINT2- To what extent do you think alternative 2 would contribute to higher costs of product introduction?

COSTTR2- To what extent do you think that alternative 2 will require costs due to training?

COSTEC2- To what extent do you think alternative 2 would contribute to higher costs of introducing environmental standards?

RISKECON2- To what extent do you think alternative 2 would cause economic risk due to diversification (new products)?

RISKSOL2- To what extent do you think alternative 2 would cause social risk associated with traditions?

RISKECOL2- To what extent do you think alternative 2 would cause environmental risk related to water protection?

Q12- How do you assess the contribution of agriculture and forestry to provide the following 3 public benefits to society: quality and availability of water; food security; landscapes and recreation?

BRMARJNOV - Gross margin in euro per 1 ha.

ANNEX 5.1

Length of vectors in demand of public goods

№ Potential consumer	Overall demand level of the three public goods		Demand level of the PGB1 „Water quality and availability”	
	Lentgh	Scale from 0 to 1	Lentgh	Scale from 0 to 1
1	63.49634511	0.549471699	55.71863356	0.504972209
2	73.10643828	0.63263356	64.59280716	0.585397926
3	63.52886707	0.549753131	55.78194775	0.505546019
4	49.99462652	0.432633285	33.12005231	0.300163606
5	41.14061738	0.35601427	17.23944283	0.156239286
6	39.36964933	0.340689028	6.26952869	0.05682009
7	41.17913777	0.35634761	15.19114815	0.137675803
8	79.49412253	0.687909997	69.29961815	0.628055267
9	49.2861385	0.426502316	28.63516075	0.259517498
1	99.01067031	0.856798311	92.08521728	0.834558794
11	83.00766163	0.718314744	73.65356934	0.667514676
12	69.06144997	0.597629866	60.30889253	0.546573251
13	39.06214798	0.338028036	7.191692151	0.065177562
14	48.58113245	0.420401479	28.97871038	0.262631053
15	39.55130052	0.342260964	8.300337945	0.075225104
16	115.5589431	1.000000373	110.1416564	0.998202433
17	97.54808302	0.844141672	91.87728901	0.832674361
18	66.05187128	0.571586189	55.79860272	0.505696961
19	46.49538166	0.402352235	24.54818537	0.222477663
20	70.09975607	0.606614948	60.57699106	0.549003
21	36.55851845	0.316362638	4.88490962	0.04427143
22	67.99455751	0.58839741	60.73819666	0.55046399
23	46.64779605	0.403671167	28.95455251	0.262412113
24	34.92516847	0.302228288	8.299807046	0.075220292
25	57.28444442	0.495716422	42.6705514	0.386718791
26	58.05243908	0.502362337	42.26559733	0.383048734
27	77.50379982	0.670686549	69.44553598	0.629377705
28	49.3782477	0.427299392	28.6913579	0.260026807
29	59.69777008	0.516600366	46.72171412	0.423434059
30	53.13075467	0.45977207	41.96693902	0.380342025
31	66.02511199	0.571354625	55.51353575	0.503113429
32	104.6492329	0.905592152	100.9197921	0.914625631
33	102.2648665	0.884958809	96.57644953	0.875262367
34	91.6754534	0.793322309	82.98991993	0.752129055
35	90.23066531	0.780819697	83.03338997	0.752523019
36	66.57945888	0.576151719	55.83766426	0.506050972
37	91.87594324	0.795057267	82.98991993	0.752129055
38	54.48527358	0.471493529	37.4930468	0.339795603
39	102.4828823	0.886845429	96.59620297	0.87544139

40	59.41777006	0.514177359	42.25005618	0.382907886
41	65.60987636	0.567761344	51.06451425	0.462792408
42	106.1521836	0.91859808	101.0813671	0.916089968
43	77.44130141	0.670145713	69.29961815	0.628055267
44	48.92026275	0.423336175	28.69859756	0.260092419
45	65.40847711	0.566018516	55.35480793	0.501674895
46	61.98496698	0.536392844	46.74420664	0.423637907
47	19.75545845	0.17095575	11.04061783	0.100059977
48	49.62891413	0.429468558	45.98453733	0.416753102
49	100.7881603	0.87217999	101.1031913	0.916287759
50	60.95051215	0.52744109	46.51845092	0.421591906
51	56.14439352	0.485850882	38.32658687	0.34734989
52	52.01164171	0.450087719	29.46910664	0.267075463
53	65.2768951	0.564879859	64.17088053	0.581574049
54	56.10623819	0.485520702	55.02796524	0.498712754
55	54.40693168	0.47081559	46.03440033	0.417205006
56	57.49249332	0.497516793	38.1314401	0.345581295
57	108.5171643	0.939063666	101.3122935	0.91818283
58	114.7425436	0.992935582	110.3374683	0.999977055
59	55.99873413	0.484590405	37.49564923	0.339819188
60	53.25811824	0.460874223	37.03307449	0.335626921
61	51.54677301	0.446064933	29.08393634	0.263584705
62	88.78915987	0.768345492	78.81826478	0.714321776
63	67.89883224	0.587569043	56.06644395	0.508124379
64	63.17183196	0.546663493	47.06840293	0.426576064
65	92.6271131	0.801557588	83.2915403	0.754862609
66	59.48561296	0.514764444	42.4885409	0.385069249
67	59.78762524	0.517377937	42.2678996	0.383069599
68	54.90172019	0.47509729	37.6274821	0.341013976
69	43.76071472	0.378687533	21.40065235	0.193951897
70	51.94675116	0.449526182	37.6274821	0.341013976
71	78.82160786	0.682090327	69.37564185	0.628744262
72	60.79995814	0.526138256	46.61278091	0.422446809
73	37.25302221	0.322372593	15.95380278	0.144587663
74	47.46534737	0.410745926	28.9281004	0.26217238
75	49.03763666	0.424351882	25.30833995	0.229366866
76	62.23536022	0.538559646	51.21487894	0.464155147
77	58.72702676	0.508199946	46.648658	0.422771959
78	51.3152152	0.444061126	41.97638329	0.380427617
79	37.83826121	0.327437014	12.67681561	0.114888668
80	40.49280523	0.350408365	19.96226893	0.180915977
81	40.00697794	0.346204212	19.87703836	0.180143541
82	40.0646652	0.346703414	24.40184946	0.221151436
83	43.89908858	0.379884964	20.79025356	0.188419916
84	49.47922166	0.42817318	28.48971527	0.258199341
85	53.72724662	0.46493387	37.51246835	0.339971618

86	57.30937404	0.495932153	46.6088031	0.422410759
87	43.10934489	0.373050842	19.23057448	0.174284706
Average	**62.77675927**	**0.543244694**	**48.43317719**	**0.438944872**

ANNEX 5.2

Length of vectors in supply of the three goods

№ farm	Length	Scale from 0 to 1
1	753.282	0.859911
2	759.8225	0.867377
3	875.7107	0.99967
4	752.8599	0.859429
5	152.2042	0.173749
6	112.9046	0.128886
7	353.8897	0.403984
8	193.8607	0.221302
9	463.1792	0.528743
1	159.1969	0.181732
11	61.47987	0.070182
12	160.3935	0.183098
13	128.0576	0.146184
14	279.5524	0.319124
15	118.0206	0.134727
16	237.725	0.271376
17	226.5141	0.258578
18	207.8835	0.23731
19	182.9671	0.208867
20	131.9415	0.150618
21	217.8852	0.248727
22	865.8768	0.988444
23	553.3636	0.631694
24	622.0954	0.710155
25	752.8599	0.859429
26	192.7223	0.220003
27	393.1204	0.448768
28	216.4439	0.247082
29	356.4381	0.406893
30	285.9201	0.326393
Average	**358.939**	**0.409748**

ANNEX 6.1.

Gross margin value per farm under different scenarios regarding the supply of PBG1 (Euro/ha)

			Scenarios		
№ farm	Baseline Sc.	Scen.1.	Scen.2.	Scen.3.	Scen.4.
1	9220	8220	8270	8720	8850
2	9280	8270	8320	8770	8900
3	10700	9580	9630	10080	10210
4	9220	8220	8270	8720	8850
5	1900	1180	1230	1680	1810
6	1430	790	840	1290	1420
7	4350	3370	3420	3870	4000
8	2410	1840	1890	2340	2470
9	5680	5010	5060	5510	5640
1	1980	1980	2030	2480	2610
11	790	790	840	1290	1420
12	1990	1990	2040	2490	2620
13	1600	1600	1650	2100	2230
14	3440	2720	2770	3220	3350
15	1480	1480	1530	1980	2110
16	2930	2930	2980	3430	3560
17	2800	2800	2850	3300	3430
18	2580	2580	2630	3080	3210
19	2270	2270	2320	2770	2900
20	1650	1650	1700	2150	2280
21	2700	2380	2430	2880	3010
22	10580	9470	9520	9970	10100
23	6810	6020	6070	6520	6650
24	7620	6740	6790	7240	7370
25	9220	8220	8270	8720	8850
26	2400	1400	1450	1900	2030
27	4860	3800	3850	4300	4430
28	2690	1610	1660	2110	2240
29	4390	3410	3460	3910	4040
30	3520	3570	3620	4070	4200
Average	**4420**	**3860**	**3910**	**4360**	**4490**

ANNEX 6.2.

Gross margin value per farm under different scenarios regarding the supply of PBG2 at Alternative 1 (EURO / ha)

			Scenarios			
№ farm	Baseline Sc.	Scen.1.	Scen.2.	Scen.3.	Scen.4.	Scen.5.
1	9220	9710	10210	10710	11720	14230
2	9280	9790	10300	10810	11840	14400
3	10700	11260	11820	12380	13510	16330
4	9220	9710	10210	10710	11720	14230
5	1900	2090	2280	2470	2860	3820
6	1430	1590	1770	1940	2290	3150
7	4350	4600	4850	5110	5620	6900
8	2410	2550	2710	2860	3170	3940
9	5680	6010	6340	6680	7360	9050
1	1980	2200	2300	2460	2780	3590
11	790	940	940	1020	1180	1570
12	1990	2180	2290	2440	2740	3500
13	1600	1770	1840	1970	2230	2870
14	3440	3630	3820	4010	4390	5360
15	1480	1620	1770	1920	2210	2960
16	2930	3100	3270	3450	3800	4680
17	2800	2980	3170	3360	3740	4690
18	2580	2730	2900	3060	3400	4230
19	2270	2420	2590	2750	3080	3900
20	1650	1780	1920	2060	2330	3030
21	2700	2860	3020	3180	3510	4330
22	10580	11130	11700	12260	13380	16190
23	6810	7190	7590	7990	8790	10790
24	7620	8060	8510	8960	9860	12100
25	9220	9710	10210	10710	11720	14230
26	2400	2650	2910	3170	3700	5000
27	4860	5120	5400	5680	6230	7620
28	2690	2960	3250	3530	4090	5500
29	4390	4640	4890	5150	5660	6950
30	3520	3780	4040	4310	4840	6170
Average	**4420**	**4690**	**4960**	**5240**	**5790**	**7180**

ANNEX 6.3.

Gross margin value per farm under different scenarios regarding the supply of PBG3 (EURO/ha)

	Scenarios					
№ farm	Baseline Sc.	Scen.1.	Scen.2.	Scen.3.	Scen.4.	Scen.5.
1	9220	9230	9360	10720	10730	9860
2	9280	9360	9490	10780	10860	9990
3	10700	10780	10910	12200	12280	11410
4	9220	9290	9420	10720	10790	9920
5	1900	1980	2110	3400	3480	2610
6	1430	1510	1640	2930	3010	2140
7	4350	4430	4560	5850	5930	5060
8	2410	2490	2620	3910	3990	3120
9	5680	5760	5890	7180	7260	6390
1	1980	2110	2240	3480	3610	2740
11	790	920	1050	2290	2420	1550
12	1990	2120	2250	3490	3620	2750
13	1600	1720	1850	3100	3220	2350
14	3440	3520	3650	4940	5020	4150
15	1480	1610	1740	2980	3110	2240
16	2930	3060	3190	4430	4560	3690
17	2800	2930	3060	4300	4430	3560
18	2580	2700	2830	4080	4200	3330
19	2270	2400	2530	3770	3900	3030
20	1650	1780	1910	3150	3280	2410
21	2700	2780	2910	4200	4280	3410
22	10580	10660	10790	12080	12160	11290
23	6810	6880	7010	8310	8380	7510
24	7620	7700	7830	9120	9200	8330
25	9220	9290	9420	10720	10790	9920
26	2400	2480	2610	3900	3980	3110
27	4860	4940	5070	6360	6440	5570
28	2690	2770	2900	4190	4270	3400
29	4390	4470	4600	5890	5970	5100
30	3520	3600	3730	5020	5100	4230
Average	**4420**	**4510**	**4640**	**5920**	**6010**	**5140**

7.3 RO-1: Natural landscape quality in the Dorna valley in the Romanian North East region

7.3.1 Introduction

7.3.1.1 Description of case study region

- **Name** North-East Region
- **Location** North-East area of Romania
- **Size** 36.850 sq.km
- **Inhabitants/km²** 101.5 inhabitants/km2
- **Share of agricultural area** approximately 57,83%
- **Dominating agricultural system**

Mostly intensive agriculture in 4 of the 6 counties (dominated by hills, plateaus and plains) and extensive agriculture in 2 of the 6 counties (where mountainous areas are predominant);

Small farms represent the majority of agricultural entities in the CSR: below 2 ha – 76.6% (~568 000), between 2-10 ha – 21.9% (~163 000), between 10-13 ha – 1% (~7 500), and 30 ha and above – 0.5% (~3 600). Small farms are mostly utilized for subsistence agriculture in rural areas where income per capita is low.

The region is characterized by a harmonious arrangement among all relief forms: 30% mountains, 30% sub Carpathian landforms, 40% plateau. The diversified relief offers plateau and plane areas suitable for a large variety of agriculture, and mountain areas with spectacular landscapes favourable for tourism development and organic farming. The quality and type of the soil varies significantly across the region.

The main environmental problems of the North-East Region are linked to: poor management of the industrial and housing waste (non-selective collection, decreased level of revalorisation and/or treatment of waste, inadequate depositing, existing sawdust deposits on river shores alongside roads); deforestation, with implications in amplifying the land slips; soil erosion phenomena which affect, mainly, the east side of the region; hazardous levels of air pollution within and around the main cities.

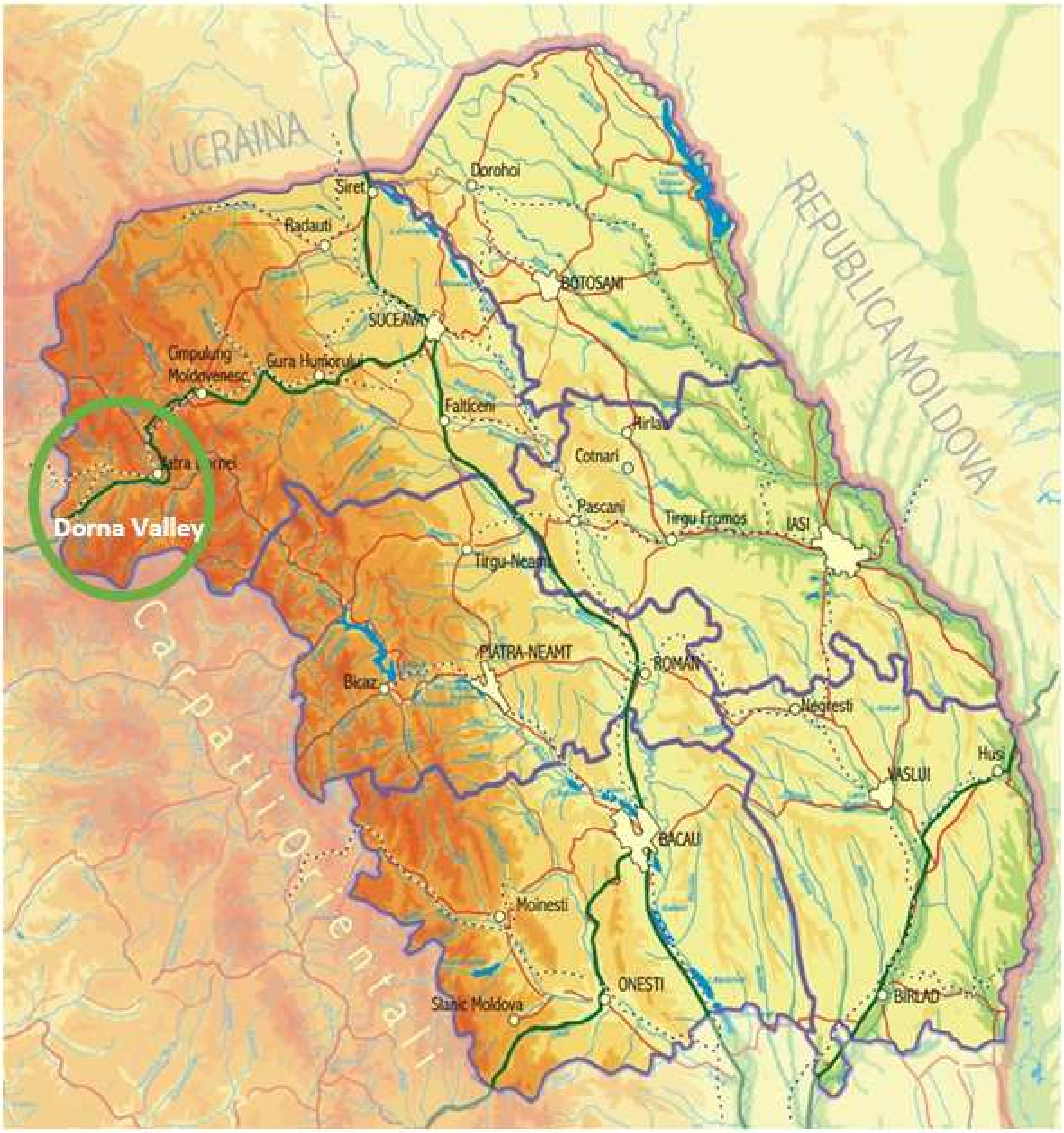


Figure 1. Geographical map of the North-East Region (*Source: ADR North-East (2008))*

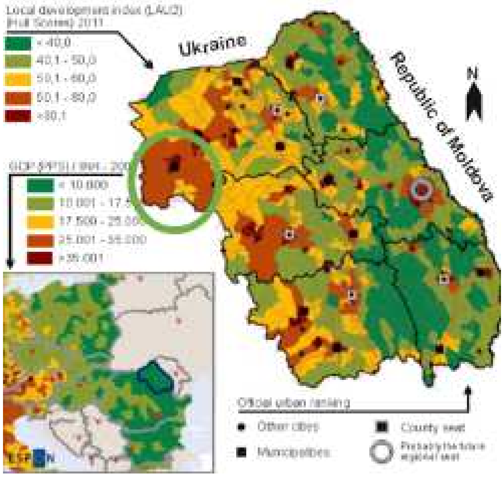


Figure 2. Rural development (*Source: ESPON (2014)*)


Figure 3. Areas isolated from urban settlements (*Source: ADR North-East (2015)*)

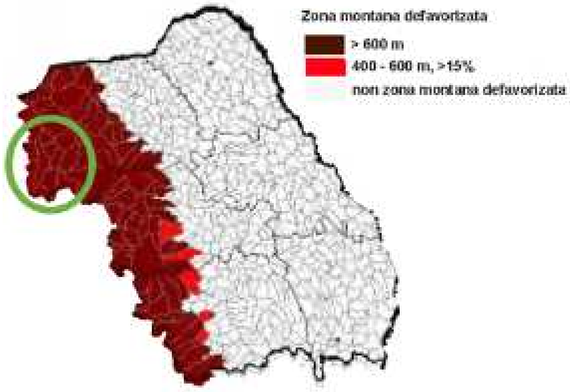


Figure 4. Disadvantaged mountain areas (*Source: APIA (2014)*)

Figure 5. Land usage *Source: ICPA (2008)*

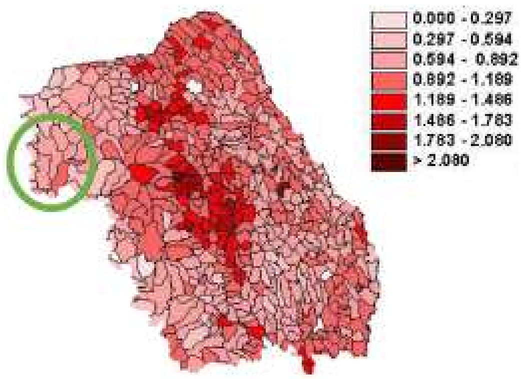


Figure 6. Animal farming potential (UVM/ha) (*Source: ICPA (2008)*)

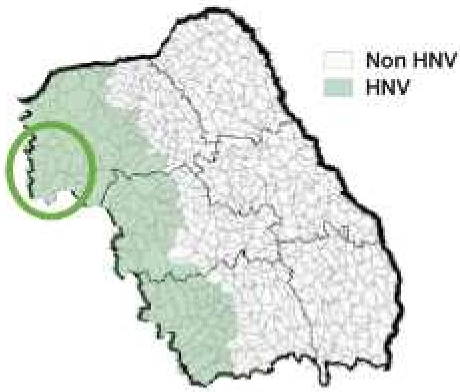


Figure 7. Meadows with High Natural Value (HNV) (*Source: APIA (2014)*)

7.3.1.2 Description of public good issue

The Dorna Valley surpasses other areas of the North-East Region of Romania with regard to the availability of public goods. Many of the farms in this region conduct their activities using traditional, extensive practices. Thus, the main agricultural activities in the region are focused on livestock, primarily cattle, but also sheep.

The public good that will be investigated is “natural landscape”. The stakeholders have considered this to be an essential resource in the Dorna Valley region (the Hotspot), due to its direct impact on the tourism sector and its indirect impact on the agro-food sector. Tourists usually visit Dorna in order to benefit from nature walks, outdoor sports and relaxation. The agro-food businesses in the region benefit from the forested mountainous environment by generating high quality food products, which are then sold to consumers who associate the Vatra Dornei brand with healthy food due to the natural landscape. All of these activities are essential parts of the local economy and its perspective for sustainable development.

Natural landscape is affected by several activities in the region, including illegal deforestation, conversion of natural pastures to farmland, as well as increased urbanization and real estate development. Such activities can be curbed if local entrepreneurs were provided with consultancy or education services which would provide knowledge regarding successful sustainable farming and forestry practices and consultancy on leveraging funding opportunities for green businesses. In addition, the provision of AES payments would help in vectoring their efforts for improving farming practices and provide a financial motivation for such activities.

7.3.1.3 Description of the governance-strategy

We are investigating a mix of two governance mechanisms:

- AES
- Education/information and consultancy services

Considering the characteristic of the farms in the region, and the results of the interviews with experts and stakeholders, we have proposed a mix of governance mechanisms which can be adopted in the region in order to maximize the supply of public goods, as well as contribute to an increased adoption of sustainable practices with maximum overall results from a societal point of view.

The mix of Agro-environmental schemes with Education/information and consultancy services could improve the farms’ performance while insuring a better provision of public goods.

After analyzing the Romanian situation and the specific conditions from CSR we concluded that the implementation of the goals set for the existing public mechanisms is not possible without a high level of acknowledgement of the provision of public goods and public bads. The capacity to react to the public incentives directly depends on the farmers' capacity to become aware of the mechanisms, to understand all their effects and to use them in their activity with maximum results.

The relevant criteria for good governance that are going to be improved are related to the high level of general and specific education, a good flow of information and an extended network of consultancy in the area. Better education will insure that the adequate PG governance measures are leveraged efficiently that will result in an improved quality of life and level of welfare in rural and remote areas, which should, in turn, revitalize these regions and slow or even reverse the phenomenon of population aging. A younger population is better able to adapt to new practices, to be aware of the available tools and mechanisms and to act strategically in developing their communities in a sustainable manner.

With regard to the effects of implementing the proposed governance strategy, it is expected that this will lead to an increased provision of public goods. Farmers will be able to acknowledge the importance of such goods and they will receive compensatory payments for the individual productivity losses. As a result, they will be able to understand the arguments that support the implementation of practices which generate public goods and that such practices are preferable to traditional ones when the overall result for the farm does not change. Thus, it is expected that the proposed measures will have positive effects on the quantity and quality of the public goods in the mountainous region.

7.3.2 Methodological approach

7.3.2.1 Theoretical background

Using the multiple objective linear programming model (with two criteria) for the Dorna Region Case Studies, we develop some analyses for different situations that allow the maximization of Gross Margin and Public goods provision. The objective is to find the best practices and machinery uses that are both efficient and result in improvements of the public goods (or avoidance of public bads), depending upon the farm situation related to market prices (both for agricultural products and input factors), potential activities, soil and weather characteristics. In particular, the model uses a flexible approach to choose the activities, levels of inputs (work and machinery), type of environmental practices.

The farmers, in position of decision makers, have to discover solutions to the problems related to a multiple competing criteria/objectives and a large and complex set of constraints.

Linear programming integrates some important criteria into a mathematical model in order to find out a satisfactory solution.

Multi-objective optimization permits the usage of a *k* number of objective functions involving *n* decision variables satisfying the constraints. To obtain an efficient feasible solution for this model, it is necessary to accomplish the conditions for a Pareto optimal state, where no other feasible solution is at least as good for every objective and strictly better in one.

In our case we will use two objective functions: one for gross margin obtained from the market orientated activities and the other referring to the public goods provision.

For solving the model we use the ”weighted sum strategy” converting both objective functions into one single using weights and summation. The appropriate weights are assigned depending on the importance of each objective function:

Obj = max ($w_1obj_1+w_2obj_2$), where $w_i > 0$.

7.3.2.2 Model implementation

Objective function:

$$Multiobjective\ function = w^0 \times GM + \sum_{e=1}^{E} w^e \times (Sub^e + LS^e + RV^e)$$

The level of Sub^e is deducted by the subsidies for agro-environmental measures for ~natural grassland~ for pastures and hay.

LS^e is obtained by the cost of Landscape determined in WP4 exercise (supply side). Taking into account that the cost of total improvement of one ha of degraded land is valuated by farmers at 2300 Euro and, also, that the level of improvement for pasture and grassland is at 5% (by the interviews with farmers), we considered the level of PG missed by non-adopting agri-environmental scheme.

At the same time, the new forest obtained by the natural grassland has a value equal to 10% of Landscape more like before.

Rural vitality is obtained by avoidance of mechanised activities when the farm needs more human activities for maintaining the natural characteristics of the land. In this case, the augmentation with one worker (mainly member of the family, usually renouncing to other activities) was valuated at WP4 at 90,7 Euro.

Where: w^0, w^e reprezent the weights defined by user; *0* means profit orientation, *e* means environment orientation.

The first solution considered is $w^0 = 1 \; and \; w^e = 0$: farmer oriented to profitability without any environmental constraints

$$GM = \sum_{j=1}^{T} I^{je} - \sum_{j=1}^{T} C^{je} =$$

$$= w^0 \times GM$$

Variables	*SNatPast* *x1*	*SNatPast Conv* *x2*	*SnatPGrassland* *x2*	*SGrasslandConv* *x2*	*New Sforo* *x2*	*SForConv* *x2*	Livestock Diary Cow *x2*	Aquisitions *x2*		
Explication	Natural Pasture	Traditional Pasture to natural pasture	Natural Pasture	Traditional Pasture to natural pasture	forest	Pasture or Agric to Forest	Number of great beef units	Hay aquisitions		
Income	I_1^e	I_2^e	I_3^e	I_4^e	I_5^e	I_6^e	I_7^e	I_8^e		
Cost	C_1^e	C_2^e	C_3^e	C_4^e	C_5^e	C_6^e	C_7^e	C_8^e		
Objective1 (Gross Margin)	$\boldsymbol{GM_1^0}$	$\boldsymbol{GM_2^0}$	$\boldsymbol{GM_3^0}$	$\boldsymbol{GM_4^0}$	$\boldsymbol{GM_5^e}$	$\boldsymbol{GM_6^e}$	$\boldsymbol{GM_7^e}$	$\boldsymbol{GM_8^e}$	**=**	**Max**
Subsidies	Sub_1^e		Sub_3^e			Sub_6^e				
Landscape	LS_1^e	LS_2^e	LS_3^e	LS_4^e	LS_5^e	LS_6^e	LS_7^e	LS_8^e		
Rural vitality	RV	RV_2^e	RV_3^e	RV_4^e	RV_5^e	RV_6^e	RV_7^e	RV_8^e		
Objective2 (PG Outcome)	$\boldsymbol{PG_1^e}$	$\boldsymbol{PG_2^e}$	$\boldsymbol{PG_3^e}$	$\boldsymbol{PG_4^e}$	$\boldsymbol{PG_5^e}$	$\boldsymbol{PG_6^e}$	$\boldsymbol{PG_7^e}$	$\boldsymbol{PG_8^e}$	**=**	**Max**

For environmental practices we can use the following scenarios:

- w^0=1; w^e=0 as initial situation: - profit orientation , no PG interest.
- w^0; w^e>0 as simulations public good orientation. For this simulations we analise the following situations:
- II.1 w^0=0,75; w^e=25 as first simulationage public good orientations: low intensity of PG preference
- II.2 w^0=0,50; w^e=0,50 as second simulation for public good orientation: medium intensity of PG preference
- II.3 w^0=0,75; w^e=0,25 as third simulation for public good orientation: high level of PG values

These levels will be reached depending on intensity of information/education. A positive influence on the farmers behavior can be quantified by

Conditions (impact on constraints) imposed by conditions for – „Meadow/Pasture with high natural value" and „Traditional practices" agri-environmental measures:

- first cut must be done (in mountain area) after 01 July to protect biodiversity. Effects on model: diminishing productivity of fooder (with 25%) that means a supplementary quantity of foorage for livestock
- interdiction to use chemicals on this lands
- grazing on this pasture can be made at maximum 1 LSU (livestock Unit) per ha.
- using natural fertilizers at maximum 40 KgNs.a./ha
- maximum 2 weeks for harvesting vegetal mass – using more Labor work (10%) in the same period.
- can't be used machinery for plowing or disking – low use of machinery
- good records of the works carried out – education/consultancy

Impact of objective function: In this case, the farmer will receive 142 Euro/Ha for payments for S^e accomplishing the conditions for a high natural value of meadow/pasture and for working meadows/pasture without machines. The public good efects will be at the level of 2300 Euro for Landscape meadows (grassland)(only 5% of value for little farms) if the ecological conditions are applied and 91 Euro for rural vitality (if meadows and pasture will be worked without machineries) - values deducted from public good supply side valuation(WP4 supply size valuation of public goods).

The constraints of the model are the following:

	SNatPast	*SNatPast_{Conv}*	*SnatPGrassland*	*SGrassland_{Conv}*	*New Sfor0*	*SForConv*	Livestock Diary cow	Aquisitions	Sign	*Restrictions*
	Natural Pasture	Traditional Pasture to natural pasture	Natural Pasture	Traditional Pasture to natural pasture	forest	Pasture or Agric to Forest	Number of great beef units	Hay aquisitions		
Limit of grassland	1	1	1	1					<=	Total grassland
Limit of forests					1	1			<=	Total forests
Hay equilibrium			H_3^e	H_4^e			$-H_7^e$		>=	0
Soilage equilibrium	S_1^e	S_2^e	S_3^e	S_4^e	S_5^e	S_6^e	$-S_7^e$			
Manure equilibrium	$-Man_1^e$	$-Man_2^e$	$-Man_3^e$	$-Man_4^e$			Man_7^e		>=	0
Machinery	M_1^e	M_2^e	M_3^e	M_4^e	M_5^e	M_6^e	M_7^e		<=	TotalMachinery
Labor/work	L_1^e	L_2^e	L_3^e	L_4^e	L_5^e	L_6^e	L_7^e		=	TotLab
Diary cow limit						C_6^e			>=	Sample limit
Pasture limit	1	1							>=	Sample limit
Consultancy and information	CI_1^e		CI_3^e		L_5^e				<=	Sum limit/farm
Lower bounds	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		

7.3.3 Scenarios

Because of the different answers of the farms to the general conditions of the market and governance mechanisms, we considered one of the first sets of scenarios to be connected to the dimension of the farms.

In order to determine the level of response in choosing the applied technologies, we start from classifying the farms into three generic groups:

- **Small farms**: with surfaces under 10 ha of the total surface occupied (pastures, meadows and forests);
- **Medium farms**: between 10 and 20 ha of the total surface occupied;
- **Large farms**: over 20 ha of the total surface.

The basic principle is the covering of needed feed for a minimum number of animals (large units of cattle), as it appeared from the farms' situation in this region.

By considering the main sensitivity factors deducted from the interviews with farmers and stakeholders, the following scenarios were produced based on the vulnerabilities of the management system specific to each of the three farm categories:

<u>Scenario 1 – rising prices of farm inputs for small and medium farms</u>

Based on this scenario, we will assess the impact of the increased prices of farm inputs on the behavior of farmers in relation to the provision of public goods, as well as on the efficiency of the applied governance mechanisms. The analysis will focus primarily on small and medium size farms for which the cost of these inputs is most likely to rise.

<u>Scenario 2 – decreased prices of agricultural products sold by small farms with low negotiating power</u>

A significant risk for small farms is that sale prices for the main products that they supply to the market (hay, milk and meat) will decrease. Their weak negotiating position in relation to collectors and processors of such products, as well as the lack of processing or storage capacity for these products makes this a significant risk for small farms. This can have a significant effect on their behavior related to the provision of public goods.

7.3.4 Participative approach

The option for the utilized governance mechanisms was determined through the applied local surveys and interviews with the farmers' representatives from the region. In their opinion, the fees for agri-environment represented the most important mechanism because of their clear objectives oriented to the acquisition of public goods such as landscape, quality of water, biodiversity, ecological products, and rural vitality. Unfortunately, some communication problems, including information issues and poor understanding of the mechanisms for stimulating the acquisition of public goods, were emphasized. Taking into consideration this fact, the stakeholders revealed that, besides the existence of such governance mechanisms, actions of counseling and training strategies would be recommended in order to amplify the effects of the fees for agri-environment.

The following analysis is based on secondary data (especially from the Agricultural Census, 2010), but also from data collected from 44 farms in the Hotspot area. This data was used for the valuation of public goods from a supply perspective.

For the model implementation, the results of the analytical interviews for five farms (as a reference point) were used. They were chosen taking into consideration the representative criteria regarding dimension, structure of activities, profile of the exploitation head. We considered 2 farms with low dimension (with exploitation surface lower than 10 ha), 1 for medium dimension (with exploitation surface between 10 and 20 ha) and 2 „big" farms (with more than 20 ha).

The assessment of behavioural aspects using expert interviews uses two main types of variables:

a) structural variables accounting for the types of farms/private forest owners and forest management/farming. These data rely on the existing regional statistics (such as the Agricultural Census of 2010) and on the onsite observation and pools performed;
b) main context variables. These variables refer to data gathered through interviews with experts in the field.

The role of this analysis is to identify the main characteristics with regard to the farm categories in the Dorna Region. Also, the analysis sets the framework for a future investigation of the structure of these farm categories and the decisions taken by these entities within a context harnessed by public good policies. Moreover, based on these characteristics a set of possible decisional responses are identified, and correlated with various scenarios identified for the area analyzed.

A. With regard to the structural variables, as a farm characteristic the age of exploatation Head is analyzed. This variable is considered given that the age classes can influence the decisions of modifying or preserving the farms' activities.

Age classes (years)	**Proportion (%)**
15-24	8,58%
25-34	12,31%
35-44	21,26%
45-54	18,02%
55-64	17,46%
over 65	22,37%

As one can notice from the panel analysed, the majority of the farmers are people with experienced and well settled in their activities (over 35 years), most of them being more than 65 years old. Only about 9% of the panel was represented by young people bellow 24 years.

The analysis is conducted on a sample of 41 farms from the Dorna region. These farms are selected also based on their size which is directly connected to the various instruments specific to public goods policies.

Age class (years)	**Small Farm (14) (<10 ha)**	**Medium Farm (11) (10-20ha)**	**Large size farm (16) (> 20 ha)**
<30	7,15%	9,10%	0,00%
30-40	7,15%	0,00%	18,75%
40-50	**50,00%**	**54,54%**	**43,75%**
50-60	**21,45%**	36,36%	**31,25%**
>60	14,25%	0,00%	0,00%

Taking into consideration also the size of the farms, in all three clusters (small, medium and large size farms) the dominant age class is between 40 and 50 years. Very few farms are encountered in the panel having farm leaders bellow 40 years.

Another structural variable used in the study is the Education level. This indicator has an impact on the decisions taken within a farm; the decisions are, in turn, directly linked to the objectives of each specific farm, their need to supply public goods and also to the response on the variation of the different indicators for the scenarios taken into account.

Level of Education	
(agriculture specialization)	
Practical experience	98,0%
Basic instruction	1,8%
High level of education	0,1%

Calculated after Agricultural Census, 2010

Needless to say what is very clear from our results: almost all of the persons interviewed have practical experience in the field (98%).

Level of agricultural education	Small Farm (14) (<10 ha)	Medium Farm (11) (10-20ha)	Large size farm (16) (> 20 ha)
Practical experience	35,71%	**90,91%**	37,50%
Medium instruction	**57,14%**	9,09%	**62,50%**
High level of education	7,14%	0,00%	0,00%

When considering also the size of the farms, one can easily notice that within small farms, more than half of the farmers interviewed have medium instruction (around 57%), and only about one third have practical experience. This situation is also encountered within large size farms. Within medium size farms, almost all of the farmers that participated in the study have practical experience.

With regard to the business model that the farmers follow (a valuable variable analyzed giving its potential to influence the decisions within farms), as one can notice from the table bellow almost all the people interviewed have adopted a family business model type.

Type of business	**Proportion in total**
Family business	97,5%
Authorised producer	0,7%
Cooperatives	0,1%
Companies	0,5%
Others	1,3%

This observation stands for all farms, regardless of their size.

	Small Farm (14) (<10 ha)	Medium Farm (11) (10-20ha)	Large size farm (16) (> 20 ha)
Type	Family business	Family business	Family business

Studying the “degree of involvement” is very important given that the time worked within a farm is essential when assigning tasks to each specific individual. In our panel, as one can notice, in small farms around half of the persons interviewed have part time contracts (with a threshold bellow 50%). When analyzing the medium and large size farms we noticed that people were working there in a part time manner but with a threshold above 50%.

	Small Farm (14) (<10 ha)	Medium Farm (11) (10-20ha)	Large size farm (16) (> 20 ha)
Part time(<50%)	**50,00%**	27,27%	18,75%
Part time(>50%)	**42,86%**	**63,64%**	**56,25%**
Full time	7,14%	9,09%	25,00%

The "structure of farm land' has a significant impact in establishing the structure of the farms for which the decision will be analyzed. Regardless of their size, the farms have a mixed structure, and only some of them a pastoral structure (with no evidence of a forestry area).

	Small Farm (14) (<10 ha)	Medium Farm (11) (10-20ha)	Large size farm (16) (> 20 ha)
Forestry area	-	-	-
Pastoral	42,86%	27,27%	0%
Mixed	**57,14%**	**72,73%**	**100,00%**

The final structural variable analyzed was the "ownership structure", given its impact on the freedom of decision to change the activities. As one can easily notice from the table below, almost all the farms that were analyzed are positioned on owned land (regardless of their size), with the exception of some large size farms that area on leased land.

	For all farms	Small Farm (14) (<10 ha)	Medium Farm (11) (10-20ha)	Large size farm (16) (> 20 ha)
Owned land	**97,20%**	**100%**	**100%**	90%
Leased land	2,80%	0%	0%	**10%**

B. With regard to the main context variables, these were documented based on partial interviews. Their importance is undisputable for the farms' local economy, for the decisions taken but also for the scenarios considered in this analysis.

Some important economic factors that were analyzed refer to: the amount of payments, the prices for agricultural/forestry products and the prices for input factors (e.g. energy/fuel/fertilizers…). As seen in the table below, there are not many differences between these features in small size farms compared to medium size farms: cost covering is the form of payment, the prices for agricultural/forestry products are low and the prices for input factors are high. Nonetheless, the situation is a little bit different when dealing with large size farms (for all the economic factors analyzed). Most certainly, these differences are caused by the more than 20 ha of the farm.

Economic factors	Small Farm (14) (<10 ha)	Medium Farm (11) (10-20ha)	Large size farm (16) (> 20 ha)
Amount of payments	Cost covering	Cost covering	Cost covering &incentives
Prices for agricultural/forestry products:	Low	Low	Low and medium
Prices for input factors (e.g. energy/fuel/fertilizers…): High vs. low	High*	High*	Medium

Availability of information is another important context variable, and it seems that the access to available, reliable or locally relevant information is quite optimal for small and medium size farms (with some cases where is tends to be more difficult than usual), and rather easy for those big farms.

Availability of information	Small Farm (14) (<10 ha)	Medium Farm (11) (10-20ha)	Large size farm (16) (> 20 ha)
Access to available, reliable or locally relevant information	Optimal (sometimes difficult)	Optimal	Easy

Technical support, through the availability of machinery, availability of technical knowledge (TK) is seen only in medium and large size farms (and usually it is given by consultancy), a context variable for which small size farms are deprived.

Technical support	Small Farm (14) (<10 ha)	Medium Farm (11) (10-20ha)	Large size farm (16) (> 20 ha)
Availability of machinery, availability of technical knowledge (TK)	Not given	TK given by consultancy (pasture)	TK given by consultancy (pasture)

Social infrastructure/ Cultural Pressures was the last context variable analyzed, and the panel showed that in all cases (regardless of the farm's size), there is a supporting context of neighbours, kin and peer farmers.

Social infrastructure/ Cultural Pressures	Small Farm (14) (<10 ha)	Medium Farm (11) (10-20ha)	Large size farm (16) (> 20 ha)
Supporting context of neighbours, kin and peer farmers	Given	Given	Given

7.3.5 Results and interpretation

7.3.5.1 Overall results

The applied model generated some activities structures (surfaces of pasture, grassland and forest, number of dairy cattle and acquisitions) analyzed according to the primary orientation on to profit (measured through the gross margin indicator) or to the public good acquisition, when the farm's holder shows the availability to diminish his "request" for immediate incomes, favoring the sustainable benefits of the public goods, especially represented by the "quality of landscape" and by the "rural vitality". In fact, these two public goods were seen as being important near by a third one, i.e. "the quality of water", but, for this one, the availability to pay, measured on the surface unit, generated insignificant values (especially in the case of small farms). For the quality of landscape, the availability to pay was equal to 2300 Euro per "improved" hectar, and, for the rural vitality, the payment availability was equal to 91 Euro (the results has been obtained in the evaluative exercise of the public goods – supply side from WP4).

Through its application, the model is adapted to the dimensions of available surfaces, to the limits imposed by the number of animals and surfaces of each category of use, to the particularities related to work and utilized machines on the surface unit and on animal head, for each of three categories of farms. The following values from the Table 1 (for the farms with a total surface that is less than 10 ha) resulted. In order to solve the linear programming problem, the Solver (Add-ins) module in Excel version 14 was used. The complete solution for the exclusive profit orientation is shown in Annex 2.

Table 1. The results of activity structure's simulation for different levels of orientation – farms under 10 ha of the total detained surface

Management Orientation	W^0 W^1	Natural Pasture - ha -	Pasture - ha -	Natural Grassland - ha -	Grassland - ha -	Forests - ha -	New forests - ha -	Diary cow LSU	Hay aquisitions - kg -	**Benefits EUR**
Profit	1 0	0	2,3	0	2,7	1	0	5	4530	4498
Mainly profit	75% 25%	**2,3**	0	0	2,7	1	0	5	4530	3503
Equilibrium	0,5 0,5	**2,3**	0	**2,7**	0	0	**1**	5	6150	3442
Mainly PG	0,25 0,75	**2,3**	0	**2,7**	0	0	**1**	5	6150	3381

For these "small farms", the level of general benefits (financial, but also economic ones – generated by the production of public goods) registers a low reduction from 4498 Euro/exploitation to 3381 Euro/exploitation.

It can be observed that, on a change of preferences equal to 25% (W^0 =0,75 profit and W^1=0,25 public goods), the farmers are inclined to transform the 2,3 ha of pasture in natural grassland worked without mechanized means.

The increase of the preference for public goods to 50% (W^0 =0,50 profit and W^1=0,50 public goods) determines the conversion of the pastures (2,3 ha) and, also, of the grassland (2,7 ha), and of the forests surfaces (1 ha) into natural surfaces, with a high biodiversity and with a low level of mechanized work.

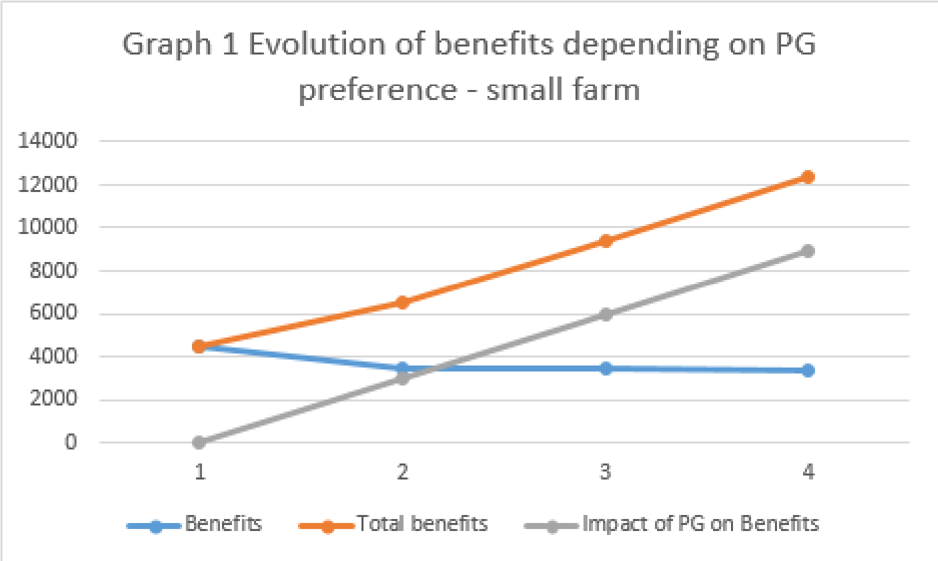
The situation does not change when the main disposition is related to the public goods acquisition (W^0 =0,25 profit and W^1=0,75 public goods).

It can also been observed that a quantification of the public goods' value as benefits to farms is able to generate high levels of total benefits (Table 2).

Table 2. Comparative situation of the different benefits of diverse practices from the small farms

Benefits	Total benefits	Impact of PG on Benefits
4498	4498	0
3503	6491	2988
3442	9418	5976
3381	12346	8965

The representation of this situation depending on the level of preference for public goods is shown in the Graph 1.



For putting into practice these preferences, a dominant role is played by the payment mechanisms for agro-environment, that, through the given subsidiaries (100 Euro /ha for pastures and natural grass land and 42 Euro /ha for renouncing on mechanized work), balances an important part of the lost benefits caused by the exploitation restrictions.

These measures for agro-environment are directly correlated with the financing for consultancy and with the level of farmers' education because the understanding of the (immediate and next) benefits and, also, the application of these agro-environment measures require clear evidences and analysis related to the potential of the farms from Dorna Valley.

For the **medium farms**, with total surfaces (pasture, grassland, and forests) between 10 and 20 ha, the situation needs some adjustments:

- A higher volume of available work (usually, 3 persons);
- Lower consumption of work on the surface unit and on the animal head;
- Lower consumption of mechanized hours on the surface unit;
- Higher availability of machines and equipment.

The high number of dairy cows determines a higher productivity and efficiency of the way the resources are used in these farms. The activities' structure, influenced by the preference for public goods' production is reflected in Table 3.

Table 3. The results of activity structure's simulation for different levels of orientation – farms with total surface between 10 and 20 ha

Management Orientation	W^0 W^1	Natural Pasture - ha -	Pasture - ha -	Natural Grassland - ha -	Grassland - ha -	Forests - ha -	New forests - ha -	Diary cow LSU	Hay aquisitions - kg -	**Benefits EUR**
Profit	1 0	0,5	3,6	0,0	6,0	3,0	0,0	9,3	4927,4	9654
Mainly profit	75% 25%	4,0	0,0	0,0	6,0	3,0	0,0	9,3	4927,4	6762
Equilibrium	0,5 0,5	1,5	2,5	6,0	0,0	3,0	0,0	9,3	8518,0	4563
Mainly PG	0,25 0,75	1,5	2,5	6,0	0,0	3,0	0,0	9,3	8518,0	2840

For these medium farms, the level of general benefits (financial, but also economic ones – generated by the production of public goods) registers a strong reduction from 9654 Euro/exploitation to 2840 Euro/exploitation.

It can be observed that, on a change of preferences equal to 25% (W^0 =0,75 profit and W^1=0,25 public goods), the farmers are inclined to transform the 4 ha of pasture in natural grassland worked without mechanized means.

The increase of the preference for public goods to 50% (W^0 =0,50 profit and W^1=0,50 public goods) determines the conversion of the pastures (1,5 ha) and, also, of the grassland (6 ha).

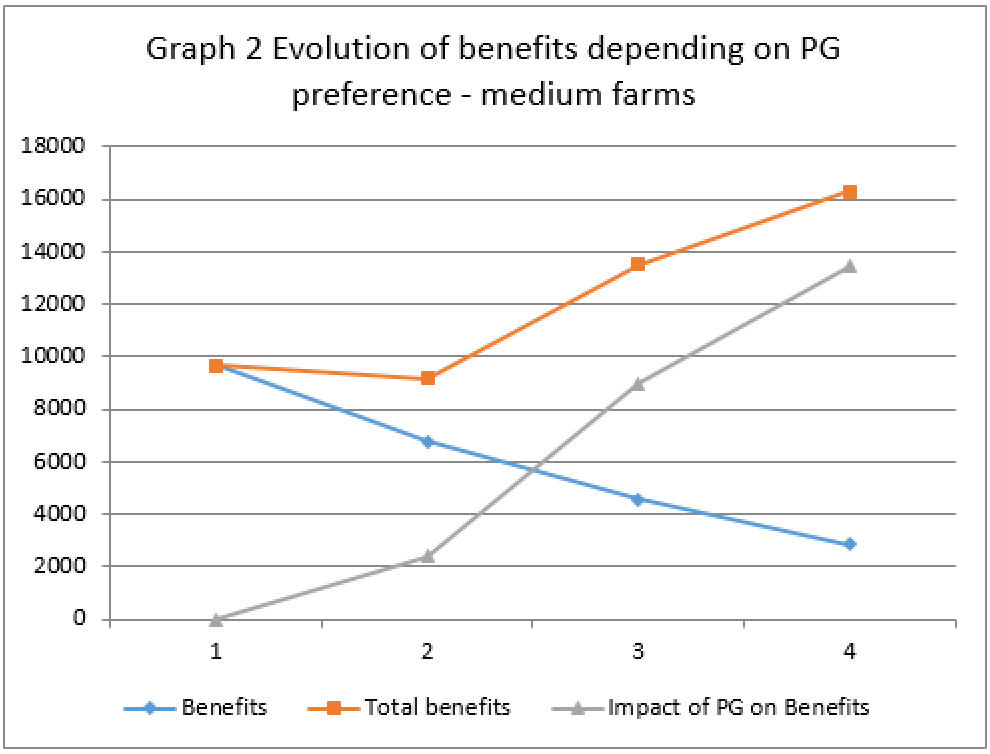
The situation does not change when the main disposition is related to the public goods acquisition (W^0 =0,25 profit and W^1=0,75 public goods).

It can also been observed that a quantification of the public goods' value as benefits to farms is able to generate high levels of total benefits (Table 4).

Table 4. Comparative situation of the different benefits of diverse practices from the small farms

Benefits	Total benefits	Impact of PG on Benefits
9654	9654	0
6762	9162	2400
4563	13528	8965
2840	16287	13448

The representation of this situation depending on the level of preference for public goods (situations 1-4) is shown in the Graph 2.



Similarly to the small farms, for putting into practice these preferences, a dominant role is played by the payment mechanisms for agro-environment, that, through the subsidiaries offered to farmers (100 Euro /ha for pastures and natural grass land and 42 Euro /ha for renouncing on mechanized work), balances an important part of the lost benefits caused by the exploitation restrictions.

These measures for agro-environment are directly correlated with the financing for consultancy and with the level of farmers' education because the understanding of the (immediate and next) benefits and, also, the application of these agro-environment measures require clear evidences and analysis related to the potential of the farms from Dorna Valley.

For the large farms, with total surfaces (pasture, grassland, and forests) higher than 20 ha, the situation needs the same type of adjustments as the medium farms:

- A higher volume of available work (usually, 4 persons – 960 hours);
- Lower consumption of work on the surface unit and on the animal head;
- Lower consumption of mechanized hours on the surface unit;
- Higher availability of machines and equipment (500 hours).

The high number of dairy cows determines a higher productivity and efficiency of the way the resources are used in these farms. The activities' structure, influenced by the preference for public goods' production is reflected in Table 5.

Table 5. The results of activity structure's simulation for different levels of orientation – farms with total surface bigger than 20 ha

Management Orientation	W^0 W^1	Natural Pasture - ha -	Pasture - ha -	Natural Grassland - ha -	Grassland - ha -	Forests - ha -	New forests - ha -	Diary cow LSU	Hay aquisitions - kg -	**Benefits EUR**
Profit	1 0	8,3	0,0	1,0	10,7	3,0	0,0	18,6	11508,7	18143
Mainly profit	75% 25%	8,3	0,0	1,0	10,7	3,0	0,0	18,6	11508,7	13056
Equilibrium	0,5 0,5	1,4	6,9	11,7	0,0	2,1	0,9	18,6	17935,9	8684
Mainly PG	0,25 0,75	1,4	6,9	11,7	0,0	2,1	0,9	18,6	17935,9	5276

For these large farms, the level of general benefits (financial, but also economic ones – generated by the production of public goods) registers a severe reduction from 18143 Euro/exploitation to 5276 Euro/exploitation.

It can be observed that, on a change of preferences equal to 25% (W^0 =0,75 profit and W^1=0,25 public goods), the farmers do not have any modification of land structure compared to the situation in which their option is for profit, as they imply 8,3 ha for natural pasture and 1 ha for natural grassland.

The increase of the preference for public goods to 50% (W^0 =0,50 profit and W^1=0,50 public goods) determines the increase of the share of intensive utilized pastures (6,9 ha), but, also, of the grassland (6 ha).

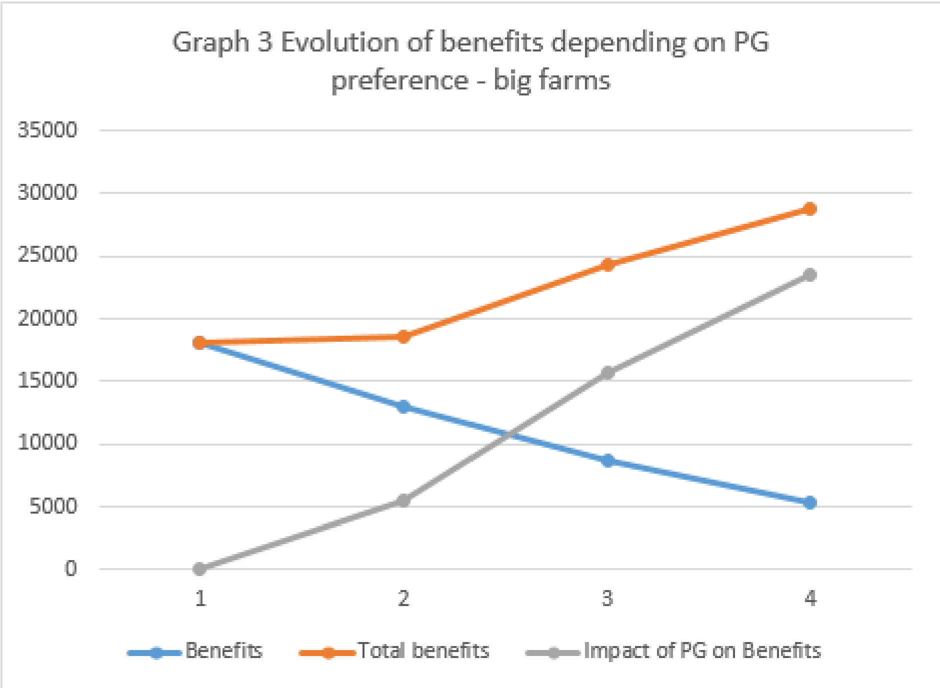
The situation does not change when the main disposition is related to the public goods acquisition (W^0 =0,25 profit and W^1=0,75 public goods).

It can also been observed that a quantification of the public goods' value as benefits to farms is able to generate high levels of total benefits (Table 6).

Table 6. Comparative situation of the different benefits of diverse practices from the medium farms

Benefits	Total benefits	Impact of PG on Benefits
18143	18143	0
13056	18607	5551
8684	24348	15664
5276	28779	23502

The representation of this situation depending on the level of preference for public goods (situations 1-4) is shown in the Graph 3.



Similarly to the small farms, for putting into practice these preferences, a dominant role is played by the payment mechanisms for agro-environment, that, through the given subsidiaries (100 Euro /ha for pastures and natural grass land and 42 Euro /ha for renouncing on mechanized work), balances an important part of the lost benefits caused by the exploitation restrictions.

These measures for agro-environment are correlated with the financing for consultancy and with the level of farmers' education because the understanding of the (immediate and next) benefits and, also, the application of these agro-environment measures require clear evidences and analysis related to the potential of the farms from Dorna Valley.

7.3.5.2 Scenario related results

With regard to **Scenario 1 (rising prices of inputs for small farms)**, the analysis considered an increase of 10% in the cost of hay and of other costs related to farm inputs. The results did not show a significant change in the structure of the farming sector or its activities. The effect of this change consisted in a reduction of the overall benefits of between 5.35% and 15.51%, depending on the goals pursued (orientation) of the farm, as shown in Table 7. This suggests that a high sensitivity exists only for profit focused farming.

Table 7. Variation of benefits caused by an increase of 10% in the cost of inputs for small farms

Orientation	W^0	W^1	Benefits	Benefit variation
Profit	1	0	**3800**	-15,51%
Mainly profit	0,75	0,25	**3150**	-10,08%
Equilibrium	0,5	0,5	**3081**	-10,49%
Mainly PG	0,25	0,75	**3200**	-5,35%

Thus, the effects of the governance mechanisms do not generate changes in the behavior of farmers when planning their activities. No direct impact on the provision of public goods exists.

The same analysis was performed for **Scenario 1 (rising prices of inputs for medium sized farms)**. In the case of farms focused mainly on profits (W^0 =0,75 profit and W^1=0,25 public goods), the structure of land use changes significantly: out of the 6 ha used for producing hay, 3.5 ha are dedicated to practices that generate public goods (natural pastures without the use of machinery), which means that the efficiency of agro-environmental payments is improved (Table 8).

Table 8. Variation of the structure of land use and the benefits caused by a 10% increase in the cost of inputs for medium sized farms

Orientation	W^0	W^1	Natural Grassland	Grassland	Benefits	Benefit variation
Profit	1	0	0,0	6,0	**8389**	-13,10%
Mainly profit	0,75	0,25	**3,5**	**2,5**	**5561**	-17,77%
Equilibrium	0,5	0,5	6,0	0,0	**3889**	-14,78%
Mainly PG	0,25	0,75	6,0	0,0	**2502**	-11,89%

In addition, a high sensitivity of the benefits can be observed for all types of preference for the provision of public goods (reduction of benefits is between 11.89% and 17.77%).

With regard to **Scenario 2 (decreased prices of agricultural products sold by small farms with low negotiating power)** the following effects were observed (Table 9):

- For small farms, negative effects were observed with regard to natural pastures (2.3 ha), which are included in an intensive farming system in the case of a mainly profit oriented entity that is also concerned with the provision of public goods (W^0=0.75 profit and W^1=0.25 public goods)
- For the same type of entity, there is a high sensitivity of benefits to the reduction of sale prices (a reduction of 21.87% of the benefits)

Table 9. Variation in the structure and benefits caused by a 10% decrease in sale prices for small farms

Orientation	W^0	W^1	Natural Pasture	Pasture	Benefits	Benefit variation
Profit	1	0	0	2,3	4095	-8,96%
Mainly profit	0,75	0,25	0	→ **2,3**	2737	-21,87%
Equilibrium	0,5	0,5	2,3	0	3275	-4,85%
Mainly PG	0,25	0,75	2,3	0	3297	-2,48%

The scenario analysis presented here and the direct observations from the Dorna Valley (North-East Region of Romania) have illustrated some important trends related to the effects of the governance strategy:

- In relation to the level of knowledge, education and consultancy regarding the importance of providing public goods, all farms (regardless of size) are responsive in changing the structure of their outputs in the direction of increasing the areas of land that are worked manually.
- The implementation of agro-environmental schemes had a direct and noticeable impact on the real benefits obtained by the farmers. All cases showed that, after adopting production methods that generate public goods, the immediate financial benefits decrease.
- The market conditions can influence the performance of the governance mechanisms taken into consideration. The macroeconomic context, as well as the negotiating power of small and medium farms in the case study region influences the likelihood of adopting a behavior that leads to the provision of public goods.
- Overall, at the level of the case study region, it is considered difficult to obtain information related to applying agro environmental measures at the level of the small farms. This is connected to the lack of information and knowledge regarding the effects of altering traditional practices in favor of activities that generate a high quality landscape and that encourage young people to settle in rural areas.

7.3.6 Discussion

7.3.6.1 Discussion of results

By analyzing the results in the case of the three categories of farms, it is noticeable that the governance strategy based on AES and expenditures on consultancy and information services does generate effects with regard to management – the traditional activities are replaced with those that generate public goods.

Conclusions:

A. The change does not occur for the same orientation for the provision of public goods:

- For **small farms**, the propensity to apply traditional practices on their own pastures existed from the beginning. This means that, even in the absence of agro environmental payments, 0.5 ha of pastures are natural. When the orientation toward public good provision is W^1=0.25, the entire surface of pastures is managed in a natural manner. After surpassing the value of W^1=0.50, meadows are managed naturally, while for some pastures the intensive practices are resumed. This is explained by the high willingness for work within small farms and by the traditional approach in managing its holding.
- For **medium sized farms**, the impact of the orientation towards public goods provision is gradual. Firstly, meadows are transformed into natural meadows (at W^1=0.25), followed by pastures and even coupled with the creation of new forests in the case of a public goods orientation exceeding W^1=0.50. Medium sized farms tend to have an excessive amount of labor force and, as a result, a lot of the work in the Drona Valley is performed manually, without mechanical instruments.
- In the case of both small and medium sized farms, the impact of the market and of the economic context can result in a higher or lower efficiency of the governance strategies.
- Even though the land in the Dorna region is managed in a traditional manner that is close to natural, the rural population is responsive to governance mechanisms (in this case the use of agro environmental payments), as they represent important financial resources for the farmers.
- Small and medium sized farms in the mountainous region of the Dorna Valley are mainly focused towards the specific needs of the farm. This results in a sustainable

usage of the land in the region and an innate preservation of their quality and the production of public goods (in this case natural landscape and rural vitality). An increase in the degree of support offered for such practices leads to a higher retention of young people in rural areas, where they can be productive and lead a good quality life. The interviews conducted for the supply side valuation of PGs (WP4) have shown a strong preference by farmers to pass on the farms to young people (their children) and to share with them the value of the traditional practices in the region.

- **Large farms** have a very different behavior: in the absence of any kind of agro environmental payments, the entire area of pastures, as well as part of the meadows, is worked naturally. As the intensity of the orientation towards the provision of public goods increases above W^1=0.50, the entire area of meadows is exploited naturally, while some pastures revert to intensive practices. This can be explained by the need to feed a rising number of livestock during the warm seasons from the same holding (the principles of 1 large cattle unit per ha are breached).

B. Quantifying and understanding the value of public goods justifies the orientation towards the preservation of the environment and of rural practices. After the benefit of public goods is highlighted, the efficiency of practices that provide such goods can be reasoned based on their value. However, the benefit surplus is obtained only by those farms that also develop tourism or entertainment activities in the area. A large portion of farmers, especially from small farms, have justified the preservation of the natural landscape and of the rural vitality through their importance on one's health and satisfaction: healthy food, clean air, the pleasure of working and interacting with animals etc.

7.3.6.2 Discussion of methodological approach

The usefulness of the linear programming model is widely recognized in the area of economic decision making. Some of the strengths of the model applied in this case (analysis of the effects of governance mechanisms on the orientation of mountain farms towards the provision of public goods) are as follows:

1) It allows the inclusion of a high number of variables and restrictions. In fact, these can cover any practical requirement, being adaptable for all the sensitivity scenarios that are considered.
2) It offers the possibility to combine several objective functions, including minimum or maximum goals related to the provision of public goods. Given that the inclusion of a single objective function is not sufficient in order to define the end result of mountain farming activities, several such functions can be defined. Depending on the weighting factors considered in the analysis, these functions can have a higher or a lower impact on the end results.
3) It allows the creation of solutions through electronic tools that can also be available for stakeholders. After the model is designed and the parameters and restrictions quantified, solving the model and generating simulations is not a difficult process and it can be performed with relative ease using specialized software tools.
4) It offers the possibility to develop a diverse set of scenarios. By adding or eliminating objective functions, variables or restrictions, it is possible to outline scenarios that evaluate the potential risks of decisions related to the provision of public goods.

As with any model, linear programming has some weaknesses, such as:

1) Numerous values and starting points are used, which can sometimes cause erroneous results.
2) Detailed knowledge is necessary with regard to the types of farms, the technologies used, as well as the traditions of each region regarding farming practices. These are needed in order to define feasible models for the analysis of the farming activities that provide public goods.
3) It is based on an arbitrarily defined classification of farms, based on the analyst's intuition, that does not always constitute an accurate representation of the assessed population, as would be the case for econometric models.

For the purpose of analyzing the behavior of stakeholders and providers of public goods from the mountainous regions of the North-East Region of Romania, the model can prove to be useful in highlighting some social and economic effects of the governance measures implemented for this purpose.

7.3.6.3 Discussion of the participative elements in the modelling approaches

The application of the model is closely linked to the active participation of the stakeholders in the supply of data regarding the formulation of the problem and the restrictions. In addition, the orientation of the farmers from the North-East Region (Dorna Valley) can only be understood by observing the behavior of the population in the region, as well as their degree of understanding the long term effects of their activities. Under such circumstances, the sincerity, knowledge and willingness of respondents to provide answers has a significant impact on the accuracy of the model and on its results.

The cooperation between technical and economic specialists can successfully resolve potential issues related to incoherence of data or of the objectives.

If the stakeholders fully understand the usefulness of such exercises and the importance of the data that they provide to the analysts, the resulting model is likely to be relevant for the studied cases.

In order to improve the participatory attitude of the stakeholders, the following conditions are needed: getting to know the stakeholders and establishing a lasting relationship with them, overcoming any barriers caused by a lack of clarity regarding the usefulness of the study, good communication and clear explanations of the assessed phenomenon. This study and the model itself are based on interviews with a diverse sample of farmers, who were visited on their own holdings; the discussions were open and allowed the respondents to also express other opinions and present experiences from which the fundamental outline and direction of the analysis were extracted.

The developed model attempts to capture a large portion of the quantifiable aspects related to public goods in the assessed region. However, the conclusions and discussions were complemented by qualitative aspects and fine details extracted from the discussions held with each individual farmer.

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ANNEX 1: OTHER MAPS REGARDING CSR

Figure 8. Meadows important for birds *Source: APIA (2014)*

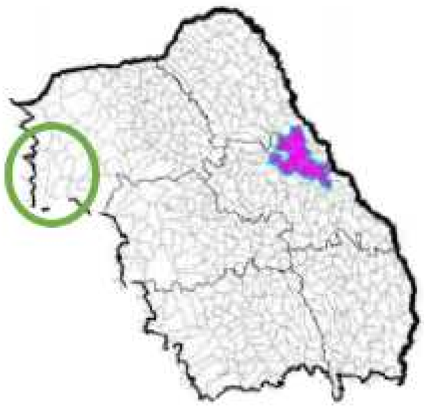


Figure 9. Meadows important for butterflies *Source: APIA (2014)*

Figure 10. Surface waters *Source: ICPA (2008)*

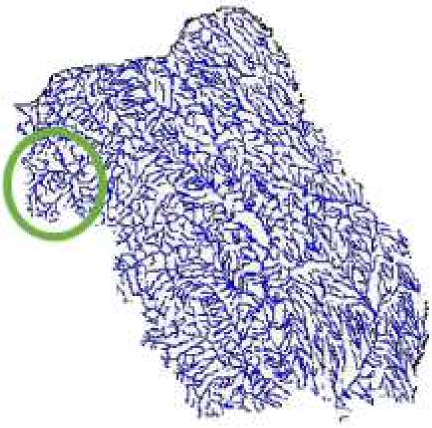


Figure 11. Underground waters *Source: ICPA (2008)*

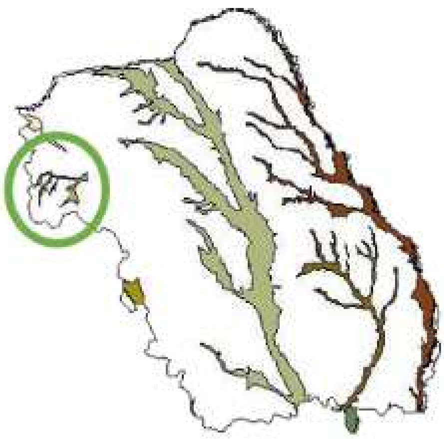


Figure 12. The physical and chemical quality of river waters *Source: Romanian Waters National Authority (2009)*

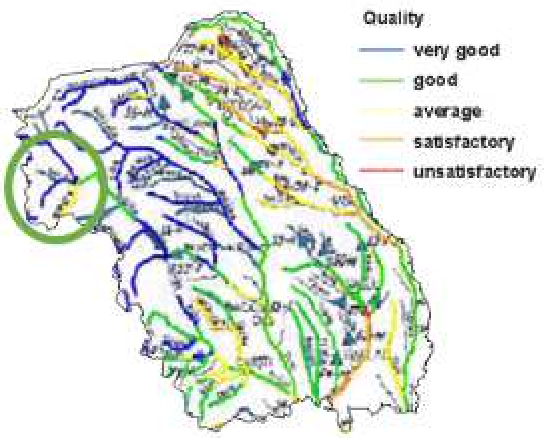


Figure 14. The biological quality of river waters *Source: Romanian Waters National Authority (2009)*

Figure 13. Deficit of precipitations *Source: ICPA (2008)*

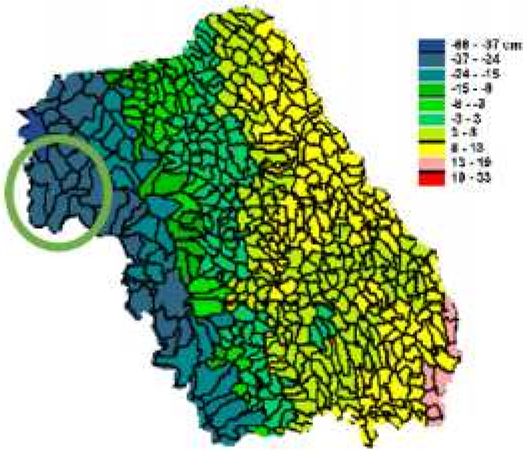


Figure 15. Land production capacity *Source: ICPA (2008)*

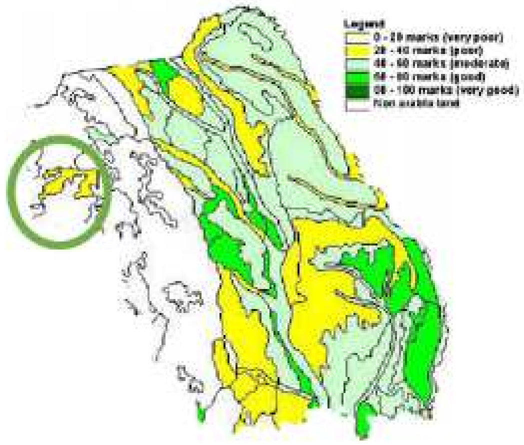


Figure 16. Soil texture *Source: ICPA (2008)*

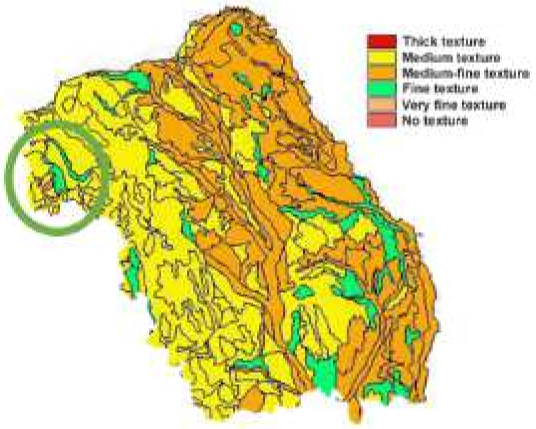


Figure 17. Soil classes *Source: ICPA (2008)*

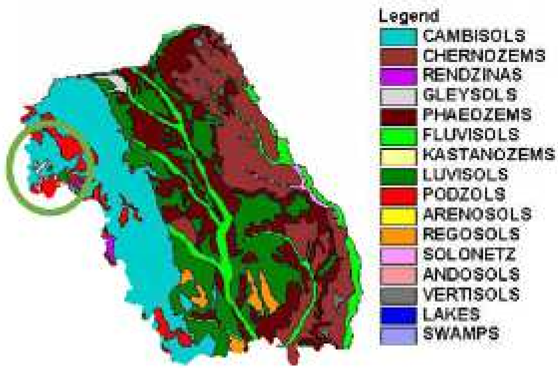


Figure 18. Soil sub-classes *Source: ICPA (2008)*

Figure 19. Soil erosion (tonnes/ha/year) *Source: Ionita (2011)*

Figure 20. Distribution of gullies in the Moldavian Plateau *Source: Ionita (2011)*

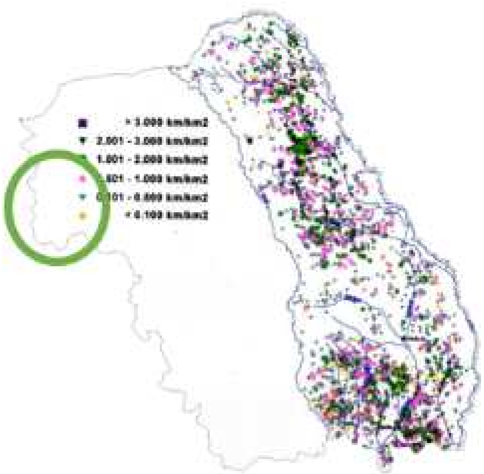


Figure 21. Special Protection Areas (SPA) *Source: Geacu, Dumitrascu and Maxim (2012)*

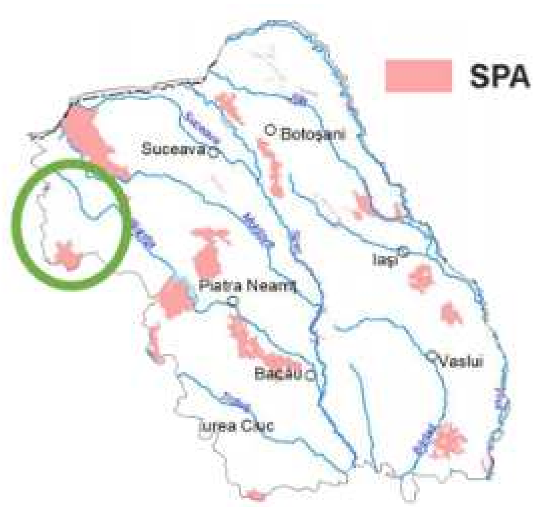
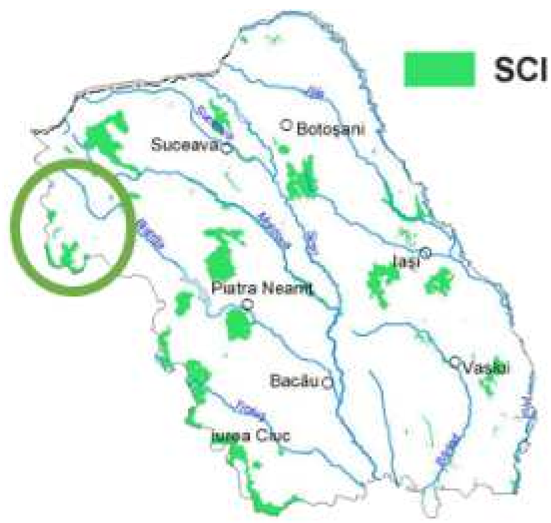


Figure 22. Sites of Community Importance (SCI) *Source: Geacu, Dumitrascu and Maxim (2012)*



ANNEX 2: MULTIPLE OBJECTIVE LP ANSWER REPORT (EXEMPLE)

W^0=1w^e=
0
Engine: Simplex LP
Solution Time: 0,047 Seconds.
Iterations: 11 Subproblems: 0
Max Time Unlimited, Iterations Unlimited, Precision 0,000001, Use Automatic Scaling
Max Subproblems Unlimited, Max Integer Sols Unlimited, Integer Tolerance 1%, Assume NonNegative

Cell	Name	Original Value	Final Value	
$P$6	Weighted Sum Objective	16040	**20240**	**lei**
			4497,78	**Euro**

Cell	Name	Original Value	Final Value	Integer
$C$1	Natural Pasture	2,3	0	Contin
$D$1	Pasture	0	2,3	Contin
$E$1	Natural Grassland	2,7	0	Contin
$F$1	Grassland	0	2,7	Contin
$G$1	Forests	0	1	Contin
$H$1	New forests	1	0	Contin
$I$1	Diary cow	5	5	Contin
$J$1	Hay aquisitions	6150	4530	Contin

Cell	Name	Cell Value	Formula	Status	Slack
$L$15	Total grass area	5	$L$15=$N$15	Binding	0
$L$16	Total forests	1	$L$16=$N$16	Binding	0
$L$17	Hay	-2,72848E-12	$L$17>=$N$17	Binding	0
$L$18	Soilage	-7,27596E-12	$L$18>=$N$18	Binding	0
$L$19	Manure	1150	$L$19>=$N$19	Not Binding	1150
$L$20	Machineries	150	$L$20<=$N$20	Not Binding	150
$L$21	Work	295	$L$21<=$N$21	Not Binding	185
$L$22	Diary cow	5	$L$22>=$N$22	Binding	0
$L$23	Pasture	2,3	$L$23>=$N$23	Not Binding	1,3
$L$24	Grassland	0	$L$24>=$N$24	Binding	0
$L$25	Consultancy and information	0	$L$25<=$N$25	Not Binding	6750
$C$1		0	$C$1>=$C$27	Binding	0
$D$1		2,3	$D$1>=$D$27	Not Binding	2,3
$E$1		0	$E$1>=$E$27	Binding	0
$F$1		2,7	$F$1>=$F$27	Not Binding	2,7
$G$1		1	$G$1>=$G$27	Not Binding	1
$H$1		0	$H$1>=$H$27	Binding	0
$I$1		5	$I$1>=$I$27	Not Binding	5
$J$1		4530	$J$1>=$J$27	Not Binding	4530

8 Risk of abandonment of agricultural land use system

CSR	Topic	Model	Authors
FR-1	Water purification, habitat and flood prevention in the Odet Watershed in Brittany in France – Evaluation of a decentralisation of governance for AES & PES schemes	Mathematical model	F. Bareille P. Dupraz
ES-1	Biodiversity in the Andalusian mountain olive groves in Spain – Evaluation of improved agri-environmental schemes	Principal-agent model	J.A. Gómez-Limón C. Gutiérrez-Martín A.J.Villanueva, M Castillo J. Berbel
IT-1	Soil erosion, rural vitality and carbon sequestration in the hilly and mountain area of the Bologna province in Italy – Evaluation of and existing RDP	Land allocation model	M. Zavalloni R. D'Alberto M. Raggi D. Viaggi

8.1 FR-1: Water purification, habitat and flood prevention in the Odet Watershed in Brittany in France

8.1.1 Introduction

8.1.1.1 Description of case study region

The Odet watershed is a territory of 724 km², representing 2.64% of the size of the Brittany region. The territory presents a density of 174 inhabitants per km², with about 127,000 inhabitants in total in 2014. The watershed is constituted of 27 municipalities. The main city of the watershed is Quimper, the third largest city of Brittany, famous for its cathedral overhanging the Odet coastal river (Figure 1) and its half-timbered houses. Half of the inhabitants of the watershed lives in Quimper. Eight watercourses cross the watershed. They all group within the Odet coastal river. In particular, three of the tributaries of the Odet (namely the Steïr, the Frout and the Jet) group within the Quimper boundaries, leading to regular flooding events (Figure 2).

Agriculture still represents an important economic activity of the watershed. The Utilized Agricultural Area (UAA) represents about 75% of the total area. The 779 farmers of the watershed (reported in the Agricultural Census of 2010) are mainly orientated towards mixed farming. The density of cows is close to the departmental mean. The largest part of the organic nitrogen comes from cattle. Compared to the rest of the Region, the agriculture is relatively extensive in animals and suffer less from water pollution. Permanent grasslands constitute approximatively the half of the UAA. Among these areas, 3700 Ha are wet grasslands. Taking into account for other kinds of wetlands, there are about 7000 hectares of wetlands in the watershed, i.e. more than 20% of the watershed area. Agricultural wetlands represent 11% of the watershed area.

8.1.1.2 Description of public good issue

The hydric soil characteristics of agricultural wetlands provide a distinct ecosystem from other land types. Wetlands support the provision of many ecosystem services, principally water purification, flood control and carbon sink. Despite the existence of various international agreements and national policies (notably specific Agro-Environmental Measures), wetlands have been lost or are threatened. These threats are linked to the lack of agricultural profitability of these areas but also to changing legislations. The uncertainties around the legislation frame coupled to the potential high penalties and the opportunity costs has incited some farmers to sell or abandon their wetlands. The proposed payments in the existing Agro-Environmental Measures (AEM) do not provide enough incentive for farmers, especially for high capital-intensive farms. Higher payments would lead to decrease of abandonment.

In 2014, stakeholders from Finistère have conducted a census of wetlands to provide detailed information on their evolution. A comparison of the registered agricultural wetlands from 2014 with farmers' CAP declarations of the same year highlight that 46% of the agricultural wetlands were abandoned. This high abandonment worries local authorities because it conducts to a loss of public good provision.

Indeed, expression of ecosystem functionalities depends on the agricultural management of wetlands (Gerakis and Kalburtji, 1998). Extensive agricultural management such as mowing and grazing provide the highest levels of ecosystem functionalities. Based on benefit transfer functions and cost accounting and taking into account for water filtration, flood control, nursery function, carbon sink and biodiversity habitat, the PROVIDE WP4 demand study in Odet concludes that the abandonment of wetlands leads to, at least, a decrease of 440€/Ha of abandoned wetlands. Thus, farmers managing wetlands provide a minimal environmental service of 440€/Ha to society (and a maximal value of 1860€/Ha). In particular, due to the high demand for local public good, 90% of the environmental service value is captured inside the watershed.

8.1.1.3 Description of governance-strategy

Today, the current AEM proposed to the farmers do not prevent high abandonment. Local stakeholder has stressed the need to improve the system governance in order to maintain farmers on wetlands, notably on valuable ones (to simplify, the closest ones to Quimper). The main worry of local stakeholders is to have more freedom to take into account the diversity of the situations (i.e. the heterogeneity of the supply of environmental service), notably to offer higher subsidies to farmers managing abandoned but potentially high valued wetlands.

One possibility for such freedom is to implement to a Payment for Environmental Service mechanism, which best suited the high variability of demand for local public goods. Indeed, several stakeholders such as water companies, angler associations or local communities are interested in the agricultural wetlands because they benefit to their activities. The PES offers legislative solutions to these stakeholders to propose incentive payments to farmers for the objective of maintaining farmers on the wetland area. The PES payments would be complementary of already existing AEM.

The local stakeholders have higher information on the local demand. Thus, they can best adapt the proposed payments to the demand, taking into account for heterogeneity of local public good preferences.

The subsidies would be higher for valuable wetlands. The degree of abandonment should be lower for valuable wetlands.

8.1.2 Methodological approach

8.1.2.1 Theoretical background

The model we present is fully developed in the work in progress proposed by Bareille & Zavalloni (2018). The model compare welfares from an economy in three situations: (i) the case where the central government is in charge of the design of agri-environmental schemes, (ii) the case where the local government (e.g. a region or a city) is in charge of the design of agri-environmental schemes and (iii) the case where both governments participate to the design of complementary agri-environmental schemes. Both governments face an exogenous budget constraint: the share of the Common Agricultural Policy devoted to AEM (i.e. 4% of the EU common budget). The proposed model is inspired from the literature on fiscal federalism (Epple and Nechyba, 2004), and in particular, on environmental federalism (Oates, 2001). The aim of this literature is to examine the effectiveness of decentralization of public instrument design, considering both advantages and disadvantages of decentralization. The advantages are notably due to the knowledge of the heterogeneity of local demand and supply. The disadvantages are either the effectiveness of public money management (transactions costs benefit from scale economies) or the externalities generated from one region to the others. The aim of the analysis is to examine the effectiveness of AEM towards lower level of governments.

The model developed by Bareille & Zavalloni (2018) rely on four assumptions. First, similarly to Bougherara and Gaigné (2008), the suppliers of public goods are not the public sector (as it uses to be in fiscal federalism literature) but the private sector (i.e. the agricultural sector). Second, the public good suppliers jointly produces two types of public goods: local and global ones. This explains why both local and central government are interested in the way the public funds are spent. Third, both suppliers and consumers of public goods are immobile, i.e. that there is no competition between local jurisdictions. Fourth, the local government can integrate that the utility of local public good provision decreases with the distance between its provision and the beneficiaries. This last assertion has been stressed out by the growing empirical literature of "distance-decay willingness-to-pay" (León et al., 2016; Sutherland and Walsh, 1985). This literature stresses that the utility derived from the provision of local public goods decreases with the distance between the production area and the area of consumption. The larger the distance is, the less the value of the public good consumption is (Bateman et al., 2006; Jørgensen et al., 2013; León et al., 2016; Pate and Loomis, 1997; Rolfe and Windle, 2012).

Assuming in addition that the economy is constituted of homogeneous regions, the problem is similar to a problem with one local government (governing one region or one city) and a central government (the EU). Each region contains a farming sector, constituted of two spatially disjoint farmers, labeled F_1 and F_2. F_1 and F_2 are respectively located to a distance d_1 and d_2 to the main city of the region, with $d_1 < d_2$. Otherwise, the farmers are homogenous. The farmers produce agricultural goods on a fixed quantity of lands and can produce public goods on $\overline{X}$ units of land with suitable environmental quality. The $\overline{X}$ units of land can be allocated to the production of public goods or not (the land units are either farmed or abandoned). The farmed (or managed) lands are respectively noted as X_1 and X_2 with $X_1 + X_2 \leq \overline{X}$ (by consequence, there are $\overline{X} - (X_1 + X_2)$ unit of abandoned lands). The farmers are assumed to produce agricultural goods on a fixed quantity of lands and that they derive an exogenous profit from this production. In addition, the farmers can produce public goods on $\overline{X}$ with marginally increasing costs. The farmers maximize the profit from the production of public goods. The program of F_i is:

$$\Pi_i = \rho_i X_i - \frac{1}{2} c X_i^2 \tag{1}$$

where ρ_i is the subsidy proposed to the farmers for each unit of X_i and c is the parameter of the quadratic cost function. The level of ρ_i depends on the entity in charge of the provision of the public good. Each farmer chooses X_i under the constraint $X_i \leq \overline{X}_i$ in order to maximize her profit. In the presented analytical results, we assume that the constraint is not binding, i.e. that the given budget for the provision of public goods prevents $X_i = \overline{X}_i$.

The management of X_1 and X_2 leads to the joint production of local and global public goods. The utility derived from the production of the local public goods is captured by the main city of the region where the production occurs. The utility derived from the production of the local public goods decreases with the distance. The other regions do not benefit from the local public goods produced in the region where the production occurs. The utility derived from the production of the global public goods is captured by all the regions of the economy (including the region where the production occurs). The value derived from the production of the global pubic goods does not depend on d_1 and d_2.

The utility of the main city of the region is linear and given by:

$$U_{city} = \frac{v}{d_1} X_1 + \frac{v}{d_2} X_2 + w(X_1 + X_2) \qquad (3)$$

where w is the marginal utility derived by the inhabitants of the main city from the consumption of global public goods provided by F_1 and F_2 and v/d_i is the marginal utility derived from the consumption of the local public goods provided by F_1 and F_2, in line with the distance decay literature related to willingness-to-pay for the local public goods. The preferences for local and global public goods are exogenous.

The objective of the central government is to maximize the utility of the whole economy. Contrary to the government of the main city, the central government does not know the relationship between the utility derived from the consumption of the local public goods and the distance. We assume that it considers that the utility of the main city of the region for the consumption of local public goods does not depend on the distance. On the opposite, it knows perfectly the utility derived from the consumption of the global public goods, both in the region and the rest of the economy. The central government maximizes the following function:

$$U_{central} = \left(E\left(\frac{v}{d}\right) + w + y \right)(X_1 + X_2) \qquad (5)$$

where w is the marginal utility derived from the consumption of the global public goods within the considered region, y is the marginal utility derived from the consumption of the global public goods outside the considered region (i.e. in the rest of the economy) and $E(v/d)$ is the central government's expected value of the utility derived by the main city due to the provision of local public goods within the considered region. We assume that the central government's expected value of the utility derived from the provision of local public goods is comprised between the minimum and the maximum levels: $v/d_2 \leq E(v/d) \leq v/d_1$. Because most of the value derived from the provision of global public goods is captured outside from the considered region, we have also $w << y$.

Knowing that the city is more efficient to finance the local public goods (because it knows the heterogeneity of the demand), the central government can also choose to allocate a share of its budget to the government of the city. The transfer equation should insure the following equilibrium:

$$\overline{B} = B_{central} + (1+\tau)B_{city} \tag{7}$$

where τ is the rate of deadweight losses incurs by the city when it is charge of managing public money and $\overline{B}$ is the exogeneous budget for environmental provision. The rate of deadweight losses as the following property: $-1 \leq \tau < 1$. Indeed, we can decompose τ as $\tau = \tau_{se} + \tau_c$ where τ_{se} is the additional transaction cost rate incured by the city due to the scale economies implied by public money management and τ_c is the additional transaction cost rate incured by the central government due to the coordination between the different governments (the EU spends the money but has to coordinate with the regions and the cities to know the heterogeneity oft he supply, implying additional transaction costs). We have $0 \leq \tau_{se} \leq 1$ and $-1 \leq \tau_c \leq 0$. When $\tau = 0$, the city does not support any additional deadweight losses. When $\tau < 0$, the city spends more efficiently the public money than the current situation. When $\tau > 0$, the city supports additional deadweight losses. Each government chooses ρ_i for $i \in \{1;2\}$ anticipating the farmers' supply response.

Bareille and Zavalloni (2018) examine the public good provision properties emerging in the three types of governance, namely the *full-centralization* case, the *full-decentralization* case and the *mix-centralization-decentralization* case. They compare the levels of X_i, the level of subsidies, the utilities and the welfare (labeled W)[17] of the economy between each case. For

[17] The welfare is equal to $W = U_{city} + y(X_1 + X_2) + \Pi_1 + \Pi_2$.

the *mix-centralization-decentralization* case, they provide the optimal share of the budget that should go to the regional government.

8.1.2.2 Model implementation

The defined theoretical background leads to analytical solutions on the optimal level of decentralisation (what share of the actual budget should be allocated to the local governments), on the proposed subsidies, on the structure of the landscape (X_i for $i \in \{1;2\}$) and on the profits of the farmers. The analytical solutions depend on the exogenous budget, the transaction cost rate, the parameter of preferences for local and global public goods provided by X_i, the cost parameter of the cost function and the relative distance of the farmers. The analytical solutions are available in Bareille and Zavalloni (2018).

We apply the analytical results to our CSR (the Odet watershed), the X_i being the area of agricultural wetlands. Indeed, we have valued in WP5 the value of local and global PG produced by agricultural wetlands. The valued local PG were the ability of managed wetlands to filter water, to provide a nursery site for salmon and trout and to prevent flooding. Together, they were valued at 400€/Ha of managed wetlands at minimum. The valued global PG were the ability of managed wetlands to sequestrate carbon and to provide suitable habitat for biodiversity (existing value of biodiversity). Together, they were valued at 40€/Ha at minimum. We use these results as parameters. In WP4, we also provide information on the level of abandonment in the watershed. We use this information for the calibration of the definied cost parameter c. We provide in the next paragraph the calibration of the parameters.

We first begin with the budget allocated to environmental good provision within the watershed. A report from the regional public authority in charge of agriculture stresses that farmers of Brittany have received 13.5 millions € through AEM in 2012 (AGRESTE, 2014). Assuming a uniform repartition of AEM based on area, we have a budget constraint $\overline{B} = 162000$ (measured in euros) in the Odet watershed. WP4 report for FR1 have estimated at 400,000 € minimum the value of the actual abandoned wetlands in the Odet watershed (and even 950,000 € minimum if abandoned wetlands were pastured). We thus verify that $\overline{B}$ is binding. $\overline{B} = 162000$ is obviously the upper range of the real budget allocated to wetland management inside the watershed. The underlying assumption is that the single type of AEM inside the Odet watershed is for wetland management. Anyway, even with this upper range, $\overline{B}$ is binding.

The preferences parameters are easily obtained from WP4. We have $(w+y)=42$ (measured in euros per hectare). Assuming that the value is proportional to populations and that all the global public good value is captured inside the EU (this is a restrictive assumption), we have $w=0.009$ (0.02% of European Union citizens lives inside the watershed). We do have $w << y$. For the empirical estimation, we consider that $w=0$ and $y=42$[18]. For local public good preferences, we have to define two areas defined by two average distances d_1 and d_2. Assuming $d_1=2$ and $d_2=5$, we deduce that $v=1143$€/Ha[19].

These two areas are managed by two groups of identical farmers F_1 and F_2. We assume that these farmers have the same levels of abandoned wetlands in both areas in the actual financing rules (i.e. the centralization case): i.e. 900 Ha of abandoned wetlands located at d_1 and 900 Ha of abandoned wetlands located at d_2. The two groups of farmers face the same profit function (relation (1)) with $c=0.2778$, leading to the abandonment of 900 Ha of wetlands for each farmer in case of the homogenous subsidy of 120€/Ha. The marginal cost is thus defined in both areas by: $C_{m,i} = 0.2778 * X_i$.

8.1.3 Scenarios

See report on the 3rd local stakeholder workshop in FR1 for a full description of the scenario: business as usual (Scenario 1), changes in social preferences for environmental PG (Scenario 2) and restructuring of the farms (Scenario 3). Below are the modifications of the parameters for the three scenario.

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18 We can also consider that, because only 7% of world inhabitants lives in European Union, $y = 3$ €/Ha. Assuming that European Union does not behave as a free rider for the financing of global public good (EU pays its share), we do have $y=42$ €/Ha.

19 We do have $\frac{1}{2}\left(\frac{1143}{d_1}+\frac{1143}{d_2}\right)=400$.

Scenario: Business as usual

Same parameters as defined in 2.2. but only expression of local demand for water companies. So $v = 857$€/Ha[20].

Scenario: Changes in social preferences for environmental PG

- Opportunity costs to maintain wetlands: +10%.
- Expression of local demand for all local PG
- Social benefits from PGs at the local level: +50%
- Social benefits from PGs at the global level: +100%

So: $c = 0.3056$, $v = 1715$ and $(w + y) = 84$

Scenario: Restructuring of farms

- Opportunity costs to maintain wetlands: +40% (due to urbanization and mechanization)
- Social benefits from PGs at the local level: at the same rate than the number of new urban habitants (+20%)
- Social benefits from PGs at the global level: +50%

So: $c = 0.3889$, $v = 1372$ and *(w+y)*=63

8.1.4 Participative approach

8.1.4.1 Stakeholders' input to the development of governance mechanisms

Farmer representatives of Brittany are currently organizing the supply of environmental service to facilitate the contractualization between future payers and farmers managing wetlands. During this developing phase, they have conducted survey to evaluate the market, notably to determine the potential companies interested in wetland financing. Their conclusion is that there are several potential local payers but the surveyed companies do not seem to be willing to pay for wetlands (no water companies were surveyed unfortunately). Their partial conclusion is that the public sector is more willing to finance the wetlands. However, farmer representatives are currently trying to attract potential companies. They

[20] We do have $\frac{1}{2}\left(\frac{857}{d_1} + \frac{857}{d_2}\right) = 300$.

have also begun to develop the structure aggregating the offer with the objective to decrease transaction costs. This could allow estimating the additional transaction costs.

<u>Stakeholders input to the modelling exercise:</u>
The parameters come from real evaluation, not from stakeholders.

8.1.5 Results and interpretation

8.1.5.1 Scenario 1

Based on this set of parameters, we can compute the landscape structure, the set of subsidies and the welfare on the three types of governance. All the results are recorded in table 1 (in case of null transaction costs).

Table 1. comparative statistics in the three governance strategy with null transaction costs ($\tau = 0$)

	Centralization	Decentralization	Mix-centralization-decentralization
X_1^*	540 Ha	709 Ha	695.3 Ha
X_2^*	540 Ha	283.6 Ha	315.7 Ha
W	446,526 €	471,007 €	471,416 €
U_{city}	320,166 €	348,316 €	347,951 €
$U_{rest\_of\_the\_econom}$	45,360 €	41,690 €	42,462 €
Π_1^*	40,500 €	69,828 €	67,151 €
Π_2^*	40,500 €	11,172 €	13,849 €

In case of null additional transaction costs, the decentralization increases the welfare of the economy. The welfare increases by 5.5% in case of full decentralization and by 5.6% in case of mix-centralization-decentralization. However, these gains are captured by the city. Indeed, there are a reorganization of the landscape such as:

$$\begin{cases} X_1^{*\_centralization} < X_1^{*\_mix} < X_1^{*\_decentralization} \\ X_2^{*\_centralization} > X_2^{*\_mix} > X_2^{*\_decentralization} \end{cases}$$

and

$$X_1^{*\_decentralization} + X_2^{*\_decentralization} < X_1^{*\_mix} + X_2^{*\_mix} < X_1^{*\_centralization} + X_2^{*\_centralization}$$

As predicted by Bareille and Zavalloni (2018), the decentralization leads to a reorganization of the subsidy vector with higher subsidies proposed to F_1. It leads to a reorganization of the landscape, with more managed wetlands closer to the city, increasing its utility. Because these additional wetlands cost more to manage for F_1, the total amount of wetlands is lower with decentralization, decreasing the aggregate production of global public good. It leads to a decrease of the utility of the rest of the economy. Comparing full and optimal decentralization situations, the full decentralization incurs externalities to the rest of the economy, but there are relatively close to the optimum. The total amount of externalities weights for 772€, i.e. a decrease of 1.9% of the utility of the rest of the economy compared to the optimal case.

Table 2. Scenario1, comparative statistics in the mix-centralization-decentralization

	τ=0.5	τ=0.3	τ=0.15	τ=0	τ=-0.15	τ=-0.3	τ=-0.5
X_1^*	603.3 Ha	639.0 Ha	666.9 Ha	695.3 Ha	723.4 Ha	748.3 Ha	763.2 Ha
X_2^*	478.2 Ha	421.8 Ha	372.9 Ha	315.7 Ha	245.3 Ha	154.8 Ha	28.64 Ha
Π_1^*	48,905 €	56,068 €	61,615 €	67,151 €	72,535 €	77,266 €	80,531 €
Π_2^*	31,765 €	24,713 €	19,311 €	13,849 €	8,357 €	3,327 €	113 €
$B_{city}/\overline{B}$	2.5 %	7.9 %	14.8 %	24.8 %	39.1 %	60.2 %	92.3 %

The provision of X_2^* is much more sensible to τ than X_1^* (Figure 2). Even in case of null deadweight losses, the central government should only allocate one quarter of its budget to the local government. The central government internalize the joint production of global public good, which would incur negative externalities to the rest of the economy. In case where the local government is relatively more efficient to spend the public money (because they are less need for coordination among governments), the central government should keep a high share of the initial budget. When the local government presents a relative transaction cost rate of -0.50, 92.3% of the budget goes to the local government. Symmetrically, if τ=0.50, 97.5 % of the budget remains to the central government. This non-symmetry is due to the internalization of the global PG provision, which is an advantage of centralization.

8.1.5.2 Scenario 2: Changes in social preferences for environmental PG

We find the same general results than the scenario 1: decentralization increases the welfare of the economy and the gains are captured by the city (Table 3). We find a high augmentation of the welfare, by 43.4% in case of full decentralization and by 43.6% in case of mix-centralization-decentralization. The total and partial decentralization leads to 8 times more gains than in scenario 1 (5.5% and 5.6% respectively). This is explained by the fact that both global public good value and local public good value double in comparison to the first scenario. Because the two PG values have increase in the same proportion, we observe the same repartition in the landscape beteween the two scenarios (X_1^* / X_2^* remains constant). The consequence is that farmers' profit remains identic in the two scenarios. The only difference in the levels of X_1^* and X_2^* is due to the augmentation of the cost parameter.

The transaction costs have the same influence in scenario 2 than in scenario 1 (Tables 2 and 4). Indeed, for the same transaction cost level, the same share of the budget goes to the city. This is explained beacause the two PG values have increase in the same proportion.

Table 3. Scenario 2, comparative statistics in the three governance strategy with null transaction costs ($\tau = 0$)

	Centralization	Decentralization	Mix-centralization-decentralization
X_1^*	514.9 Ha	676.0 Ha	663.1 Ha
X_2^*	514.9 Ha	270.4 Ha	300.7 Ha
W	580,551 €	832,586 €	833,524 €
U_{city}	459,195 €	672,251 €	671,561 €
$U_{rest\_of\_the\_econom}$	121,356 €	79,501 €	80,962 €
Π_1^*	40,500 €	69,828 €	67,180 €
Π_2^*	40,500 €	11,172 €	13,819 €

Table 4. Scenario 2, comparative statistics in the mix-centralization-decentralization

	τ=0.5	τ=0.3	τ=0.15	τ=0	τ=-0.15	τ=-0.3	τ=-0.5
X_1^*	575.2 Ha	609.3 Ha	635.9 Ha	663.1 Ha	689.8 Ha	713.5 Ha	727.7 Ha
X_2^*	455.96 Ha	402.2 Ha	355.5 Ha	300.7 Ha	233.9 Ha	147.6 Ha	27.3 Ha
Π_1^*	48,906 €	56,070 €	61,615 €	67,180 €	72,536 €	77,266 €	80,531 €
Π_2^*	31,764 €	24,713 €	19,310 €	13,819 €	8,357 €	3,327 €	114 €
$B_{city}/\overline{B}$	2.5 %	8.0 %	14.8 %	24.8 %	39.1 %	60.2 %	92.3 %

8.1.5.3 Scenario 3: Restructuring of farms

As our global PG valuation in FR-1 D4.2. rely on actual tutelary values and expenses from France and EU, we provide here a sensitivity analysis with the relative augmentation of PG value, as global PG tutelary values are suspected to increase in the future. This scenario provide a robustness check for the case where global PG value increases relatively to local PG value.

We confirm that decentralization increases the welfare of the economy and the gains are captured by the city (Table 5). In scenario 3, we find a small augmentation of the welfare, by 5.9% in case of full decentralization and by 6.0% in case of mix-centralization-decentralization. The total and partial decentralization are more comparable to the first scenario (5.5% and 5.6% respectively) than it was for the second one. The similarity between the two scenario is due to the augmentation of cost parameter by 50% and the local PG value by 20%. Indeed, as the analytical solution integrates the value of PG at the square but not the cost parameter, the two augmentations compensate each other. The difference is due to the augmentation of the global PG value parameter by 50%, which, taken at the square, changes slightly the figures. Contrary to the second scenario, we observe a different reparation in the landscape, with the share of X_2^* being slighlty in the optimal decentralization case of scenario 3 compared to scenario 1 and 2. This is explained by the relatively higher increases of global PG value compared to local one. Our sensitivity analysis underlines that the augmentation of global PG values only shifts partially the equilibrium towards more centralization.

The transaction costs have almost the same influence in scenario 3 than in the two first scenarios (Tables 2, 4 and 6). We do observe that the share going to the city decreases with transaction costs. On average, the share of the budget going to the city increases in scenario 3 compared to the first ones. This is explained by the increasing of the cost parameter, the marginal cost of managing wetlands having increased. However, for negative additional transaction cost rate (the city being more efficient to spend public money), we observe a decrease of the share of the budget going to the city compared to the first scenarios (91.8% compared to 92.3%). This non-linearity is probaly due to the increase of global PG value. The 50% increase of ist value coupled to the 20% increases and the 50% increases of cost parameter has changed the marginal profitability of X_1^* and X_2^*. In the case of τ=-0.5, the available budget has increased compared to τ=0, so authorities have more flexibility to deal with the trade-off between local and global PG values.

Table 5. Scenario 3, comparative statistics in the three governance strategy with null transaction costs (*τ = 0*)

	Centralization	Decentralization	Mix-centralization-decentralization
X_1^*	456.4 Ha	599.2 Ha	588.4 Ha
X_2^*	456.4 Ha	239.7 Ha	265.09 Ha
W	576,667 €	610,562 €	611,046 €
U_{city}	438,165 €	476,709 €	476,274 €
$U_{rest\_of\_the\_econom}$	57,501 €	52,853 €	53,772 €
Π_1^*	40,500 €	69,828 €	67,335 €
Π_2^*	40,500 €	11,172 €	13,665 €

Table 6. Scenario 3, comparative statistics in the mix-centralization-decentralization

	τ=0.5	τ=0.3	τ=0.15	τ=0	τ=-0.15	τ=-0.3	τ=-0.5
X_1^*	510.8 Ha	540.9 Ha	564.4 Ha	588.4 Ha	612.0 Ha	632.8 Ha	645.0 Ha
X_2^*	402.9 Ha	355.1 Ha	313.7 Ha	265.1 Ha	205.7 Ha	129.2 Ha	25.8 Ha
Π_1^*	49,097 €	56,254 €	61,790 €	67,335 €	72,662 €	77,351 €	80,494 €
Π_2^*	31,568 €	24,526 €	19,136 €	13,665 €	8,231 €	3,246 €	129 €
$B_{city}/\overline{B}$	2.6 %	8.1 %	15.1 %	25.1 %	39.5 %	60.6 %	91.8 %

We do find in the three scenarios:

$$\begin{cases} X_1^{*\_centralization} < X_1^{*\_mix} < X_1^{*\_decentralization} \\ X_2^{*\_centralization} > X_2^{*\_mix} > X_2^{*\_decentralization} \end{cases}$$

and

$$X_1^{*\_decentralization} + X_2^{*\_decentralization} < X_1^{*\_mix} + X_2^{*\_mix} < X_1^{*\_centralization} + X_2^{*\_centralization}$$

These properties are respected in the robustness checks, even if the levels of X_1^* and X_2^* in the three governance strategies and the three scenarios change.

8.1.6 Discussion

8.1.6.1 Discussion of results

Bareille and Zavalloni (2018) provides some theoretical background for a potential decentralization of the design of agri-environmental policies. They show that a total or partial delegation of decisions to regional governments should improve the total welfare. They find that the benefits of decentralization increase as the heterogeneity of preferences for local PG increases and when the spillovers (the global PG value) decrease. These results are coherent with the "Decentralization Theorem" proposed by Oates (1972), but within a given jurisdiction. A partial decentralization is the optimal strategy if the additional transaction costs do not significantly affect the budget. Our empirical application provides a numerical illustration of the potential gains from AECM budget deconcentration with the case of risk of abandonment of agricultural wetlands. We find that the landscape resulting from either total or partial decentralization always improve the welfare compared to the centralized government. Even if the total of abandoned wetlands increases with decentralization, the managed wetlands are the most valuable ones, i.e. the closest ones to Quimper. It results also to heterogeneous subsidies inside the watershed, the heterogeneity of the payments increasing with the degree of decentralization. Partial decentralization would lead to welfare gains of 5.6% (in case of no additional transaction costs and the first scenario). Without any additional transaction costs, about 25% of the budget should go to the regional government. However, this share decreases quickly as transaction cost rate increases, with for example 8% budget going to the regional government in case of an additional transaction cost rate of 30%. Considered as robustness checks, scenario 2 and 3 confirm these figures. Our empirical results are however subject to some limitations.

First, wetland abandonment is a specific example with a specific feature: the agricultural management of wetlands increases in the same time local and global PG provision. The agro-environmental technology being complex, we can imagine cases where the subsidies would improve provision of one type of PG but decrease the other. Such a context could lead to a competition between the two governments, which is inexistent in our case. Second, our results hold under the assumption that the single source of revenue from wetlands is the subsidy. We use this assumption to parametrize the wetland supply. However, wetlands generate also market revenues for the farmers. Regarding their role of pasture, agricultural wetlands can benefit to farmers depending on milk and feed prices and fixed input dotation. More generally, extensive dairy farms can valorize these lands without any subsidies. As a result, our simulation leads to more contrasted landscapes than the ones that would emerge in reality. Scenarios 2 and 3 modify the cost parameter to model such processes. Third, the results depend on the valuation of the considered PGs. Even if we use the minimal estimated values for the preference parameters, the estimations are subject to their own limits (see FR-1 D4.2. report for a complete discussion). In particular, the spatialization of the local PG values is based on assumptions from distance-decay literature. In addition, as we analyze the properties of the model on an imaginary landscape with arbitrary choice of distances (2 and 5 kilometers), we fix the heterogeneity of local PG values. We did not run any sensitivity analysis on this point, considering that landscape properties were irremovable. The consequence is that we are not able to test some of the results of Bareille and Zavalloni (2018).

As stressed by Bareille and Zavalloni (2018), the main interest of this research is to use the fiscal federalism literature as a way to analyze the decentralization of agro-environmental policies. Two motives to model advantages and disadvantages of respective governments have been considered: the asymmetry of information and the economies of scale to manage public money. The asymmetry of information explains partly why one government is more suitable to implement specific instruments. In our case where local PG value is high, it gives an advantage to the local government. The economies of scale for transaction costs is a common feature in the fiscal federalism literature, which usually give an advantage to the central government (Oates, 1999). However, we have here considered that the transaction costs are not only due to economies of scale, but also to information asymmetry, leading to information costs. Indeed, as interestingly suggested by Crémer et al. (1996), the information asymmetry is not exogenous: the central government can spend resources to fill the information gap between the central and local governments. This is precisely the case of the existing CAP where there exists such coordination costs between agencies (or information searching costs). Economies of scale and coordination costs have been both observed in the literature on the effectiveness of AES (e.g. Falconer et al., 2001; Mettepenningen et al., 2011; Weber, 2015). To our knowledge, no study has estimated the resulting transaction costs when considering both economies of scale and information searching costs.[21] This lack in the literature is a huge drawback to study the effectiveness of decentralization of AES, as already stressed out by Beckmann et al. (2009) and Mettepenningen et al. (2011).

8.1.6.2 Discussion of methodological approach

We did a theoretical approach and derived analytical results in Bareille and Zavalloni (2018). This approach has strengths in the name of the analysis of ex-ante policy changes and the transparency of the results. Indeed, econometric approach is impossible when dealing with decentralization as the centralization is the rule in Europe. Formal assumptions allow examining such processes. The transparency of the assumptions allow discussing the results but, any change in the assumptions is easily manageable by the modeller. The modeller can easily interpret the change of the results.

Obviously, the approach has the limits of its strengths: the results are only valid in the case of the theoretical world. Any forgotten mechanisms compared to the reality may lead to invalid results. In our case for example, we have considered that the two farmers face the same

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[21] Our sensitivity analysis on the transaction cost rate illustrates this lack of information.

supply function. Indeed, our results in the FR-1 D4.2. report indicated that population density increases abandonment of wetlands, i.e. that farmers located close to cities face higher costs, a result which is commonly admitted in the literature. The good point is that the results from Bareille and Zavalloni (2018) can be easily modify to integrate the difference of cost parameters. To integrate that the farmer located closer to the main city faces higher costs than the farther one would only move the equilibrium towards a more homogenous landscape. Eventually, if the relative difference of cost parameter between the two farmers is higher than the relative distance, X_2^* could be prefered to X_1^*, even in the case of decentralization. This feature could be established anatycally. Finally, we have to recall that, if we know that the homogenous cost for farmers is an assumption, there are several unknown/unobserved mechanisms/heterogeneity that cannot be captured inside a theoretical framework. However, as decentralization of agro-environmental policy has not been applied, we cannot control for such features using an econometric approach. One solution to control for heterogeneity could be to use experimental approaches.

8.1.6.3 Discussion of the participative elements in the modelling approach

To better learn about "participatory" research approaches, please identify specifically the strengths/weaknesses/limitations of the participative parts of your modelling approach and – in case you faced any difficulties, please let us know how you dealt with them and/or make suggestions on how to overcome these in future research.

Local stakeholders were interested in the introduction of a Payment for Environmental Services (PES) scheme, with payers being private companies. Here, we have rather model the decentralization of the European agri-environmental budget. Indeed, the modelling of PES in case of private payer is rather simple (Engel et al., 2008), the PES success depending mainly on the willingness-to-pay of private companies.

The choice of stakeholders to focus on private funds is due to the existing AEM mechanisms (i.e. homogenous subsidies, payments based on opportunity costs). However, the European Commission is currently thinking on new possibilities to improve AEM effectiveness, one of them being decentralization of AEM budget. Indeed, the European Commission published the communication COM(2017) 713 "The future of Food and farming" in November 2017. Discussing the future reform of the CAP, the European Commission claims that, concerning environmental goal, "Member States will need to define quantified targets which will ensure that the agreed environmental and climate objectives defined at EU level are achieved. Member States will have the flexibility to formulate strategic plans allowing for addressing climate and environmental needs at local level.”. So, we can imagine that local authorities will have more freedom to capture the high heterogeneity of agricultural and environmental contexts, and notably to consider in a better way the potential spatial mismatch between supply and demand for local PGs produced by agriculture. We do think that such decentralization gives higher opportunity for stakeholder to introduce a PES mechanism, however, in our case, the payers are public authorities, not private companies. However, the ambition to introduce private companies do not change the modelled mechanisms, the only difference being the budget changing.

Here, we have considered a fixed and exogenous budget. We agree that an endogenous budget could be more interesting for stakeholders. However, in our case, there is no reason to observe a competition between local and central governments. Indeed, all the states/regions contribute to the European budget proportionally to their wealth and development levels. The European budget is then split between the European objectives, including CAP and the agri-environmental budget. This decision being taken at the European level, the region has no impact on this budget. The regions have then very limited possibilities to subsidies farmers to incite them to produce PGs. Indeed, as stated by article 107 (paragraph 1) of the Treaty on the Functioning of the European Union, agricultural subsidies (including agro-environmental subsidies) from local or state governments are not possible due to concurrence distortion concern. The specificities of the CAP hinder regions to raise their own taxes, preventing from such competition between regions or between each region and the central government. Here, we have studied the effectiveness of deconcentration of the agro-environmental budget, considering that the first money transfer from regions to EU still exists. Future works could introduce such local taxes. If such local expenses are not currently possible under public agencies, it could feat to public-private companies (like water purification factory or collective catering) in the framework of Payment for Environmental Services. The tarification of water purification factory is an interesting point for stakeholders, consdering the important contribution of agricultural wetlands for water purification. Collective catering is already a current and building strategy in Rennes. Local stakeholders are trying to give a premium to farmers on the watershed provising the water for Rennes through an increase of meal tickets in all the collective restaurants of Rennes.

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8.2 ES-1: Biodiversity in the Andalusian mountain olive groves in Spain

8.2.1 Introduction

8.2.1.1 Description of case study region

The Spanish case study region analysed within the PROVIDE project is Autonomous Community of Andalusia, located in southern Spain.

Andalusia has a population of 8.4 million of inhabitants and 87,268 km^2 of area. The GDP per capita is €16,884/year. The agriculture and forestry sector accounts for 4.7% of GDP and 7.4% of workforce in the region (period 2008-2013).

The region has a heterogeneous geography with four main parts (see map attached), namely: i) the Guadalquivir Valley, ii) northern low mountain range of Sierra Morena (where mountains below 1,000 masl), iii) southern-eastern big mountain range of Sierras Béticas (with some few peaks over 3,000 masl in some parts), and iv) southern and eastern semi-tropical coastal areas. With regards to the regional land use, according to the Yearly Handbook of Agricultural Statistics 2012, the land is distributed as follows: 44% agricultural land, 16% grasslands, 32% forest, natural and semi-natural land, 5% urban areas, and 3% other areas. Olive groves are the main crop, representing 40% of agricultural land (around 15,000 km^2 – one third of which is irrigated). Also of importance are herbaceous crops (9,000 km^2 rainfed and 4,000 km^2 irrigated), other permanent crops (mainly citrus, almond trees, vineyards, etc. totalling 3,000 km^2) and coastal intensive irrigated crops (1,000 km^2). Within forest land, the system is the agroforestry system "dehesa", with around 12,000 km^2.

There are 242,016 farms and they have an average size of 21.1 hectares (14.7 hectares if only utilized agricultural area is considered). However, a large part of the farms is small (around 60% have less than 5 hectares indeed).

Within this case study region there are several hotspots of agricultural and forestry systems (AFS) worth to be empirical analysed because relevant issues regarding the provision of public goods and bads. However, based on stakeholders participating in PROVIDE workshops, the most interesting case study is the mountain olive groves, mostly located in central, northern and north-eastern parts of the region (in the mountainous ranges of Sª Morena and Sierras Béticas, especially). According to the participants, most important public goods provided by this agricultural system is biodiversity, although fighting climate change and soil conservation are also relevant.

8.2.1.2 Description of public good issue

Olive groves represent the main AFS in Andalusia, covering 1.52 million hectares. It is a key generator of income and employment in the rural areas where it is located. The vast area of olive groves in Andalusia encompasses a heterogeneous sector, within which a wide range of different systems can be identified, including the so-called "mountain olive groves" (MOG). This type of olive groves is typically located on steep slopes in poor, shallow soils, resulting in low yields. This, along with the high production costs due to the difficulties of mechanisation, makes it an agricultural system with low economic profitability and at high risk of abandonment of agricultural activity.

For the purposes of this research, the MOG is characterised as one growing under rainfed conditions in areas with slopes of 15% or more, and average olive yields equal to or less than 2,500 kg/ha. Thus defined, MOG cover 211,000 hectares in Andalusia, representing about 14% of the total area of olive groves in the region.

The low profitability of the activity and the difficulties in employing mechanised farming methods in this type of olive grove make it an extensive, "high nature value" farming system (Paracchini *et al.*, 2008). Indeed, the low intensity work and limited use of agrochemicals, together with the maintenance of long-standing plantations and traditional elements such as walls, hedges, riverbank vegetation, etc. have enabled this system to continue providing environmental public goods, especially those related to biodiversity (Stroosnijder *et al.*, 2008). In any case, the provision of the biodiversity public good by this agricultural system is under threat due to both the intensification processes aimed at improving productivity and profitability, and the abandonment of agricultural activity on those lands (Rocamora-Montiel *et al.*, 2014). This reveals the possible existence of a market failure, insofar as the level of biodiversity production is suboptimal from a public perspective, given the growing social demand for it (Rodríguez-Entrena *et al.*, 2014). In such a case, public intervention would be justified in order to encourage the use of agricultural practices that improve the provision of this public good.

8.2.1.3 Description of governance-strategy

One of the most notable policy instruments that can be used to ensure the adequate provision of public goods by agriculture is agri-environmental measures (OECD, 2010; Hart et al., 2011). These measures comprise a system of voluntary incentives for farmers wherein they sign multi-year contracts with the public administration; under the terms of these contracts, farmers commit to employing a set of specific agricultural practices aimed at improving (or maintaining) the level of provision of environmental public goods, in exchange for an annual payment per unit area that compensates for lost profits, additional costs and transaction costs incurred due to the implementation of these practices (Uthes y Matzdorf, 2013). A typical example of such measures is the agri-environmental schemes (AES) included in the second pillar of the Common Agricultural Policy (CAP).

Stakeholders participating in the 3rd Local Stakeholders Workshop held in May 2017 agreed AES is the most suitable governance strategy aiming at a smart provision of biodiversity in the agricultural system analysed (MOG). Main advantages given by stakeholders were that this policy instrument ensures an improved provision of public goods (especially biodiversity) with relative lower transaction costs and non-desired issues (such as moral hazard and adverse selection). For this reason, once the public intervention is justified, it is reasonable to propose the implementation of a new AES that encourages the use of agricultural practices that improve the provision of this public good (Villanueva *et al.*, 2017b; Villanueva *et al.*, 2015).

Numerous studies have demonstrated the high potential of olive grove systems to improve their biodiversity supply (see, for example, Rocamora-Montiel *et al.*, 2014; Villanueva *et al.*, 2014; Carmona-Torres *et al.*, 2016). These studies have identified soil management practices and phytosanitary treatments amongst the most important elements for olive growers to improve, from an agri-environmental perspective. As such, an AES aimed at improving the biodiversity of the MOG should be designed to promote the use of cover crops and the correct choice and dosage of biocidal products[22].

[22] Land abandonment could be another option worth to be analysed for the case study under analysis. However, this option has not been considered for three main reasons: i) to promote land abandonment is not in the policy agenda since a decrease in the provision of the social public goods such as “rural vitality” or “landscape” would result from only looking at the best combinations of agricultural production with environmental conservation (i.e.

Along those lines, a possible AES might consist of five-year contracts through which olive growers would commit to employing, in exchange for an annual per-hectare payment, a set of practices to improve the provision of biodiversity. These agri-environmental commitments could be set out in the corresponding contracts establishing certain levels of stringency for the three following variables: cover crop area (CCA), cover crop management (CCM) and insecticide treatment (INT). The levels of these three variables are set in an attempt to include a variety of practices associated with different levels of provision of the biodiversity public good, from the minimum level required by cross-compliance, to the most demanding level. In practical terms, five alternative designs or scenarios for AES application have been proposed, with increasingly stringent requirements, as shown in Table 1 (further details can be consulted in Villanueva *et al.*, 2017a).

Table 1. Level of biodiversity provision by mountain olive groves (MOG) for the AES scenarios considered

AES scenario	Level of stringency	Bird species/farm (no.)	Increase in bird species/farm (no.)
Minimum level required (cross-compliance)	CCA:10% of the MOG area under cover crops CCM: free management TIN: free treatment	7.8	0.0
Integrated production	CCA: 30% of the MOG area under cover crops CCM: restricts the use of herbicides (they can be used in two of the five years) and tillage (only shallow tillage is allowed) TIN: limited treatment (dimethoate and copper oxychloride are not allowed)	13.0	5.2
Integrated production plus	CCA: 50% of the MOG area under cover crops CCM: management using only mower or animal grazing TIN: limited treatment (dimethoate and copper oxychloride are not allowed)	17.6	9.8
Ecological production	CCA: 50% of the MOG area under cover crops CCM: management using only mower or animal grazing TIN: only treatments used in organic production	19.8	12.0
Ecological production plus	CCA: 100% of the MOG area under cover crops CCM: management using only mower or animal grazing TIN: only treatments used in organic production	23.6	15.8
Provision of environmental public goods	CCA: 100% of the MOG area under cover crops CCM: non-management, except mowing or grazing the cover crops early in the summer to reduce fire risk TIN: non-treatment (use of any biocidal product is prohibited)	30.0	22.2

biodiversity); ii) previous studies suggest that most of the olive growers reject the idea of abandoning their farms, raising doubts about the extent to which land abandonment would be a cost-efficient alternative compared with environmental-friendly production alternatives; and iii) there is lack of information on the impact of land abandonment on biodiversity and the scarce studies that deals with it do not agree about to what extent abandonment results in an increase of this public good, especially when compared to low-input farming such as organic.

Once the different AES designs had been established, secondary information sourced from scientific publications was used to quantify the biodiversity provided by MOG for each of the AES scenarios considered. Since bird richness represents one of the most suitable indicators to quantify biodiversity (EEA, 2010), we use the number of bird species per 10 hectares of MOG to quantify it. However, as the most common size of MOG farm is around 10 hectares, this indicator has been also considered as bird species per farm (see Villanueva *et al.*, 2017a, for a more comprehensive explanation). Table 1 summarises the levels of provision set in each case.

8.2.2 Methodological approach

8.2.2.1 Theoretical background

<u>AES design using principal-agent modelling</u>

The effective design of AES aimed at improving the production of public goods poses a real challenge for policymakers, given the major information gaps regarding the costs and benefits of implementing these instruments and their voluntary nature (Westhoek *et al.*, 2013). Indeed, the contractual mechanism on which AES are based has displayed problems of information asymmetry, which significantly reduce the efficiency of these measures (Blandford, 2007). Thus, a common issue for designing and implementing these types of schemes is the lack of information that would allow to distinguish between potential beneficiaries of these contracts on the basis of actual compliance costs. This gives rise to the problem known as *adverse selection* (or 'hidden information'), allowing producers to sign contracts that overcompensate the costs of compliance incurred. On the other hand, these measures also face difficulties in terms of monitoring farmers' level of compliance with the contracts they signed, since it is not feasible to audit the individual compliance of all the beneficiaries (perfect monitoring). This gives rise to what is known as the *moral hazard* problem (or 'hidden actions'), which means that some of the famers that benefit from these measures decide not to comply with the programme obligations.

Both problems have been extensively analysed in the literature, especially through the use of principal-agent models (PAM) (Laffont y Martimort, 2009), where the administration managing the measures is considered the "principal", characterised as having incomplete information on the real costs incurred by farmers, who act as "agents". The papers that have analysed the problems of adverse selection with relation to AES include Moxey *et al.* (1999), Viaggi *et al.* (2009) and Quillérou y Fraser (2010). In addition, the problem of moral hazard in the implementation of these measures has been analysed in Choe y Fraser (1999), Hart y Latacz-Lohmann (2005), Ozanne y White (2008), Bartolini *et al.* (2012) and Fraser (2013). It is also worth highlighting the studies that jointly consider the two problems, such as Melkonyan y Taylor (2013) and White y Hanley (2016). Interested readers can also consult Fraser (2015), where a comprehensive collection of papers in this field is compiled.

All the abovementioned studies have attempted to analyse the available tools that the administration can use to minimise these two problems, and thus increase the efficiency of the measures. In any case, almost all studies to date analyse these issues from an essentially theoretical perspective, using applications based on parameters whose values are assumed for explorative numerical analyses. In this respect, the main novelty of this study is that it takes an applied approach to provide practical, realistic support for the design and implementation of a new AES. More specifically, the objective of the research is to support policy decision-making for an effective design and implementation of a new scheme aimed at improving biodiversity in Andalusian mountain olive groves, a system that has enormous potential for improvement in the provision of this public good. To that end, we propose to build and exploit a PAM that can, taking into account the existing information asymmetry (moral hazard or hidden actions), determine the optimal values for the design variables of the proposed AES. This model is fed with the results obtained through two valuation exercises relating to the biodiversity provided by this agricultural system: one on supply (the costs of provision incurred by the olive growers) and the other on demand (the welfare gains due to improvements in the provision), both of them using choice experiments.

<u>Farmer decision-making model</u>

Farmers' decision-making in relation to AES can be assumed to take place in two successive stages (Ozanne *et al.*, 2001). The first is where the farmer decides whether or not to take part in the scheme by signing the corresponding contract. It is during this first stage that the problem of adverse selection can arise. If the farmer does decide to take part, the second decision regards the extent to which he will comply with the contract, that is, the degree of compliance with the conditions stipulated by the scheme. This is where moral hazard problems can appear.

Assuming profit-maximising behaviour, farmer *i* makes the first of the two decisions discussed above by comparing the amount of the agri-environmental payment (p, quantified in euros/hectare/year) with the cost ($\psi_i(E)$, also quantified in euros/hectare/year) that would be incurred for increasing the provision of the biodiversity public good to the level stipulated in the contract (E represents this increase and is expressed as the number of bird species per farm). Thus, for the farmer to take part in the scheme, the so-called rationality or participation constraint must be satisfied:

$$p - \psi_i(E) \geq 0 \qquad (1)$$

If this constraint is satisfied and the farmer decides to sign the corresponding agri-environmental contract, he is placed in a situation of moral hazard, where he has to decide on the degree of compliance with the requirements to which he has committed himself on signing the contract. This variable, which we denote c_i, expresses contractual compliance, ranging from 0 (indicating total breach of the contract) to 1 (indicating perfect compliance). In our case study, the level of compliance is quantified as representing the increase in the effective provision of biodiversity by the farmer *i* compared to the required increase in the provision (E) in order to reach the level stipulated in the contract. Thus, the effective improvement in the level of provision of the public good for each farm *i* can be defined as $e_i = c_i E$, which is also quantified by the number of bird species per farm.

Bearing in mind the existing information asymmetry, the farmer (acting as an 'agent') assesses the effects of his potential non-compliance, taking into account the probability that the public administration responsible for the implementation of the scheme (acting as the 'principal') will detect the breach of contract and that he will be sanctioned for it. This probability depends on the intensity of the monitoring carried out by the administration and on the farmer's degree of compliance (Bartolini *et al.*, 2012):

Probability that the principal detects non-compliance: $m\,\theta(c_i)$ (2)

Probability that the principal does not detect non-compliance: $1 - [m\,\theta(c_i)]$ (3)

where m is a continuous variable [0,1] that measures the percentage level of monitoring of the scheme (number of inspections over the total number of farms), and $\theta(c_i)$ is a function of the probability of detecting non-compliance with the scheme, which depends on c_i.

From the above, it can be assumed that the farmer tries to maximise the profit associated with the AES (Bartolini *et al.*, 2012), quantifying it as a weighted sum of the profit when the principal does not detect possible non-compliance (payment less the cost of effective provision of the public good) and the profit when this non-compliance is detected (payment less the sanction for non-compliance and less the cost of effective provision of the public good):

$$\max_{c_i} \pi_i = \Big[\big[1-\big(m\,\theta(c_i)\big)\big]\big[p-\psi_i(c_iE)\big]\Big] + \Big[\big[m\,\theta(c_i)\big]\big[p\big(1-\rho(c_i)\big)-\psi_i(c_iE)\big]\Big] \quad (4)$$

where $\rho(c_i)$ is a continuous dimensionless variable that quantifies the sanction for non-compliance as a percentage of the agri-environmental payment.

Operating and rearranging, expression (4) can be simplified as follows:

$$\max_{c_i} \pi_i = p - \psi_i(c_iE) - p\,m\,\theta(c_i)\,\rho(c_i) \quad (5)$$

The solution to the optimisation problem (6) can be obtained through the corresponding first-order condition:

$$\frac{\partial \pi_i}{\partial c_i} = -\frac{\partial \psi_i(c_iE)}{\partial c_i}E - p\,m\left[\frac{\partial \theta(c_i)}{\partial c_i}\rho(c_i) + \theta(c_i)\frac{\partial \rho(c_i)}{\partial c_i}\right] = 0 \quad (6)$$

It is evident that in this optimisation problem, the parameters m, p, and E are exogenous to the farmer, as is the function $\rho(c_i)$, since the farmer has no control over them. However, they are decision variables for the public administration, as will be analysed below.

<u>Public administration decision-making model</u>

Taking into account the behaviour of the farmers, the decision problem for the administration is to design the policy instrument under analysis (AES) so that its real-world implementation contributes to maximising social welfare. As outlined above, the decision variables that the administration can initially consider as a means of achieving this goal are E, p, m and $\rho(c_i)$.

This study considers a different AES application for diverse groups of farmers with similar compliance costs, thus considering differences in the variables E_i, p_i and m_i for each group or class *i*. This is justified by the fact that a differentiated application (a range of different contracts) can provide better results from a public perspective.

With the decision variables for the administration responsible for designing the scheme thus established, the principal's decision problem centres on maximising the social welfare function subject to a series of constraints marked by the strategic behaviour of the farmers. This optimisation problem can be expressed algebraically as follows:

$$\max_{\gamma_i, E_i, p_i, m_i} Z = \sum_i \gamma_i w_i \begin{bmatrix} v(c_i E_i) + \left(p_i - \psi_i(c_i E_i)\right) - p_i\,\lambda \\ + p_i\,m_i\,\theta(c_i)\,\rho(c_i)\,(\lambda - 1) - M(m_i)\,\lambda \end{bmatrix} \tag{7.1}$$

s.a. $$p_i - \gamma_i \psi_i(E_i) \geq 0 \qquad \forall i \tag{7.2}$$

$$\gamma_i \left[\frac{\partial \psi_i(c_i E_i)}{\partial c_i} E_i + p_i\,m_i \left(\frac{\partial \theta(c_i)}{\partial c_i} \rho(c_i) + \theta(c_i) \frac{\partial \rho(c_i)}{\partial c_i}\right)\right] = 0 \qquad \forall i \tag{7.3}$$

The social welfare function (7.1) can be decomposed into five components. The first term ($v(c_i E_i)$) corresponds to the benefit to society resulting from the improvement in the effective provision of the biodiversity as a consequence of the implementation of the scheme (the increase in the provision from the current level to $e_i = c_i E_i$).

The second term of the social welfare function refers to farmers' net profit resulting from participation in the scheme, considering the agri-environmental payments received ($p_i - \psi_i(c_i E_i)$). In any case, it should be noted that the budgetary resources needed to implement public spending policies (such as the AES) must first be collected through the tax system, and this inevitably causes distortions that reduce economic efficiency (Auerbach y Hines, 2002). The distortions introduced by the tax system can be quantified through what is termed the marginal cost of public funds (MCF, λ), a synthetic measure intended to reflect the shadow price that society pays for each euro invested in any public spending policies (Dahlby, 2008)[23]. Thus, the third component of the social welfare function ($p_i\,\lambda$) represents the social cost of the budget allocation spent on the proposed AES, taking into account the inefficiency introduced by the tax system.

[23] The total amount paid as agri-environmental payments must be collected previously by public sector through the tax system. In this sense, collecting 100 monetary units by taxes involves an additional amount of money, say X monetary units, because of tax distortion caused on the whole economic system. Accordingly, the marginal cost of public fund can be roughly represented as the ratio (100+X)/100.

The fourth term of expression (7.1) accounts for the welfare gain derived from the imposition of sanctions for non-compliance, considering both the budgetary savings ($p_i\ m_i\ \theta(c_i)\ \rho(c_i)\ \lambda$) and the farmers' income lost ($p_i\ m_i\ \theta(c_i)\ \rho(c_i)$) as a result of these sanctions.

The last term of the objective function refers to the cost of monitoring the scheme ($M(m_i)$), which must also be multiplied by λ (MCF) because, since it is financed through the public budget, it also generates an additional cost due to the inefficiency of the tax system.

The social welfare function (7.1) is expressed as a weighted sum of the different farm types participating in the proposed AES. In this respect, γ_i is a binary variable that, depending on whether or not the participation constraint represented by expression (1) is satisfied, takes the value γ_i=1 when farm type *i* participates in the scheme, and the value γ_i=0 when that farm type does not participate. In addition, w_i represents the percentage of the area of farm type *i* over the total area eligible to participate in the scheme.

Lastly, it should be noted that the public administration's decision problem consists in maximising the social welfare function described above, subject to two constraints. The first (expression (7.2)) refers to the participation constraint derived from expression (1). The second (expression (7.3)) refers to the optimality condition of the farmers' decisions according to their level of compliance, derived from expression (6).

8.2.2.2 Model implementation

<u>The cost of provision of biodiversity between MOG farmers</u>

In order to account for the heterogeneity of farmers in the optimal design of the AES, it is appropriate to attempt to group the population of target farmers into a small number of representative classes or groups. Bearing in mind the purpose of this analysis, it is evident that farmers should be classified according to the cost of providing biodiversity, $\psi_i(c_i E)$. The data used for this purpose had recently been collected for a valuation exercise concerning the provision of public goods by Andalusian MOG farmers, as part of the PROVIDE, in which 261 farmers were surveyed (Villanueva *et al.*, 2017c). This valuation exercise used choice experiment techniques, with the attributes and levels of stringency described in Table 2. It was thus possible to determine willingness to accept (WTA) for signing agri-environmental contracts set out as alternative AES scenarios, quantified in euros/hectare/year. It is reasonable to assume that these WTA values are equivalent to the costs of providing the increased level of biodiversity corresponding to each type of proposed contract.

To group farmers according to the costs they incur for providing biodiversity (i.e. WTA), the latent class model (LCM) was used as econometric specification (see Annex 4 of Villanueva *et al.*, 2017c, where the LCM specification used is shown). This model accounts for discrete parameter distribution, assuming that there are certain latent classes of individuals that share similar patterns of preferences (Hess *et al.*, 2011). For a detailed description of LCM, the reader is referred to the Hess y Daly (2014) handbook.

The results of this valuation exercise (Villanueva *et al.*, 2017c) reveal the existence of two classes of mountain olive farmers, clearly differentiated according to their costs of provision with one class (Class 1) showing lower WTA for signing the proposed AES contracts (and therefore relatively low biodiversity provision costs), and the other class (Class 2) showing higher WTA (thus higher costs of provision of this public good). Class 1 represents 59.5% of the mountain olive farmers under study (w_1=0.595), while Class 2 covers the rest (w_2=0.405). Among the factors explaining this difference in their costs of provision, yields (i.e. opportunity costs consisting of income foregone if the AES requirements are fulfilled) especially stand out.

The results of the LCM enabled the calculation, for each class, of the WTAs for signing the different contracts (also interpreted as the costs of biodiversity provision) for the proposed AES, as shown in Table 2.

Table 2. Costs of biodiversity provision for each class of mountain olive farmers according to the AES scenarios considered

AES scenario	Increase in bird species/farm. (no.)	Class 1 WTA or $\psi_1(e_1)$ (€/ha/year)	Class 2 WTA or $\psi_2(e_2)$ (€/ha/year)
Minimum level required (cross-compliance)	0.0	0.0	0.0
Integrated production	5.2	24.0	229.4
Integrated production plus	9.8	50.2	470.0
Ecological production	12.0	69.8	721.6
Ecological production plus	15.8	160.7	1,113.7
Provision of environmental public goods	22.2	273.0	1,756.0

From the point estimates for the different AES alternatives, regressions were run to fit these points to quadratic functions, which represent the biodiversity provision curves in each class. As can be seen in Figure 1, the goodness of fit is satisfactory (R^2=0.988 for Class 1 and R^2=0.996 for Classes 1 and 2). Thus, the functions $\psi_1(e_1)$ and $\psi_2(e_2)$ to be used in the proposed PAM are as follows:

$$\psi_1(e_1 = c_1 E_1) = 0.5425\ e_1^2 + 0.4480\ e_1 \quad (8.1)$$

$$\psi_2(e_2 = c_2 E_2) = 2.0809\ e_2^2 + 33.8916\ e_2 \quad (8.2)$$

Finally, it is worth remarking that the administration managing the AES proposed has information about farmers' provision costs, since it knows the yields they obtain. Thus, the empirical application developed in the paper assumes that the regulator can detect the class of any farm willing to take part of the scheme. This makes that the PAM framework proposed is only focused on the problem of moral hazard.

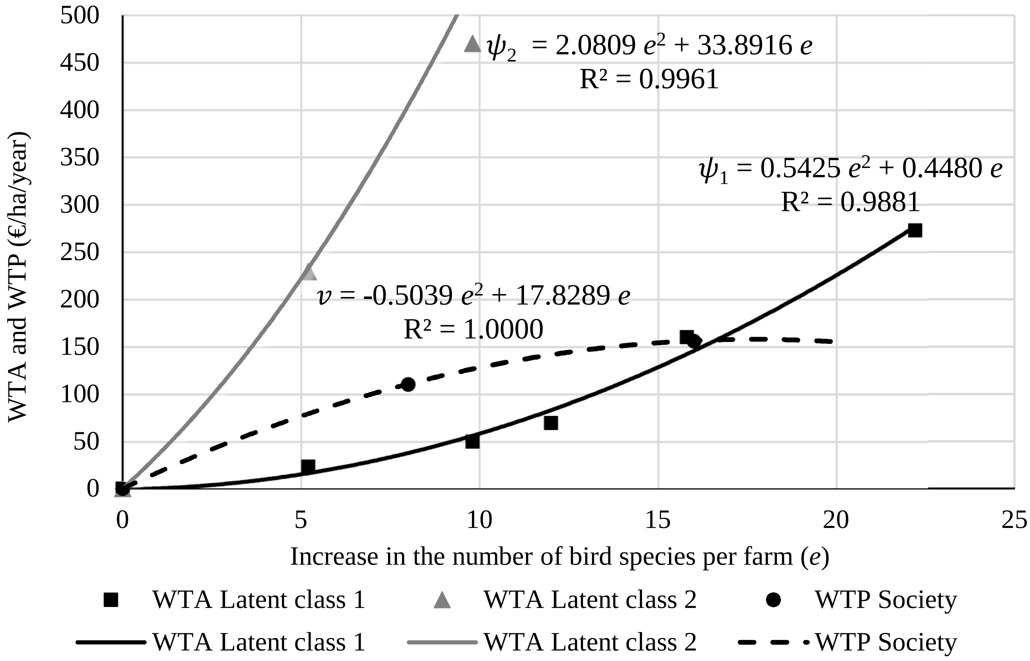

Figure 1. Cost of provision of ($\psi_i(e)$) and social benefit ($v(e)$) (WTA and WTP, respectively) associated with biodiversity in MOG

<u>The social benefit from the improvement in the provision of biodiversity</u>

The functional form $v(e_i)$ was also obtained from the results of a valuation exercise carried out as part of the PROVIDE project (Villanueva *et al.*, 2017c), the objective of which was to assess the Andalusian society's demand for public goods supplied by MOG. This valuation was carried out using choice experiments, by means of a random parameter logit (RPL) model fed with the choices of a representative sample of 504 residents of the region.

The valuation of the demand for public goods carried out determined the individual willingness to pay (WTP) for the improvement in the overall biodiversity in Andalusian MOG, measured for two separate levels: a) a "moderate" improvement, which means increasing the biodiversity to 22 bird species per farm; and b) a "significant" improvement, equivalent to raising biodiversity levels to 30 bird species per farm. This value is considered an appropriate estimate of the increase in social welfare associated with this improvement. Moreover, it is assumed that the increase in number of bird species is valued despite the farm type (class) providing this public good; this is, $v_1(e_1) = v_2(e_2) = v(e_i)$.

These WTPs were quantified in euros/individual/year, as shown in the third column of Table 3. However, the units of measurement of the social benefit from the improvement in biodiversity need to be adapted to the proposed modelling exercise, in which WTP values are expressed in euros/hectare/year. To do so, the WTP values initially obtained from the valuation exercise should be multiplied by the number of individuals comprising the total population (6.72 million of Andalusians over the age of 18) and divided by the total area of the analysed agricultural system (211,000 hectares)[24]; the results can be seen in the last column of Table 3.

Table 3. Willingness to pay (WTP) for the improvement in biodiversity provision by MOG

AES Scenario	Increase bird species/farm (no.)	WTP (€/individual/year)	$v(e)$ (€/ha/year)
Reference level	0.0	0.00	0.00
Moderate improvement	8.0	3.46	110.38
Substantial improvement	16.0	4.90	156.26

Taking the WTP measured in euros per hectare per year, it was possible to estimate the functional form of v by running the corresponding quadratic function regression, as shown in Figure 1. Thus, the function of the social benefit to be used in the optimisation model is as follows:

$$v(e) = -0.5039\, e^2 + 17.8289\, e \tag{9}$$

[24] This implicitly assumes that improvements in the number of bird species are evenly distributed among all MOG farms. An analysis explicitly accounting for spatial heterogeneity of improvements and benefits is beyond the scope of this study, but it is worth suggesting this for further research.

Other parameters of the model

Regarding the function of the probability of detecting non-compliance with the scheme $\theta(c_i)$ (), a panel of technicians from the administration and agricultural organisations with experience in AES inspections was consulted. They generally agreed that a realistic functional form would be a sigmoid type (see black line in Figure 2), instead of linear function used in most previous applications (see grey line in Figure 2). To determine the specific form of this function, panel members were asked to provide subjective probabilities of $\theta(c_i)$ for different levels of compliance. Thus, from the pairs of values $[\theta(c_i),\ c_i]$, the functional form has been determined that best fits the cloud of points obtained. This function is the Boltzmann sigmoid function, defined as follows:

$$\theta(c_i) = \frac{A_1 - A_2}{1 + e^{(c_i - c)/\alpha}} + A_2 = 1 - \frac{1}{1 + e^{\frac{0.7 - c_i}{0.05}}} \tag{10}$$

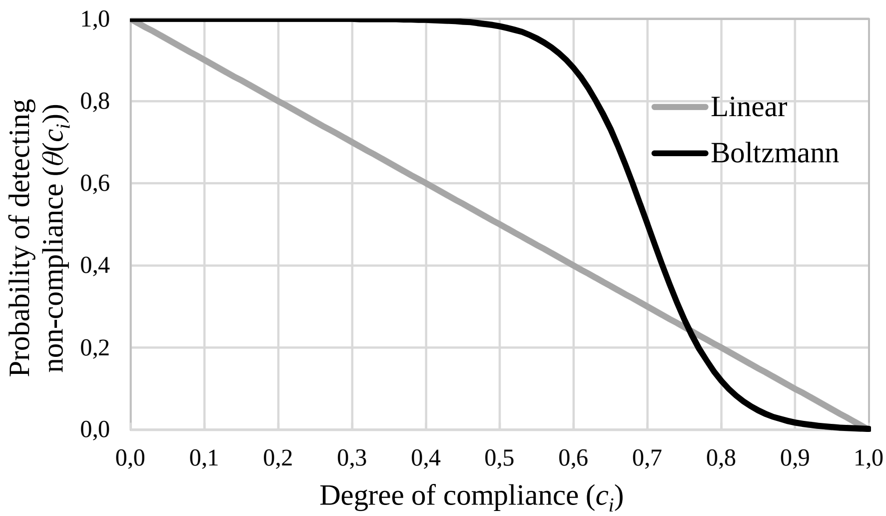

Figure 2. Functional form of the probability of detecting non-compliance ($\boldsymbol{\theta(c_i)}$)

The most reliable estimation of the MCF (λ) is the one provided by Kleven y Kreiner (2006), who calculated the MCF for a proportional tax rate increase (an equal marginal tax rate increase in all tax brackets) in several OECD countries. The computed MCF ranged from 1.29 in Denmark to 1.10 in the United Kingdom considering reasonable assumptions regarding labour supply elasticities (Dahlby, 2008, p.129). Given the divergence in these estimates, it was decided to solve the principal's decision problem by considering an intermediate λ equals to 1.2.

Under European legislation, Member States can impose sanctions based on a variable reduction in the amount of the payment received. This means that $\rho(c_i)$ can take differential values, but always within the interval [0, 1]. For this reason, it can be reasonably assumed that sanctions follow a linear function dependent on the degree of compliance:

$$\rho(c_i) = 1 - c_i \tag{11}$$

Regarding the function of monitoring costs, it is worth noting the overall lack of specific information on this (Mettepenningen *et al.*, 2011). Given this lack of information, it is impossible to estimate the functional form of such costs. As a result, a linear monitoring cost is assumed, as shown in the following expression:

$$M(m_i) = m_i k \tag{12}$$

where *k* is the cost of monitoring per hectare subject to control.

The value of *k* was estimated based on the information provided by the Andalusian public agency that carries out these inspections. According to the data provided, in 2015, 1,006 of the 12,867 AES files in Andalusia were checked (representing 7.8% of the total, notably higher than the 5% minimum required by EU legislation). To carry out these inspections, 36 technicians had to be hired for a total of 22,278 working days, representing an average of 22.15 working days per file. As a result, the approximate cost per file is estimated at 2,800 euros. Taking into account the fact that the average file for these schemes in Andalusia covers 26 hectares, the cost per monitored hectare is 108 euros (*k* = 108 euros/ha).

<u>Base scenario and sensitivity analysis</u>

The PAM approach proposed for guiding optimal AES design, first, is fed with the most reliable parameter value estimations as explained above, representing the “Base scenario”. However, most of these estimations are subject to some degree of uncertainty. To cope with this concern, a sensitivity analysis is proposed to identify which parameter estimations could critically impact model results (optimal AES design). For this purpose, this analysis is focused on the following four key parameters (those subject to higher uncertainty estimation):

a) cost of provision of biodiversity, $\psi_i(e_i)$;
b) social benefit from the improvement in the provision of biodiversity, $v(e_i)$;
c) marginal cost of public funds, λ;
d) monitoring costs, k.

Thus, once the results for *Base scenario* are obtained, the PAM approach built has been run further times, considering +10% and –10% changes (*ceteris paribus*) in the value estimations of each key parameter. The results obtained following this procedure will allow an enriching discussion on which parameters need to be more accurately estimated.

8.2.3 Scenarios

For the evaluation of the performance of the governance mechanisms proposed (AES) the three PROVIDE future scenarios have been considered for empirical analysis:

a) Business as usual scenario.
b) Sustainability driven scenario.
c) Market driven scenario.

These scenarios have been locally adapted through the narratives included in Table 4.

Table 4. Description of the locally adapted scenarios

	Business as usual scenario	Sustainability driven scenario	Market driven scenario
Overall narrative	• Climate change: two degrees increase. • Moderate world population increase. • Given consumption patterns/low willingness to pay for public goods. • Moderate prices of natural resources, in particular oil. • High market price volatility. • Technical progress without fundamental breakthroughs.	• Climate change: less than two degrees increase. • Low world population increase • Significant willingness to pay for public goods. • High prices of natural resources, clearly reflecting scarcity. • Moderate market price volatility. • Significant, clearly environmental oriented technical progress.	• Climate change: significantly higher than two degrees increase. • Strong world population increase. • No willingness to pay for public goods. • Low prices of natural resources, not reflecting scarcity. • Extreme market price volatility. • Extra ordinate, clearly market-oriented technical progress.
Local-specific main effects	• Lower profitability of agricultural production because low productivity and increasing costs. • Farm abandonment. Only those part-time olive growers with other jobs remain in the business as a secondary source of income. • Extensive agricultural production, but only a few growers with eco-friendly certifications. • Fires as a new environmental problem because of farm abandonment. Soil erosion remains as a relevant issue. • Social problems in surrounding rural areas: Depopulation and ageing issues. • Similar market conditions: Most of the olive oil production sold uniformly by large market agents without any product strategy focused on differentiating mountain or eco-friendly production. Thus, prices remain as current ones.	• Profitability of agricultural production remains low: Increased production costs are hardly compensated with higher prices of olive oil. • Agricultural production became greener: More ecological olive growing and producers implementing more environmental-friendly practices. • Mountain olive growing as High Natural Value farming system: Enhanced biodiversity and soil erosion reduced. • Rural development because other non-agricultural activities developed in the surrounding areas related with rural agritourism. • New rural dwellers: Younger population with more diverse and qualified economic activities. • Increase in the demand of local, ecological and land-related olive oil: Lower competition and higher prices.	• Less profitable agricultural production because a decrease in yields (lower rainfall and higher evapotranspiration). • More extreme events as droughts, frosts, hail, fires and floods also reducing agricultural yields. • Agricultural intensification (more dense groves, new varieties, irrigation, etc.) as main strategy to cope with lower incomes. • Where intensification is technically infeasible or not profitable, farm abandonment. • Environmental problems increased: More soil erosion and more biodiversity losses. • Social problems in surrounding rural area: Depopulation and ageing issues. • Uniformed demand for olive oil worldwide and high market competition: Moderate increase in demand but with lower market prices.

Table 4. Description of the locally adapted scenarios (cont.)

	Business as usual scenario	Sustainability driven scenario	Market driven scenario
Main effects of the provision of public goods	• Biodiversity will remain unchanged, since agricultural practices will remain as nowadays. • Soil functionality will decrease due the maintenance of current unsustainable soil management practices. • Rural vitality will decrease due to farm abandonment and rural depopulation. • Other public goods: No significant change in the provision of public goods is expected under this scenario.	• Biodiversity will increase due to the implementation of more environment-friendly agricultural practices. • Soil functionality will increase due to the implementation of soil conservation practices. • Rural vitality will increase due to new economic activities related with agritourism in surrounding areas. • Other public goods: Positive impacts on the provision of visual quality of landscapes, climate stability, water quality, and cultural heritage.	• Biodiversity will be negatively affected by intensification and degradation of natural resources. • Soil functionality will get worse due to more intensive soil management and more arid climate. • Rural vitality will decrease due to farm abandonment and rural depopulation. • Other public goods: Negative impacts on the provision of climate stability, fire and flood protection, and cultural heritage.
Main driver affecting the public goods	• Economic marginality of agricultural production. • Rural depopulation and lack of economic activities in surrounding rural areas.	• Renewed consumption and social preference patterns. • Enhanced rural development attracting new rural dwellers. • Environmentally-oriented technical progress.	• Climate change. • Rural depopulation and lack of economic activities in surrounding rural areas. • Globalization (enhanced market competition and uniformed demand).
Scenario parameters in PAM modelling	• AES compliance costs ($\psi_i(e_i)$): -10%. • Social benefits from PGs ($v(e_i)$): +10%. • Monitoring cost of AES and command-and-control (k): -20%. • Sanctions for AES non-compliance ($\rho(c_i)$): +20%.	• AES compliance costs ($\psi_i(e_i)$): +10%. • Social benefits from PGs ($v(e_i)$): +30%. • Monitoring cost of AES and command-and-control (k): -40%. • Sanctions for AES non-compliance ($\rho(c_i)$): +100%.	• AES compliance costs ($\psi_i(e_i)$): +20%. • Social benefits from PGs ($v(e_i)$): +0%. • Monitoring cost of AES and command-and-control (k): -20%. • Sanctions for AES non-compliance ($\rho(c_i)$): +0%.

8.2.4 Participative approach

Although the modelling exercise proposed is formally based on mathematical programming techniques, stakeholders have played a relevant role during its implementation. First, they all were involved in the 3rd Local Stakeholder Workshop held in May 2017, where the three following inputs were provided:

a) The selection of the governance mechanism to be analysed. As explained above, a typical practice-based AES, defined as 5-year-contract, with no opt-out option, and with the payment to be received due to compliance of certain environmental-friendly practices specifically aimed at improving the provision of biodiversity, was proposed a *priori* as the most suitable policy instrument for a smart provision of this public good.
b) The validation of the valuation results (supply-side and demand-side) used as key inputs for the modelling approach to be developed.
c) Scenario building as explained in the previous section.

Once the background for the analysis was set in this workshop, PROVIDE researchers looked for the most suitable simulation technique for an *ex-ante* analysis of the implementation of the governance mechanism chosen for both the current situation and the three future scenarios proposed. In this sense, Principal-Agent Modelling was selected.

Part of the stakeholders were also consulted afterwards in order to support model building. In fact, they provided some relevant inputs allowing a sounder model feeding. More concretely, with their expertise they supported decision-making related with value estimates of the following parameters:

a) parameters defining the function of the probability of detecting non-compliance with the scheme ($\theta(c_i)$).
b) parameters defining the sanctions function ($\rho(c_i)$).
c) parameters defining the function of monitoring costs ($M(m_i)$).

Finally, it is worth mentioning that the results obtained and reported here are planned to be presented to stakeholders within the 4th Local Stakeholder Workshop to be held around February 2018. The discussion of the model outcomes is expected to provide useful feedbacks for: i) model refining and obtaining more accurate results; ii) interpretation of the results already obtained, and iii) conclusions for policy advise.

8.2.5 Results and interpretation

8.2.5.1 Optimal AES design

As shown in Figure 1, the high WTA in Class 2 means that this group's costs to increase biodiversity provision ($\psi_2(e_2)$) exceed the associated social benefit ($v(e)$) for any level of improvement in this public good (e_2). Hence, when social welfare is maximised (optimal solution running model built in expression 7)[25], this class does not satisfy the participation constraint (expression 7.2), meaning that the proposed optimisation model excludes it from implementation of the scheme (γ_2=0). Thus, all principal's decision variables regarding this class (B_2, p_2 and m_2) take also null values.

This first result is relevant because Class 2 includes 40.5% of the olive farms analysed, and their non-participation in the proposed AES limits the potential of this instrument to improve social welfare. However, it is worth remarking that gaps between cost of provision of public goods and the associated social benefit are common in real world situations (not all underprovision situations can be considered as market failures), discouraging one or several groups of farmers to subscribe AES contracts. In fact, there is evidence that most of AES are targeted to a relative wide range of farmers, but only a certain share of them, those with lower compliance costs (in our case study, those with farms with lower yields, i.e., lower income foregone) take part of the scheme (Quillérou *et al.*, 2011).

On the other hand, there is an upside to this situation in terms of the practical implementation of the proposed scheme, in that it simplifies the management and reduces potential problems of adverse selection. Indeed, although the application of AES proposed assumes that the regulator can detect if farms belong to the class 1 or 2 (there is no adverse selection problem),

[25] It is worth remarking that, considering that AES are voluntary contracts, the enrolment of Class 2 in the scheme proposed would only be possible by setting extremely high payments (p_2) covering compliance costs ($\psi_2(e_2)$) for any effective improvement in the provision of biodiversity (e_2). Thus, taking into account that this cost of provision is much higher than the associated social benefit, the option of promoting Class 2 engagement in this scheme would lead to a decrease in social welfare (inefficient policy implementation).

this assumption could be relaxed for the concrete case study analysed since the participation constraint allows discriminating between farm types, even in case of hidden information.

In light of this result, the optimal AES design would be based on a single agri-environmental contract designed for farms with the lowest costs of provision (Class 1), which would not in any case appeal to Class 2 farms. Accordingly, AES could be uniformly rolled out through a single contract applicable to all olive groves, which would reduce the transaction costs of the scheme for both the public administration and the farmers, by facilitating the promotion of the scheme, information and support provided, contracting and subsequent evaluation.

The optimal values for the principal's decision variables (E_1, p_1 and m_1) and the objective function (Z) resulting from the model (expression 7) for the *Base scenario* are shown in the second column of Table 5. The maximum increase in social welfare for this scenario represents €9.75/year per enrolled hectare. Thus, considering that all farms included in Class 1 (125.545 hectares) would participate in the proposed scheme, social welfare would be improved in 1.22 million euros a year. To achieve this enhanced welfare, AES proposed should commit mountain olive growers to implement agri-environmental practices increasing the provision of biodiversity measured in 6.2 bird species per farm, in exchange for a payment of €97.30 per hectare and year (summing up to 12.22 million euros every year for the total MOG area included in Class 1).

This *Base scenario* also involves an optimal monitoring level of 15.0%, which is significantly higher than the 5% minimum required by EU legislation, and also higher than the 7.8% that represents current practice in the region.

Table 5. Optimal AES design and sensitivity analysis (percentage variations compared with the *Base scenario* shown in brackets)

	Base scenario	$\psi_i(e_i)$ +10%	$\psi_i(e_i)$ -10%	$v(e)$ +10%	$v(e)$ -10%	λ +10%	λ -10%	k +10%	k -10%
Z (€/ha/year)	9.75	8.08 (-17.1%)	11.72 (20.3%)	13.95 (43.1%)	6.09 (-37.5%)	3.49 (-64.1%)	20.43 (109.7%)	8.64 (-11.3%)	10.96 (12.5%)
p (€/ha/year)	97.30	92.22 (-5.2%)	102.38 (5.2%)	111.35 (14.4%)	81.77 (-16.0%)	55.66 (-42.8%)	199.73 (105.3%)	97.15 (-0.2%)	96.97 (-0.3%)
E (no. species)	6.2	5.6 (-10.1%)	7.0 (11.4%)	7.2 (15.2%)	5.2 (-16.7%)	4.2 (-32.5%)	8.6 (38.5%)	5.9 (-5.1%)	6.6 (5.3%)
m (%)	15.0	14.2 (-5.2%)	18.8 (5.2%)	17.2 (14.4%)	12.6 (-16.0%)	12.5 (-16.8%)	13.7 (-8.8%)	13.6 (-9.2%)	16.6 (10.7%)
γ_1 (0/1)	1	1	1	1	1	1	1	1	1
c_1 (%)	67.7	67.7 (0.0%)	67.7 (0.0%)	67.7 (0.0%)	67.7 (0.1%)	67.7 (0.1%)	67.7 (0.0%)	67.7 (0.0%)	67.7 (0.0%)
e_1 (no. species)	4.2	3.80 (-10.1%)	4.70 (11.4%)	4.86 (15.1%)	3.52 (-16.7%)	2.85 (-32.4%)	5.85 (38.6%)	4.01 (-5.0%)	4.44 (5.3%)
$\psi_1(e_1)$ (€/ha/year)	11.56	10.47 (-9.4%)	12.69 (9.9%)	14.98 (29.6%)	8.28 (-28.3%)	5.69 (-50.8%)	21.18 (83.3%)	10.51 (-9.0%)	12.70 (9.9%)
π_1 (€/ha/year)	82.84	79.15 (-4.5%)	86.47 (4.4%)	92.55 (11.7%)	71.45 (-13.8%)	48.60 (-41.3%)	173.12 (109.0%)	84.01 (1.4%)	81.06 (-2.2%)
$v(e)$ (€/ha/year)	66.28	60.41 (-8.9%)	72.70 (9.7%)	82.20 (24.0%)	50.81 (-23.3%)	46.75 (-29.5%)	87.04 (31.3%)	63.37 (-4.4%)	69.28 (4.5%)

The optimal AES design, as indicated above, means that the Class 1 farms sign up to the scheme (γ_1=1) with the agents choosing a degree of compliance with the agri-environmental requirements of 67.7% (i.e. the effective increase in the number of bird species would be about 4.2). This partial compliance with the scheme entails an average extra cost of only €11.56/ha/year (adding up 2.71 million euros/year for all farms involved), such that signing up to this instrument provides the agents with an extra profit of €82.84/ha/year (coming up 10.35 million euros/year for all farms involved). Society, on the other hand, benefits to the amount of €66.28/ha for the effective increase in the provision of biodiversity (equivalent to a total of 8.28 million euros).

Although the results of the PAM for *Base scenario* reveal the proposed AES to be an effective way of improving the social welfare associated with the provision of biodiversity by MOG, it can be noted that the welfare gain generated is limited compared to the amount of the public budget dedicated to that aim. Indeed, for every €100 of public spending invested in the scheme, a net welfare improvement of only €10.02 would be obtained. It is also striking that, for every €100 that the farmers receive as agri-environmental payments, only €11.88 goes towards covering the costs incurred to improve biodiversity, while €85.14 are converted into an increase in their private profit (the remaining €2.98 are lost because of inefficiency in policy implementation).

8.2.5.2 Sensitivity analysis

Table 5 also summarises the results obtained from the sensitivity analysis. These results show that value deviations (estimation errors) in the parameter λ (MCF) has the most critical impact on optimal results derived from model (expression 7). As can be observed, a 10% increase in this parameter leads to a significant reduction in the effectiveness of this policy instrument, since the improvement in social welfare is 64% lower than in the *Base scenario*. This is because considering a more inefficient tax system involves a higher social cost of public spending policies, resulting in lower optimal values for policy objectives (E decreases in 33%) and agri-environmental payments (p declines in 43%). If a 10% decrease for this parameter is considered, the impacts are even more significant, but the opposite effects: increase in the improvement of social welfare (110%), biodiversity enhancement objective (39%) and agri-environmental payments (105%).

These results highlight the importance of the efficiency of the tax system in the optimisation of public policies that require budgetary resources, such as AES. In any case, this is a horizontal aspect of public management that goes beyond the scope of this research (Auerbach y Hines, 2002; Dahlby, 2008). However, it is noticeable that, in spite of the relevance of this parameter, value estimations of MCF are neither computed periodically by governments, nor reported by official statistics. In fact, these estimates can only be found in the literature, where normally they are calculated using specific (non-standardized and comparable) methods, and reported without the required update. Therefore, the choice of reliable value estimates for λ parameter is a challenging task for policy analysists, who should carefully look at any result from PAM because of potential not robust and/or not updated enough MCF estimations.

The second most critical parameters are those used to estimate social benefit from the improvement in the provision of biodiversity ($v(e)$). As shown in Table 5, a 10% increase in the social benefit would lead to relevant increases in optimal social welfare (43%), biodiversity enhancement objective (15%) and agri-environmental payments (14%). If estimates of social benefit were 10% lower, comparable relevant decreases would be experienced in all these policy-making variables.

The need of accurate estimates of social benefits of public goods is also worth highlighting since demand-side valuation assessments are only seldom implemented by official institutions to support policy-making. Most of these valuation exercises are carried out by academics focused on scientific issues, that hardly can be used to feed PAM. Therefore, the availability of robust parameters to estimate social benefit is another limitation for policy analysts when modelling this kind of instruments.

Parameters used to estimate cost of provision ($\psi_i(e_i)$) are also relevant, although to a lesser extent. An increase (decrease) in costs estimation would lead a 17% decrease (20% increase) in optimal social welfare, and a 10% decrease (11% increase) in biodiversity enhancement. The rest of policy-making variables would change in less than 10%.

Changes in the parameter regarding monitoring costs (k) have moderate to light impacts on optimal results. This suggests that accuracy in its estimation is not as determining as for the ones commented above. This is the only among the five parameters analysed that can be more easily set by the principal, especially by minimising monitoring cost to handily increase efficiency of AES. However, in line with previous works (a recent literature review can be found in Shimshack, 2014), our results raise some doubts about the cost-effectiveness of current environmental monitoring practices.

Finally, although the changes in the key parameters analysed generate notable changes in the optimal values of the principal's decision variables, the same cannot be said for the agent's decision variable (level of compliance, c_1). Indeed, the optimal value of this variable remains fairly stable at around 67.7%. This fact is caused by the first-order condition of the agent optimisation problem and, more concretely, the function of the probability of detecting non-compliance with the scheme ($\theta(c_i)$), leading to optimal solutions located in the surroundings of its inflexion point (c_{it}=0.7 as estimated for our case study).

8.2.5.3 Scenario analysis

Table 6 shows the results obtained for the scenario analysis. First, it is worth noting that the *Business as usual scenario* would result in an important improvement in the efficiency in the implementation of the AES proposed. In fact, the increase in social welfare (Z) would be more than double than in the *Base scenario* (from €9.75/ha/year to €21.70/ha/year), since the commitments for mountain olive growers would increase the provision of biodiversity (E_1) in a 45% compared with the *Base scenario* and the agri-environmental payment (p_1) would remain relatively stable (10% increase only). Moreover, the percentage of the payments received by farmers that they would devote to cover extra costs incurred to improve biodiversity would rise from 11.9% to 19.2%, while the percentage of payments converted into their private profit would decrease from 85.1% to 76.6%. These results evidence the positive combined impact of lower compliance ($\psi_i(e_i)$) and monitoring (k) costs and higher social benefits ($v(e_i)$) and sanctions for non-compliance ($\rho(c_i)$).

If further increases in social benefits and sanctions for non-compliance and additional decreases in monitoring costs are considered, as in the *Sustainability driven scenario*, it is easy to understand that the efficiency in the implementation of the AES proposed would be further enhanced. As shown in Table 6, under this scenario the increase in social welfare would be almost four times the one achieved for the *Base scenario* (from €9.75/ha/year to €37.39/ha/year), since the environmental commitments would increase in a 73.0% and the agri-environmental payment would decrease in a 3.1%. In this case the percentage of the payments that olive growers would devote to cover extra costs would rise until a 37.0%, while the percentage of payments converted into in their private profit would decrease until a 57.9%.

It is worth pointing out that the increase in the efficiency of AES proposed under the two abovementioned scenarios also involves a relevant increase in the monitoring effort (m). In fact, this principal’s variable would grow from the 15.0% under the *Base scenario* to 20.7% and 24.3% for the *Business as usual* and *Sustainability driven* scenarios, respectively.

Table 6. Optimal AES design and scenario analysis (percentage variations compared to the *Base scenario* shown in brackets)

	Base scenario	Business as usual	Sustainability driven	Market driven
Z (€/ha/year)	9.75	21.70 (+122.7%)	37.39 (+283.6%)	8.99 (-7.8%)
p (€/ha/year)	97.30	107.54 (+10.5%)	94.32 (-3.1%)	87.86 (-9.7%)
E (no. species)	6.2	9.0 (+45.0%)	10.8 (+73.0%)	5.7 (-8.2%)
m (%)	15.0	20.7 (+5.7%)	24.3 (+9.2%)	16.9 (+1.9%)
γ_1 (0/1)	1	1	1	1
c_1 (%)	67.7	67.5 (-0.2%)	67.1 (-0.4%)	67.6 (+0.5%)
e_1 (no. species)	4.2	6.1 (+44.6%)	7.2 (+71.6%)	3.9 (-8.2%)
$\psi_1(e_1)$ (€/ha/year)	11.56	20.66 (+78.8%)	34.88 (+201.8%)	11.85 (+2.6%)
π_1 (€/ha/year)	82.84	82.38 (-0.6%)	54.62 (-34.1%)	73.04 (-11.8%)
$v(e)$ (€/ha/year)	66.28	99.07 (+49.5%)	133.51 (+101.5%)	61.51 (-7.2%)

Lastly, it can be seen that the *Market driven scenario* shows the worst results regarding the implementation of the AES proposed. In fact, social welfare gains would decrease in a 7.8% compared to the *Base scenario*. The key factors causing this inferior performance are the increase in the AES compliance costs and the maintenance of the social benefits derived from the provision of biodiversity assumed under this scenario. Indeed, this scenario also involves a smaller part of the agri-environment payments going towards compensating farmers for the extra costs incurred to improve biodiversity (13.5%); most of this payment being converted into farmers' private profit (83.1%). These percentages are similar to those obtained for the *Base scenario*.

8.2.6 Discussion

8.2.6.1 Discussion of results

On a strictly empirical level, this application has shown that the second-best solutions yielded by the PAM can differ significantly from the optimal achievable in the ideal case of perfect information. Indeed, the optimal solutions resulting from the model under the *Base scenario* reveal that only a small part of the agri-environment payments goes towards compensating farmers for the extra costs incurred as a result of implementing the AES; most of this payment is converted to farmers' private profit. However, this fact is expected to be partially corrected in the future in case social benefits from the improved provision and sanctions for non-compliance will increase and monitoring costs will decrease, as under the *Business as usual scenario* and more intensively under the *Sustainability driven scenario*. In any case, even under the most efficient scenario (*Sustainability driven scenario*), more than 50% of the agri-environmental payments granted would be directedly convert into private profits.

Considering that most of the parameters feeding the model cannot be modified by the Principal in the short-run (i.e. cost of provision, social benefits or monitoring costs), these results evidence that the concerns of the administration managing the AES would be focused on modifying the sanction system. Under current EU regulation, sanction system only (proportionally) moderates payments depending on the farmers' degree of compliance. However, it is suggested to change it to became more stringent and also to provide a mechanism for penalising non-compliance by imposing fines in cases of serious breaches (Ozanne y White, 2008). As been shown in the scenario analysis, the current level of monitoring of AES should be raised to improve the performance of AES.

This sensitivity analysis has also shown the key role played by value estimations of parameters feeding the PAM approach proposed. More concretely, it has been evidenced that the parameter most critically influencing on model results (optimal AES design) is the marginal cost of public funds, as a measure of the efficiency of the tax system. In any case, this is a horizontal aspect of public management that goes beyond the scope of this research, so we refer the interested reader to the extensive literature on this subject (Auerbach y Hines, 2002; Dahlby, 2008; OECD, 2010). Other key parameters determining PAM results are those used to estimate farmers' cost of provision of the public good and the social benefit associates to this improvement. In this sense it is worth underlining that the lack of accurate information in these regards very likely hinders achieving results precise enough to meaningful support policy-making.

8.2.6.2 Discussion of methodological approach

In line with the existing literature, this study demonstrates the utility of PAM in supporting the design of AES, minimising the problems of adverse selection and moral hazard. The main novelty of this research is that it takes a strongly applied approach, in that it is based on an empirical application that uses real information obtained *ad hoc*. In this regard, the study has revealed the substantial amount of information needed to create realistic applications that are of genuine use to policymakers, especially data related to the costs incurred by farmers for the implementation of these schemes and the social benefits stemming from the environmental improvements such schemes seek to generate.

The information required to build these types of models in the real world is not available through official statistics, but rather needs to be generated in a specific way for each case study. The time and high costs involved in generating this information is not consistent with current political decision-making practices. As such, analyses like the one proposed in this deliverable would only be feasible for the design of large-scale AES, where the transaction costs relating to the design of the instrument are of a smaller order of magnitude than the welfare improvements that can be achieved.

Despite the attempt to take a realistic approach to developing this model to support the design of the proposed AES, a number of limitations can be identified clearly representing issues for further research. Some of these have already been addressed in the literature from a theoretical point of view, such as those related with the assumption of farmers' risk behaviour (Ozanne y White, 2008), and the omission of other transaction costs different than monitoring costs (Mettepenningen *et al.*, 2011). Similarly, it would also be advisable to consider multi-period decision models that recursively cover the optimal solutions of the agents and the principal, taking into account the whole period that these agri-environmental contracts cover. This improvement in the modelling approach would allow considering alternative designs for AES with inter-temporal variation of payments, monitoring level and sanctions throughout the 5-years contract period which, as shown by Fraser (2012), would provide a broader picture of farmers' behaviour useful to incorporate time issues for the more efficient scheme design. Additionally, with respect to monitoring, it would be opportune to analyse the implementation of non-random monitoring strategies, for example focusing controls on those farmers with higher risks of non-compliance and/or a history of previous breaches (Fraser, 2004).

There are other aspects that have not been addressed in the literature yet but that should be examined in future empirical studies regarding optimal design of AES using PAM. For instance, it would be of special interest to incorporate spatial analysis to this modelling approach, especially to take into account spatial features (biophysical conditions, closeness to natural areas, etc.) and collective rather than individual participation (i.e. neighbouring effects on provision of farmland biodiversity and the role of agglomeration bonus) as key factors determining biodiversity performance. In addition, it is worth highlighting the need to explore the used of the Expected Utility Theory (EUT) or Cumulative Prospect Theory (CPT) as an alternative to the profit maximization behaviour assumed for model building. Recent works (Bocquého *et al.*, 2014) evidence that farmers are more sensitive to losses (i.e. AES sanctions for cheating) than to gains (i.e. AES payments for enrolment). Consequently, accounting for loss aversion and probability weighting can make a difference in the design of effective and efficient contracts schemes. Further, also of interest would be to take into consideration evidences showing that farmers' conservation behaviour is driven by various motivations and criteria, related to their economic, social, cultural, and natural environment situation, in addition to the expected utility of profit (Lastra-Bravo *et al.*, 2015). This fact suggests that testing new PAM approaches based on the Multi-Attribute Utility Theory (MAUT) or the Theory of Planned Behaviour (TPB) would provide new insights in the analysis of conservation-oriented and other personal motivations for AES participation and compliance.

8.2.6.3 Discussion of the participative elements in the modelling approaches

The participatory approach followed in this research is positively evaluated, since it has provided useful inputs for the modelling exercise. First, stakeholders have properly focused the empirical analysis defining the most suitable governance mechanism (AES) as the one worth to be modelled and also building future scenarios for *ex-ante* policy analysis. Second, they have supported model building by advising about the correct value estimates of the parameters to feed the PA model. These contributions have allowed a more policy-relevant and a more accurate modelling implementation.

Moreover, new further contributions are expected within the 4th Local Stakeholder Workshop to be held around February 2018. In this workshop, a full evaluation of the modelling approach followed is to be done to improve the results obtained, their interpretation, and to draw the key policy messages stemming from the empirical analysis performed.

However, it is also worth pointing out several weaknesses identified during the participatory process used. Firstly, we found it difficult to explain to the stakeholders the evaluation context, especially how the method used (PAM) could adequately reflect the main issues and factors with regards to the provision of public goods by AFS and the GM implemented to improve it. In particular, the fact that stakeholders had not dealt previously with modelling approaches, together with their lack of economic and mathematical background, is very likely behind this result. Thus, they had challenging understanding on simulation modelling approaches, difficultly recognising that these represent simplifications of real word relying on several assumptions considered to make models simple enough to be handled (models cannot manage at the same time *all* relevant issues dealing with AES implementation) but useful to analyse the expected impacts of policy instruments (models are ‘simple’, but *useful* for policy-making). Because of this, some of the participants involved hesitated about the reliability of the outcomes, as they had not fully understood how the model actually works. All this contrasts to the fact that stakeholders had previously been able to easily understand methodological approaches used in previous tasks of the project (e.g. in valuation assessments), suggesting that use of the method can facilitate or make it more difficult the active involvement of stakeholders within the research process. Thus, our experience here hints at the need to make further efforts on the explanation of the methodological approach to ensure a more successful involvement of the stakeholders.

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8.3 IT-2: Soil erosion, rural vitality and carbon sequestration in the hilly and mountain area of the Bologna province in Italy

8.3.1 Introduction

8.3.1.1 Description of case study region

The case study region is the hilly and mountain area of the Bologna province (Now called "area metropolitana"). The size of the entire province is 3,703 km² of which 36% (1330 km2) is hilly and 21% (790 km2) is mountain areas. 1 009 828 inhabitants live in the province, with an average density of 272,71 inhabitants/km².

8.3.1.2 Description of public good issue

We choose to investigate three of the most important public goods identified by the local/regional stakeholders: 1) soil erosion, 2) rural vitality, and 3) carbon sequestration.

8.3.1.3 Description of governance-strategy

We investigated existing measures of the RDP in the Emilia-Romagna. More specifically, we analyse the impact of measure 13.1.01 that provides a payment for farms located in mountain areas. The payment is set at 125 ha^{-1}y^{-1}.

8.3.2 Methodological approach

8.3.2.1 Theoretical background

<u>Benchmark model</u>

The modelling framework is a land allocation maximization problem. The basic model is described by the following equations:

(1) $$\max \Pi^{agr} + U^{pg}$$

s.t.

(2) $$\Pi^{agr} = \sum_{i,l,s} a_{i,s} x_{i,l,s} - \sum_{i,s} b_{i,s} \left(\sum_{l} x_{i,l,s} \right)^2 - \sum_{i,l,s} c_{i,l} x_{i,l,s}$$

(3) $$U^{pg} = \sum_{g} u_g \left(\sum_{l} e_{g,i,s} x_{i,l,s} \right)$$

(4) $$\sum_{i} x_{i,l,s} \leq \bar{X}_{l,s}$$

Where the variables are:

- Π^{agr}: profits from agricultural production;
- U^{pg}: utility derived from the three public goods;
- $x_{i,l,s}$: decision variable: land allocation;

and the parameters are:

- i: land uses activities subdivided in agricultural land uses ($i \in A$) and non agricultural land uses ($i \in N$);
- s: slope classes;
- l: current land used destinations (agricultural land, abandoned land, forest);
- g: public goods;
- $a_{i,s}$: agricultural profit function parameters;
- $b_{i,s}$: cost parameter;
- $c_{i,l}$: cost of land use transitions;
- u_g: willingness to pay for any given public good considered;
- $e_{g,l,s}$: parameter of the production function of the public goods, potentially differentiated by slope classes and current land use destination;
- $\bar{X}_{l,s}$: total available land use per slope classes and current land use destination;

The main characteristics of the model are thus the following:

- The total welfare of the area is given by the sum of the agricultural profit and of the utility derived by the public good.
- Private benefit and costs of the agricultural production are differentiated by crop and slope of the land.
- Costs of agricultural production are increasing in the area allocated to crops.
- Given the classification of the current land use destination (subscript l), some changes of land use are costly (e.g converting abandoned land back to agriculture) – parameter c.

<u>Mechanism model</u>

To assess the mechanisms, the model described by equations (1) to (4) is re-formulated by removing the utility part in equation (1), and by adding a policy term in equation (2) that incentivizes any agricultural activity. Public good production is not explicitly taken into account in the optimization, but their production levels follow from the resulting land allocation.

(5) $$\max \Pi^{agr}$$

s.t.

(6) $$\Pi^{agr} = p\sum_{i\in A,l,s} a_{i,s}x_{i,l,s} + \sum_{i,l,s} a_{i,s}x_{i,l,s} - \sum_{i,s} b_{i,s}\left(\sum_{l} x_{i,l,s}\right)^2 - \sum_{i,l,s} c_{i,l}x_{i,l,s}$$

(7) $$U^{pg} = \sum_{g} u_g\left(\sum_{l} e_{g,i,s}x_{i,l,s}\right)$$

(8) $$\sum_{i} x_{i,l,s} \leq \bar{X}_{l,s}$$

8.3.2.2 Model implementation

Economic parameters

We consider the following productive land uses (*i*): grape, fruit, arable, forestry, and grassland; and the following non-productive land uses (*i*): abandoned and forest.

The gross margin function for the productive land uses is differentiated by crop and land slope classes (see equation (2)). Parameter $a_{i,s}$ (Table 1) represents the intercepts. The model is calibrated taking into account the current actual land allocation across agricultural land uses, abandoned land, and forest. The calibration of the model assumes a Ricardian framework (…) coupled with the observation that UAA is lower than Total Agricultural Area (the case study region is characterized by land abandonment) which implies that the land allocation observed entails a marginal productivity of land that is null: $a_{i,s} - \frac{1}{2}b_{i,s}x_{i,s}^{obs} = 0$. Parameter $b_{i,s}$ represents the coefficient of the quadratic term in the gross margin function (Table 2). The calibration results are also used to classify land into three classes of current land uses (set *l*): agricultural land, abandoned, and forests. This information is used to account for the potential costs that a change in fundamental land uses involve. This is addressed in the model by differentiating the decision variable x (land use allocation) by crop, current land use, and slope.

Table 1. Parameter $a_{i,s}$

	Slope classes										
	sl_5	sl_5-10	sl_10-15	sl_15-20	sl_20-25	sl_25-30	sl_30-35	sl_35-40	sl_40-45	sl_45-50	sl_over50
grape	2614	2397	1832	1402	1086	855	635	424	224	136	33
fruit	2636	1918	1421	1113	893	755	613	466	337	187	51
arable	1019	957	862	762	654	535	399	268	156	79	17
forestry	422	388	361	337	370	417	427	336	214	176	46
grassland	355	395	399	381	345	291	226	156	99	49	11
abandoned	0	0	0	0	0	0	0	0	0	0	0
forest	0	0	0	0	0	0	0	0	0	0	0

Table 2. Parameter $b_{,s}$

	Slope classes										
	sl_5	sl_5-10	sl_10-15	sl_15-20	sl_20-25	sl_25-30	sl_30-35	sl_35-40	sl_40-45	sl_45-50	sl_over50
grape	8.14	3.22	1.80	1.30	1.19	1.40	1.87	2.61	3.75	5.38	2.00
fruit	4.88	1.93	1.08	0.78	0.71	0.84	1.12	1.56	2.25	3.23	1.20
arable	0.35	0.14	0.08	0.06	0.05	0.06	0.08	0.11	0.16	0.23	0.09
forestry	22.21	8.78	4.91	3.55	3.25	3.83	5.09	7.11	10.24	14.68	5.45
grassland	0.35	0.14	0.08	0.06	0.05	0.06	0.08	0.11	0.16	0.23	0.08
abandoned	0	0	0	0	0	0	0	0	0	0	0
forest	0	0	0	0	0	0	0	0	0	0	0

Land conversion costs: represent a linear annualization of the required operations to prepare the land for agricultural uses.

Table 3. Cost (€/ha) of land conversion per crop and land use type.

	Land use types (l)		
	Agricultural land	Abandoned land	Forest land
grape	0	70	500
fruit	0	70	500
arable	0	70	500
forestry	0	70	500
grassland	0	70	500
abandoned	0	70	500
forest	300	150	0

WTP parameters

The data on willingness to pay for the three public goods considered are drawn from the valuation exercise of WP4. From WP4 we obtain that

- For soil erosion is: 16.54€ per family, per year, per million of ton of non-eroded soil;
- For carbon sequestration is: 92.09€ per family, per year, per million of ton of sequestrated CO_2;
- For rural vitality is: 0.47 € per family per year per a single farm that does not exit from the market.

Consider that 11% of the interviewed did not respond to the questionnaire ("protests"). Demographic data reports that there are 2,001,717 families in Emilia-Romagna. Accounting for the protests, families in Emilia-Romagna that are supposedly willing to pay for agricultural public goods are 1,781,528. Taking into account these values, WTP are introduced in the model in the following way:

- For soil erosion: we consider 16.54€ * 1,781,528 families and we divide by 1,000,000 to reach a value of 29.5 €/ton. We introduce the WTP as a social cost for the amount of erosion generated by agriculture.
- For carbon sequestration: we apply the same procedure to reach a value of 164.0 €/ton. The WTP is introduced as the social benefit linked to the provision of carbon sequestration from the different land uses.
- For rural vitality: the same procedures lead to an estimate of 887,318€/per farm that keeps running. This figure, given the characteristic of the mathematical programming model we are using, is to be reported in terms of land allocation. Considering the

location of the UAA across altitude classes (Table 4), and taking into account 101,646 + 250,147 = 351,793 ha of hilly and mountain areas, we compute 887,318 / 351,793 = 2.38€/ha in order to have a figure for the WTP that can be attributed to the land. This implies/assumes a direct link between farm and UAA.

Table 4. Utilized Agricultural Area (ha) for location in Emilia-Romagna.

-	Utilized Agricultural Area (in ha)
Mountain	101,646
Hilly	250,147
Plain area	712,421
Total	1,064,214

Public good production function parameters

The model does not include any aprioristic target levels. Instead these levels are endogenously determined by the model that takes into account the societal willingness to pay for the public good considered, and maximizes total welfare accordingly. Rural vitality is assumed to be simply a linear function of the agricultural land. Carbon sequestration is assumed to be only produced by non-productive land uses. Land abandoned sequesters 0.95 T/ha of carbon, while forests sequester 2.30 T/ha of carbon. The production of soil erosion is differentiated per crop and slope of the land according to Table 5.

Table 5. Parameter of erosion (T/ha) per crop and slope classes.

	Slope classes										
	sl_5	sl_5-10	sl_10-15	sl_15-20	sl_20-25	sl_25-30	sl_30-35	sl_35-40	sl_40-45	sl_45-50	sl_over50
grape	0.68	2.40	5.13	8.31	10.74	13.03	16.24	18.40	19.23	23.08	27.95
fruit	0.46	1.98	4.54	7.44	10.32	12.94	14.97	16.58	18.96	21.22	23.88
arable	0.28	0.90	1.75	2.79	3.85	5.25	7.19	8.38	9.70	13.96	13.59
foresty	0.11	0.40	0.71	1.15	1.71	2.22	2.45	2.61	2.99	2.92	5.86
grassland	0.08	0.33	0.77	1.26	1.66	2.03	2.23	2.47	2.85	2.88	3.33
abandoned	0.27	1.29	3.07	5.17	6.82	7.75	8.41	8.65	8.85	9.93	11.28
forest	0.01	0.04	0.10	0.16	0.22	0.26	0.30	0.34	0.40	0.45	0.64

8.3.3 Scenarios

We consider two sets of scenarios. In the first set, we change the objective function by differentiating the type of public goods that are taken into account in the maximization problem. We hence have 8 scenarios that encompass all the possible combination of PG taken into consideration (see Table 6).

Table 6. Objective function scenarios and public good considered in each scenario.

scenarios	Soil erosion	Carbon sequestration	Rural vitality
sce_none			
sce_eros	x		
sce_carb		x	
sce_ruvi			x
sce_eros_carb	x	x	
sce_eros_ruvi	x		x
sce_carb_ruvi		x	x
sce_eros_carb_ruvi	x	x	x

In the second set of scenarios, we consider scenarios differentiated by different level of prices. Changes in prices are introduced in equation (2), which becomes:

$$(2) \qquad \Pi^{agr} = \sum_{i,l,s} \alpha^{p} a_{i,s} x_{i,l,s} - \sum_{i,s} b_{i,s} \left(\sum_{l} x_{i,l,s} \right)^{2} - \sum_{i,l,s} c_{i,l} x_{i,l,s}$$

Where $0.5<\alpha^P\leq 1.5$ indicates the level of the price with respect to the current situation.

8.3.4 Results and interpretation

8.3.4.1 Benchmark results

In this part, we present the results of the benchmark model, where no policy is assessed.

<u>Economic results</u>

The inclusion of PG into the objective function always causes a reduction of private profit due to the agricultural production (see table 7). This is mostly pronounced in the scenario that takes into account both erosion and carbon sequestration. Considering rural vitality does not affect private profit. As it will be clearer in the next section, the relative level of the WTP for rural vitality with respect to the cost of land use transition almost locks in agricultural production in the current configuration.

Table 7. Private profits, social benefit and total welfare for the objective function scenarios.

scenarios	Private profit	social benefit	total welfare
sce_none	18,405,586	30,296,368	48,701,953
sce_eros	17,501,428	32,684,688	50,186,116
sce_carb	16,104,655	34,174,810	50,279,465
sce_ruvi	18,405,586	30,296,368	48,701,953
sce_eros_carb	10,106,563	42,465,457	52,572,020
sce_eros_ruvi	17,497,504	32,681,480	50,178,984
sce_carb_ruvi	16,143,242	34,155,004	50,298,246
sce_eros_carb_ruvi	10,210,425	42,361,879	52,572,305

Land allocation and public good levels

Table 8 shows how the different objective functions affect the choice on land uses. In all the cases, taking into account the provision of PG entails an increase in the forested areas. Agricultural land uses decrease in almost all the scenario, except for the scenarios sce_eros and sce_eros_ruvi where in both cases, abandoned areas are reduced.

Table 8. Land allocation among three classes of land use type (agricultural, abandoned and forest land use) in the eight objective function scenarios.

	lt_agr	lt_aba	lt_for
sce_none	55802	6126	97011
sce_eros	56087	2135	100717
sce_carb	37802	18000	103137
sce_ruvi	55802	6126	97011
sce_eros_carb	36131	1560	121247
sce_eros_ruvi	56132	2089	100717
sce_carb_ruvi	38049	17753	103137
sce_eros_carb_ruvi	36371	1534	121034

In details, Table 9 shows that in general grape and fruit tend to decrease as PGs are taken into account in the objective function. Only the inclusion of erosion causes an increase in the agricultural land uses at the expenses of abandoned land; however this increase does not lead to an improvement in the private profits, since it also entails a substitution of crops from the most productive to grassland. Further, note that the social optimum (scenario sce_eros_carb_ruvi) involves a large expansion of forest in the current abandoned areas, and a reduction of agricultural land (-1534 ha) with respect to the current configuration. The land use allocation in such a scenario is however more balanced than in the sce_carb scenario, which entails a much larger increase in the abandoned land at the expense of agricultural production (-18.000 ha).

Table 9. Land uses

		grape	fruit	arable	forestry	grassland	abandoned	forest
sce_none	lt_agr	2642	3760	32606	313	16480	0	
	lt_aba						6126	
	lt_for							97011
sce_eros	lt_agr	2084	2899	30776	303	19739		
	lt_aba	58	58	58	54	58	2135	3706
	lt_for							97011
sce_carb	lt_agr	2267	3123	24085	174	8153	18000	
	lt_aba							6126
	lt_for							97011
sce_ruvi	lt_agr	2642	3760	32606	313	16480		
	lt_aba						6126	
	lt_for							97011
sce_eros_carb	lt_agr	1802	2360	22062	197	9711	1560	18111
	lt_aba							6126
	lt_for							97011
sce_eros_ruvi	lt_agr	2078	2891	30782	305	19746		
	lt_aba	64	68	73	53	73	2089	3706
	lt_for							97011
sce_carb_ruvi	lt_agr	2273	3132	24205	176	8262	17753	
	lt_aba							6126
	lt_for							97011
sce_eros_carb_ruvi	lt_agr	1806	2367	22168	199	9830	1534	17897
	lt_aba							6126
	lt_for							97011

The public good levels in the different scenarios follow directly from the land allocation results (Table 10)

Table 10. PG levels in the different objective function scenarios and land use classes.

		Land use classes			
Scenarios	Public good	agriculture	abandoned	forest	tot
sce_none	eros	194108	37951	30354	262413
	carb	0	5820	223124	228944
	ruvi	55802	0	10	55811
sce_eros	eros	169906	7317	31412	208635
	carb	0	2028	231649	233677
	ruvi	56087	0	10	56097
sce_carb	eros	128380	112002	31688	272070
	carb	0	17100	237214	254314
	ruvi	37802	0	0	37812
sce_ruvi	eros	194108	37951	30354	262413
	carb	0	5820	223124	228944
	ruvi	55802	0	0	55811
sce_eros_carb	eros	100881	1526	36260	138668
	carb	0	1482	278869	280351
	ruvi	36131	0	0	36143
sce_eros_ruvi	eros	170012	110543	31688	312242
	carb	0	16866	237214	254080
	ruvi	56132	0	0	56143
sce_carb_ruvi	eros	129219	7082	31412	167712
	carb	0	1985	231649	233633
	ruvi	38049	0	0	38059
sce_eros_carb_ruvi	eros	101575	1500	36214	139290
	carb	0	1457	278378	279835
	ruvi	36371	0	0	36383

Assessment of Mechanisms

In this section, we analyse the effect of the introduction of the impact of measure 13.1.01 that provides a payment for farms located in mountain areas. The payment is set at 125 $ha^{-1}y^{-1}$.

Table 11 shows the difference in the economic results between the policy scenario p=125 and the benchmark scenarios. Clearly the mechanism increases private profit with respect to the benchmark scenarios, but utility and total welfare decreases.

Table 11. Percentage change in the economic results between the policy scenario p=125 and the benchmark scenarios

scenarios	Private profit	social benefit	total welfare
sce_none	39%	-1%	-2%
sce_eros	46%	-9%	-5%
sce_carb	59%	-13%	-5%
sce_ruvi	39%	-1%	-2%
sce_eros_carb	153%	-30%	-9%
sce_eros_ruvi	46%	-9%	-5%
sce_carb_ruvi	58%	-13%	-5%
sce_eros_carb_ruvi	150%	-30%	-9%

The economic results are best explained by looking at the provision of public goods (Table 12). While rural vitality provision increases, carbon sequestration is highly reduced by the mechanisms. Erosion, that entails to certain extent some synergies with agricultural land, it increases, but such an increase does not offset the losses due to the reduction in the carbon sequestration.

Table 12. Percentage change in the public good provision between the policy scenario p=125 and the benchmark scenarios

	eros	carb	ruvi
sce_none	-6%	-2%	11%
sce_eros	18%	-4%	10%
sce_carb	-9%	-12%	63%
sce_ruvi	-6%	-2%	11%
sce_eros_carb	78%	-20%	71%
sce_eros_ruvi	18%	-4%	10%
sce_carb_ruvi	-9%	-12%	62%
sce_eros_carb_ruvi	77%	-20%	70%

Public good provision is a result of land allocation that can be observed in Table 13 and with more details in Table 14. The mechanisms, not surprisingly, causes an increase in agricultural production at the expenses of both abandoned land and forest. The comparison of land use allocation between the policy scenario p=125 and the scenario sce_none (Table 14) shows that the grape and fruits are reduced in the agricultural land but they expand in the abandoned land. This probably hints at the need for a further refinement and accounting of the effect of the current land use and the associated land use change costs.

Table 13. Percentage change in the land classes allocation between the policy scenario p=125 and the benchmark scenarios

	agriculture	abandoned	forest
sce_none	11%	-97%	0%
sce_eros	10%	-91%	-4%
sce_carb	63%	-99%	-6%
sce_ruvi	11%	-97%	0%
sce_eros_carb	71%	-88%	-20%
sce_eros_ruvi	10%	-91%	-4%
sce_carb_ruvi	62%	-99%	-6%
sce_eros_carb_ruvi	70%	-88%	-20%

Table 14. Absolute differences in land use allocation between the policy scenario p=125 and the benchmark scenarios

		grape	fruit	arable	forestry	grassland	abandoned	forest
sce_none	lt_agr	-92	-1204	886	-54	465	0	0
	lt_aba	211	1403	1888	99	2340	-5940	0
	lt_for	0	0	0	0	0	0	-1
sce_eros	lt_agr	466	-343	2716	-44	-2794	0	0
	lt_aba	153	1345	1830	45	2282	-1949	-3706
	lt_for	0	0	0	0	0	0	-1
sce_carb	lt_agr	283	-567	9407	85	8792	-18000	0
	lt_aba	211	1403	1888	99	2340	186	-6126
	lt_for	0	0	0	0	0	0	-1
sce_ruvi	lt_agr	-92	-1204	886	-54	465	0	0
	lt_aba	211	1403	1888	99	2340	-5940	0
	lt_for	0	0	0	0	0	0	-1
sce_eros_carb	lt_agr	748	196	11430	62	7234	-1560	-18111
	lt_aba	211	1403	1888	99	2340	186	-6126
	lt_for	0	0	0	0	0	0	-1
sce_eros_ruvi	lt_agr	472	-335	2710	-46	-2801	0	0
	lt_aba	147	1335	1815	46	2267	-1903	-3706
	lt_for	0	0	0	0	0	0	-1
sce_carb_ruvi	lt_agr	277	-576	9287	83	8683	-17753	0
	lt_aba	211	1403	1888	99	2340	186	-6126
	lt_for	0	0	0	0	0	0	-1
sce_eros_carb_ruvi	lt_agr	744	189	11324	60	7115	-1534	-17897
	lt_aba	211	1403	1888	99	2340	186	-6126
	lt_for	0	0	0	0	0	0	-1

Finally, we perform a sensitivity analysis on the payment level of the mechanism. Figure 1 shows that as long as the payment level does not cover the land use transition costs, the mechanism is ineffective and does not change land uses. A payment level of 150€/ha causes the conversion of the entire current land abandoned into agricultural land. Further increases in the payment levels are ineffective since any change in land use would entail the conversion of forest into agriculture, whose costs is much higher and prevents such a conversion.

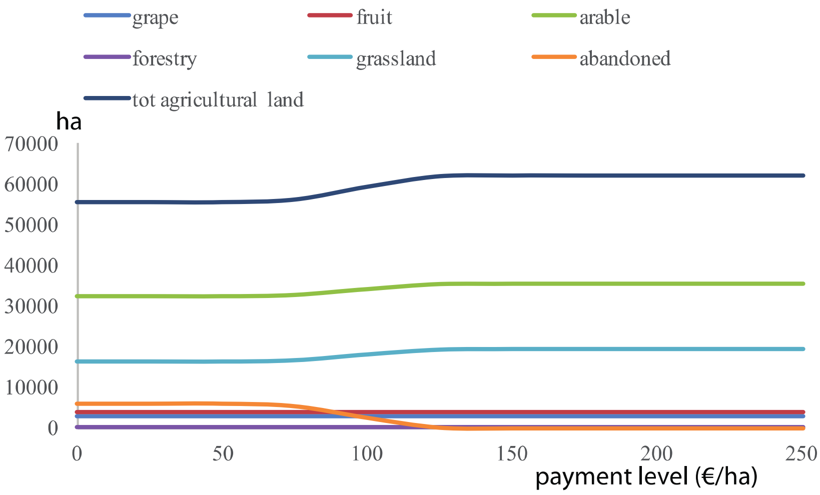

Figure 1. Land uses for different level of the policy mechanism.

Sensitivity on prices

We performed a sensitivity analysis on the prices of agricultural products. Figure 2 shows how land use is affected by changes in prices in the scenario sce_none, the one in which no public good is taken into account in the objective function. The figure displays how a reduction in agricultural prices with respect to the current one (1) cause a sharp increase in the abandoned land and a parallel decrease mostly on arable and grassland. On the other hand, an increase in prices result in a more nuanced pattern, where land allocated to arable and grassland (abandoned) increases (decreases) but a lower rate than in the price reduction case. The driving force behind the results is the transition costs to pass from abandoned land to agriculture.

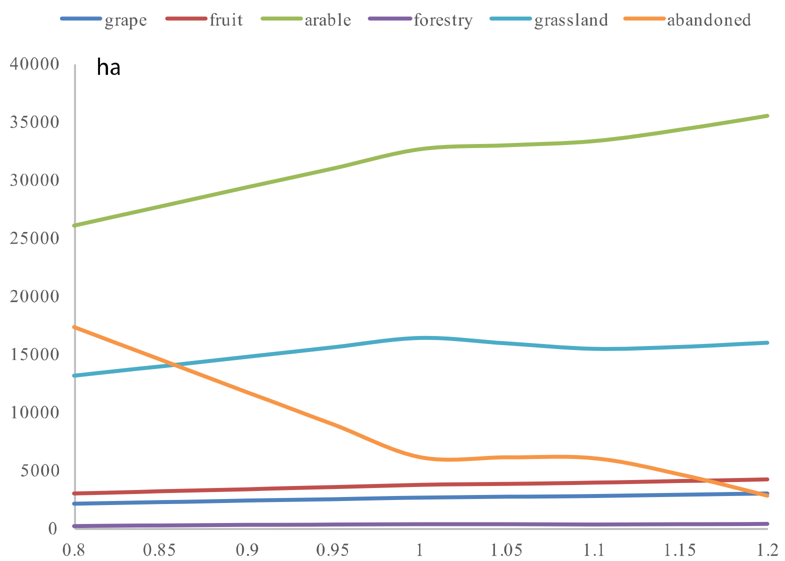

Figure 2. Land uses for different level of the policy mechanism.

8.3.5 Discussion

8.3.5.1 Discussion of results

Two are the main driving forces behind the result of the model. First, we explicitly include in the model costs associated with major land use change, namely from land abandonment and forest to agriculture. These costs almost lock in the area in the current situation (characterized by a relatively high rate of land abandonment), so that even taking into account the societal value of rural vitality does not causes an increase in the agricultural land. Second, the relatively higher societal value for carbon sequestration is the major force that would cause a change in land use. This change largely entails an increase in the forest land at the expense of both land abandoned and agricultural land uses.

Despite the obvious limitations, these results point at policy recommendations. Since, despite its reversible character, land use changes entail costs, agri-environmental policy should have a relatively large time horizon and have a comprehensive assessment of the PG provision they entail. Especially incentives towards e.g. forest might assume a option value approach. This also in lights of the volatile societal preferences for public good and the limitations that any WTP valuation assessment involve.

8.3.5.2 Discussion of methodological approach

The methodology that we use is a classic land allocation model set in a Ricardian framework. The availability of data constrained the choice of the methodology and prevented for example the estimation of cost function parameters through a positive mathematical programming model.

8.3.5.3 Discussion of the participative elements in the modelling approaches

The models' results were presented at the 4th local stakeholder workshop. The stakeholders showed a marked interest in the value of public good introduced in the model aimed at assessing the mechanism. They clearly recognized the potential impact that these values have on the model results. In particular, they expressed surprise over the relative low value for erosion with respect to carbon sequestration and apparently the disinterest of Emilia-Romagna citizens on rural vitality.

More specifically on the model results, while the appreciated the effort, they observe how the modelling of the policy could be improved to come closer to the actual policy measures that are present in the regional Rural Development Plan. More specifically, they observe how in reality abandoned land cannot be eligible for the financial scheme here analysed, and thus the results on the conversion of these land back to agriculture should be taken cautiously. Moreover, they commented in general the issue of land abandonment in mountain areas in the region. Some stakeholders commented that the current land abandonment process is somewhat the outcome of the interruption of years of coupled support that in turn had artificially supported the "unnatural" expansion of agriculture in marginal lands.

9 Forestry

CSR	Topic	Model	Authors
EE-1	Scenery and recreation in forest landscapes in Harju County, in Northern Estonia – Evaluating agreements between private forest owners and local government and financial relief scheme for the state-owned forest management	Spatial and mathematical modelling	A. Keskpaik S. Lassur K. Tafel-Viia M. Küttim
FI-1	Scenery and recreation in forest landscapes in Ruka-Kuusamo in North-Eastern Finland – Evaluating the PES-scheme “Landscape and Recreational Values Trading” (LRVT)	Multi-criteria analysis	E. Mäntymaa A. Juutinen L. Tyrväinen M. Kurttila
CZ-2	Recreation services and biodiversity of forest lands in the National Geopark Ralsko in Northern Bohemia – Fostering broader stakeholder integration	Criteria analysis MAPP (Assessing Impact of Programmes and Projects)	T. Ratinger I. Vancurova M. Bavorova

9.1 EE-1: Scenery and recreation in forest landscapes in Harju County in Northern Estonia

9.1.1 Introduction

9.1.1.1 Description of case study region

Harju County is located in Northern Estonia on the southern coast of the Gulf of Finland. Its area is 4,338 km². Harju County is home to the capital of Estonia – Tallinn. The population of the county is 582 thousand, 432 thousand of the population lives in Tallinn. Suburbanization occurs in the area surrounding the capital. Almost 80% of the population lives in urban settlements. Population density in rural areas is rather low.

There was 73,900 ha (17% of the county territory) agricultural land in use in Harju County (2016). As estimated, about one quarter of arable land and permanent grassland was out of agricultural use. A reasonable part of former agricultural land has been used for developing new residential or industrial areas - especially in the vicinity of Tallinn. A large share of Harju County is covered by forest. 215,700 thousand ha (50% of the county territory) is forest land (2016). The forest is among Estonia's most important natural resources and a source of a considerable amount of raw material.

Harju County is a region where the vast majority of population has no personal connection with rural production but is quite sensitive about the recreational, esthetical and cultural heritage features of the rural and natural environment surrounding the settlements.

Figure 1. Harju County Source: Eesti entsüklopeedia

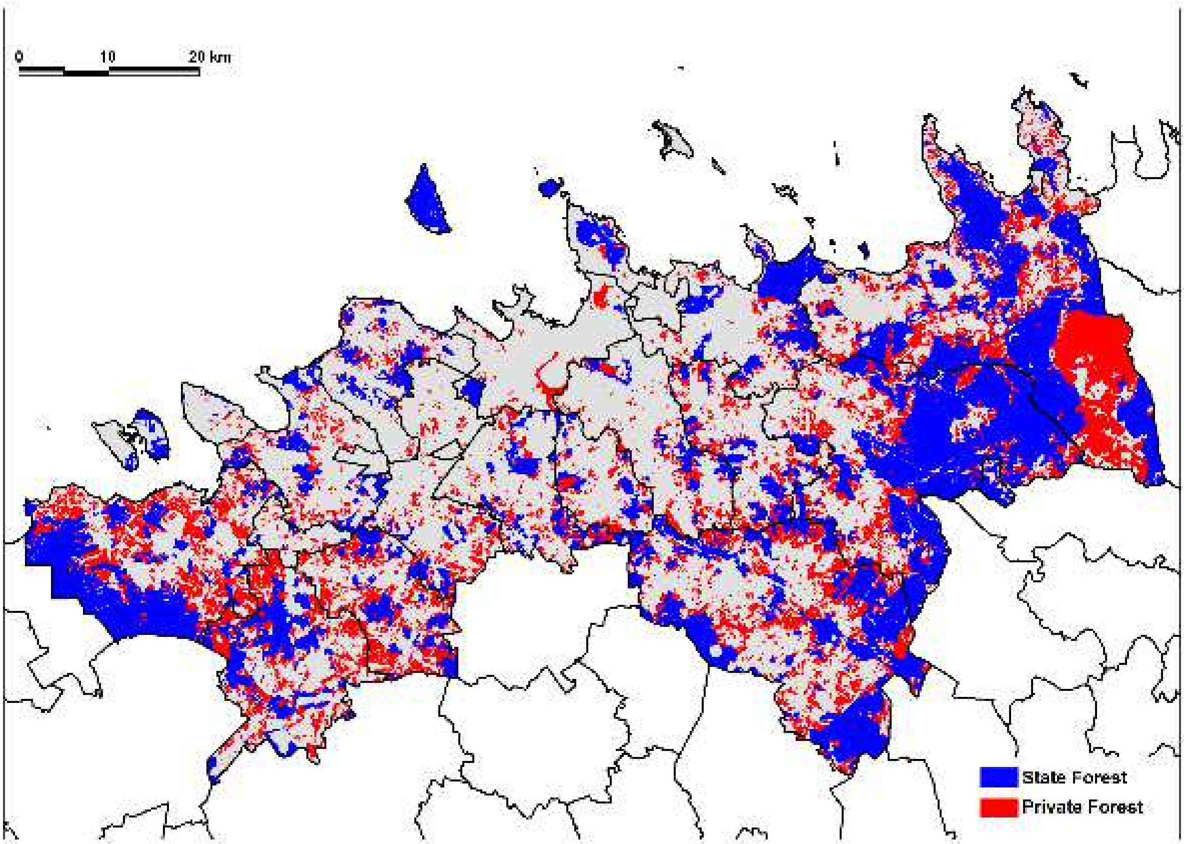

Figure 2. State and private forest stand compartments in Harju County Source: Providing Smart Delivery of Public Goods by EU Agriculture and Forestry, Estonian University of Life Sciences, 2017

9.1.1.2 Description of public good issue

It has been chosen to investigate the provision of the PGs of scenery and recreation by the forestry system in a context of high risk of large scale clear cutting deteriorating the living environment around densely populated settlements.

The importance of Harju County as recreational and vacation destination (partly also due to the vicinity of capital Tallinn) as well as living environment (development of new residential areas) has increased in the recent years and will probably continue to increase. At the same time, substantial part of forests in Harju County have achieved maturity and may go under cutting in the coming 10 years. The trend towards more effective and intensive forest management directs the forest owners to use mostly clear cutting. So there is an increasing conflict between the interests of forest managers and other stakeholders. The conflict can be mitigated by introducing GMs that:

- encourage forest owners to actively deal with forest renewal and to use different types of cutting methods;
- increase the influence of local government on directing of forest management.

9.1.1.3 Description of governance-strategy

The governance strategy investigated consists of four GMs as follows:

- GM1. Spatial planning;
- GM2. Agreements between private forest owners and local government;
- GM3. Financial relief scheme for the state-owned forest management;
- GM4. Technical assistance and information.

Presently, there is no GM that could be used to regulate forest management for keeping scenery and recreation values of forests. The suggested strategy makes use of existing procedures of county level spatial planning (GM1) for defining the forest areas where GM2 and GM3 can be implemented. GM2 and GM3 are planned to be based on voluntary long term agreements with local governments. Agreements provide opportunity of finding locally adapted complex and flexible solutions for forest management. They can include not only restrictions to clear cut on certain forest compartments but may also improve management of other forest compartments.

GM3 includes dividend reduction to the State Forest Management Centre and GM2 includes environmental support for private forest owners. These mechanisms are chosen to compensate for the reduction of income caused by cutting restrictions.

The proposed strategy complies with the criteria of good governance. It is purposeful. Effectiveness and measurability are provided through monitoring the coverage with agreements and implementation of them. Acceptability for the target groups is ensured by negotiations and voluntariness of agreements. All forest owners in the target area are treated equally.

After implementation of the strategy a remarkable part of the (from the viewpoint of scenery and recreation) most valuable forest compartments surrounding densely settled areas will be preserved years or decades longer. Hopefully, a number of less valuable compartments will be managed better too because of the strengthening co-operation of forest owners and local municipalities.

9.1.2 Methodological approach

9.1.2.1 Theoretical background

A special calculation model has been constructed for evaluation of the governance strategy. Functioning of GM2 and GM3 are modelled. Only these GMs can actually improve provision of the PG and they will be responsible for nearly all costs of implementation of the strategy.

Model consists of four blocks:

- concluding of agreements with private forest owners,
- concluding of agreements with the State Forest Management Centre,
- calculation of annual outputs,
- calculation of cumulative annual outputs.

Two outputs are calculated. The first, area covered by forest management agreements reflects improvement of prospects of provision of the PG scenery and recreation. The second, public sector financial commitments taken with the forest management agreements reflects the cost of improvement of providing PG.

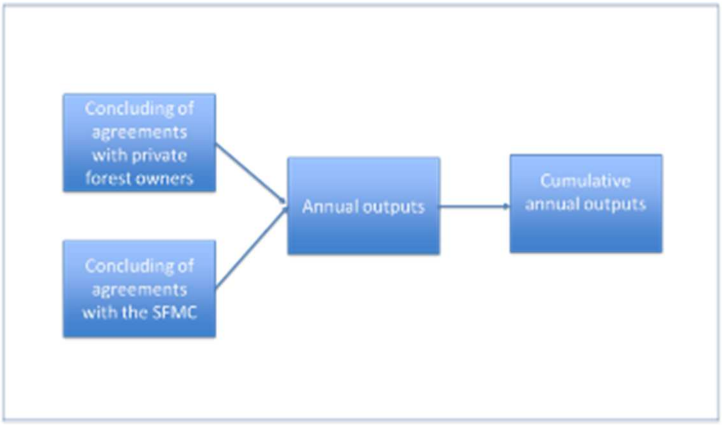

Figure 3. Structure of the model

Below we describe the structure of blocks. The block of concluding of agreements with private forest owners includes three successive steps. Calculation of:

1) forest area covered by forest management agreements with private forest owners,
2) area of cutting restriction covered by forest management agreements with private forest owners,
3) public financial commitments to private owners taken with the forest management agreements.

The formulas are given in figure 4.

$$a_{private,\,t} = F * s_{private,\,t} * a_{private,\,av}$$

$a_{private,\,t}$ - the eligible area covered by forest management agreements concluded with private forest owners in year t
t - sequential number of the year (1 ... 20)
F - number of private forest owners in the Harju County eligible area
$s_{private,\,t}$ - share of forest owners having concluded agreements in year t from all private forest owners of the eligible area
$a_{private,\,av}$ - average eligible area covered by one agreement

$$r_{private,\,t} = a_{private,\,t} * p_{av}$$

$r_{private,\,t}$ - area of cutting restriction in the eligible area covered by forest management agreements concluded with private forest owners in year t
p_{av} - the average share (part) of implementation of the restrictions in the area covered by one agreement

$$c_{private,\,t} = r_{private,\,t} * b_{av} * d$$

$c_{private,\,t}$ - public financial commitments to private owners taken with the forest management agreements in year t
b_{av} - average environmental support per annum per area unit of implementing cutting restrictions (b - benefit)
d - duration of the environmental support payment in years

Figure 4. Calculations in the block of concluding of agreements with private forest owners

The block of concluding of agreements with the State Forest Management Centre (SFMC) includes three analogous steps. Calculation of:

1) forest area covered by forest management agreements with SFMC,
2) area of cutting restriction covered by forest management agreements with SFMC,
3) public financial commitments to SFMC taken with the management agreements.

The formulas are given in figure 5.

$$a_{state,t} = A_{state} * s_{state,t}$$

$a_{state,t}$ - the eligible area covered by forest management agreements concluded with the State Forest Management Centre in year t
t- sequential number of the year (1 ... 20)
A_{state} - the total area of the state forest in the eligible area
$s_{state,t}$ - share of eligible area in the state forest covered by the agreements concluded in year t

$$r_{state,t} = a_{state,t} * p_{av}$$

$r_{state,t}$ - area of cutting restrictions in year t in the eligible area covered by forest management agreements concluded with the State Forest Management Centre
p_{av} - the average share of implementation of the restrictions on in the area covered by one agreement

$$c_{state,t} = r_{state,t} * b_{av} * d$$

$c_{state,t}$ - public financial commitments to the State Forest Management Centre taken with the forest management agreements in year t
b_{av} - average dividend reduction per annum per area unit of implementing cutting restrictions (b - benefit)
d - duration of the reduction of the dividends in years

Figure 5. Calculations in the block of concluding of agreements with SFMC

The blocks of annual outputs and cumulative outputs include only summing together outputs of the forest management agreements with the private owners and SFMC. So the final product of modelling is a quantitative description of the year by year growth of the area covered with agreements and amount of financial commitments to forest owners.

9.1.2.2 Model implementation

Implementation of the model is based on the factual data provided by our partners from the Estonian University of Life Sciences. The target area for the strategy is defined the same that was used by them in the earlier supply valuation exercise. It is as follows: private and state forest stand compartments in towns, densely populated areas and within a 100-meter-wide surrounding buffer zone (Figure 6). Using cartographic analysis and data from state registers -

the Forest Register, Land Cadaster and Land Register a database of forest compartments has been composed.

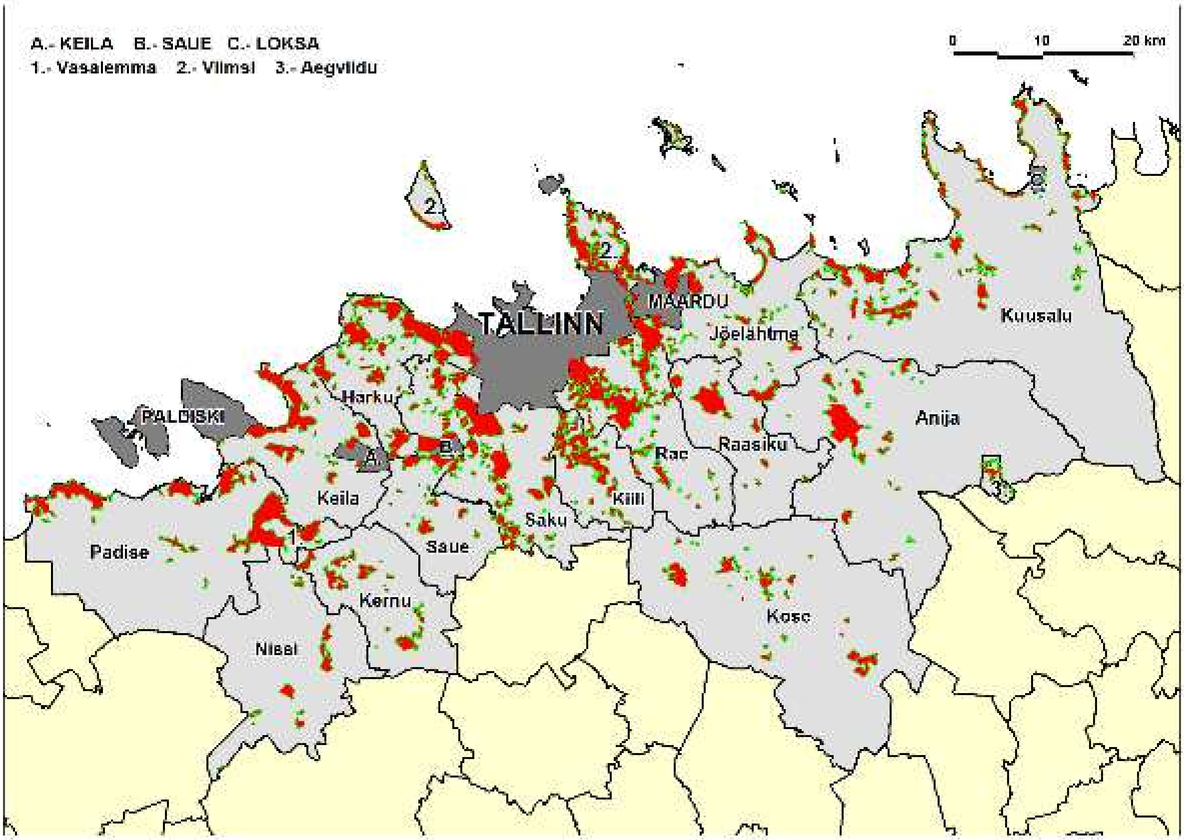

Figure 6. Densely populated areas in parishes in Harju County (marked with red) with 100-meter-wide buffer zones (marked with green) and towns; Source: Providing Smart Delivery of Public Goods by EU Agriculture and Forestry, Estonian University of Life Sciences, 2017

The database includes data of 11,035 compartments that are located in densely populated areas and the surrounding buffer zones, or at least 50% of their area is there. The total area of the target area is 3,273 ha. It is a very little part of all forests in Harju County – 1.5%. The compartments are on 2,575 cadastre units. In 56 cases the owner of cadastre unit is state. In 764 cases no information about ownership was available (in the following calculations these units are treated as state-owned).

It has been decided that the agreements between local governments and forest owners may cover all forest compartments in the eligible area but the compensation is available only for mature forests – those that are mature today or will be mature during the next 20 years until 2036.

Proceeding from the forestry expert assessments, four timber value classes of the stand compartments have been defined as follows:

1) High value: mature stand in forest site types of *Calluna* (can be found in heath forests), *Cladonia* (in heath forests), and *Rhodococcum* (in mesotrophic forests).
2) Middle value: mature spruce, pine, birch, oak, aspen and ash stand not belonging to class 1.
3) Not mature: It could be class 1 or 2 but not mature during next 20 years.
4) Low value class: All others.

Division of the target area according to timber value classes is given in figure 7.

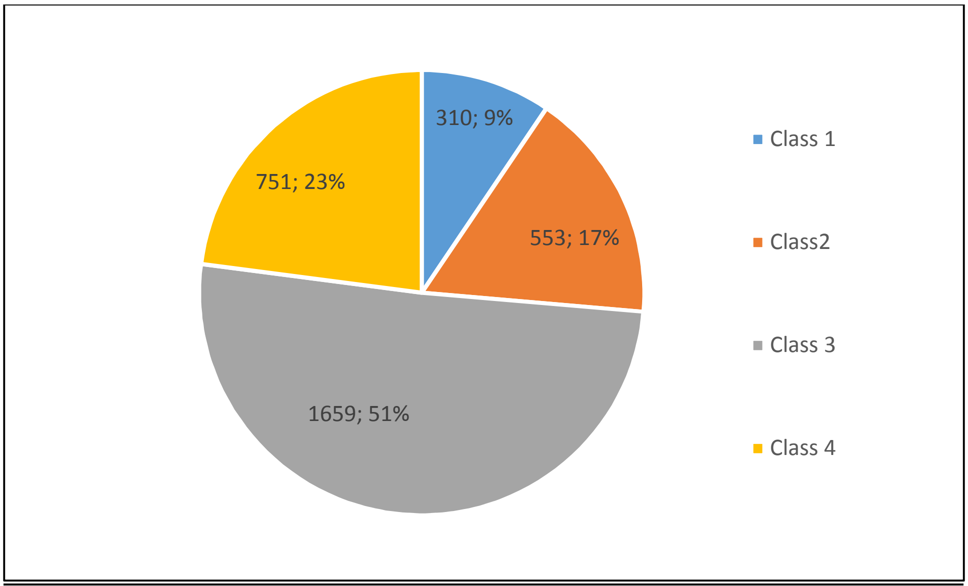

Figure 7. Division of the area of forest stand compartments by timber value classes in towns, densely populated areas and within a 100-meter-wide surrounding buffer zone in Harju County

Proceeding from the earlier results of valuation exercise and, additionally, the latest opinions of the stakeholders' representatives rates of compensation/dividend reduction per ha have been proposed by the experts from the Estonian University of Life Sciences for the value classes. The rates relate to one of the most probable clear cutting restriction that could be implemented in result of forest management agreements – using of shelterwood cutting instead of clear cutting. The proposed compensation for class 1 forest is 2,000 euros/ha that will be paid during 10 years. The compensation for class 2 forest is 700 euros/ha and that will be paid out during 5 years. These values are used for the business as usual scenario.

Final felling is not allowed in non-mature forest – class 3. It is expected that cutting restrictions are not needed at all for the class 4 as the PG provided by that kind of forest is low. So there will be no compensation need.

So it can be seen (Figure 7) that only 26% of the total target area (863 ha) that is covered by class 1 or 2 forest is expected to need cutting restrictions and will be eligible for financial compensation of these.

The following assumptions have been taken:

- Implementation of GM2 and GM3 in Harju County is modelled for seven years as an EU programming period.
- Only one specific kind of cutting restriction – allowing of shelterwood cutting instead of clear cutting is implemented for all mature forest compartments covered by an agreement and belonging to value class 1 or 2. The respective financial commitment is taken for all such compartments.

The model is implemented in the context of three scenarios. The influence of scenarios on the behavior of the model is realized through the parameters that are the share of private forest owners having concluded agreement in year t ($\mathbf{s}_{\mathbf{private,\ t}}$) and the share of state forest covered by the agreement in year t ($\mathbf{s}_{\mathbf{state,\ t}}$). These proportions are derived proceeding from the results of the third meeting with stakeholders.

At the meeting, a version of hypothetical graphs of the respective proportions for 10 years has been presented to stakeholders for discussion. Participants considered them too optimistic and suggested that the maximum cumulative level of private forest owners joining agreements would increase to 50%, and the respective level of state forest covered with agreements would rise to 80%. In this report, the pace of coverage of state forest with agreements is roughly the same that was proposed by stakeholders. For private forest owners, however, lower parameter values of the proposed dynamics have been used, considering that participation would be significantly lower than in case of the NATURA forestry support (cf. p 14) which has been in use for several years in Estonia.

9.1.3 Scenarios

Three scenarios are analysed: the business as usual (BAU), sustainability driven (SD) and market driven (MD) scenario. Below, only local-specific effects of the overall scenario narratives are described.

1) Business as usual (BAU)

Concentration of population into the settlements of Harju County surrounding the capital proceeds. Consuming patterns become a little more sustainable, but readiness of public sector to pay for PG is low. However, environmental support to private forest owners available from EU funding is used. It means that the state forests will be treated equally providing reducing of dividends to the state for preserving the PGs.

The pressure by NGOs and population to protect PGs provided by forestry increases. Readiness of forest owners and local governments to negotiate forest management issues for providing better PG is medium. Impact of public and voluntary regulations (certificates, standards etc.) that favor sustainable use of forest is stronger than today, however, many private forest owners resist them. Price of timber does not change. Technologies of forest management care little about forest as an ecosystem. Clear cutting dominates.

In this scenario, the consumption pattern is the main overall PROVIDE narrative factor that influences Harju County. The consumption pattern determines mostly the moderate attractiveness and pace of conclusion of agreements for private forest owners.

The pace of concluding agreements and level of compensation are reflected in values of parameters used for the BAU. They are following (cf. also Figure 8):

- The share of private forest owners[26] concluding agreements of balanced forest management reaches 24% during seven years (annual percentages 8,4,4,2,2,2,2);
- The share of state forest area covered by agreements reaches 56% (annual percentages 8,8,8,8,8,8,8);
- The levels of compensation for cutting restrictions are 2,000 euros/ha for class 1 forest and 700 euros/ha for class 2 forest.

[26] Private forest owners include both legal and physical persons. As presumed, the agreements will be concluded separately between each forest owner and each local government. As we need to find the average eligible area covered by one agreement, we consider the same person (or a group of physical persons) owning forest in different local governments as different owners.

2) Sustainable Development (SD)

Concentration of population into the settlements of Harju County slows down. Consuming patterns become more sustainable, and readiness of public sector to pay for PG (incl. forest scenery and recreation opportunities in woods) increases. Readiness of forest owners and local governments to negotiate forest management issues for providing better PG is high. Public and voluntary regulations (certificates, standards etc.) favor sustainable use of forests. Wood becomes a more and more prestigious building material. The price of timber supposedly increases. We suppose that it increases by 20% during seven years. It means that levels of compensation for cutting restrictions that will be set once in the beginning of period taking into account the forecasted increase of timber price, will be raised at least by 10%.

Forest management becomes more "green". Highly automated harvesters and educated drivers enable flexible use of felling methods. Technologies of forest management are adapted to tree species and forest types. Wood is used as fully as possible and valorized in many ways (building materials, bio-fuels etc.).

In this scenario, the consumption pattern, and environmental-oriented technical progress are the main overall PROVIDE narrative factors that influence Harju County. At the same time, increase of the price of timber makes inevitable a move towards higher levels of compensations for cutting restrictions. They determine higher than BAU's pace of conclusion of agreements for private forest owners but also higher costs of implementing the strategy.

The following values for parameters are implemented for SD:

- The share of private forest owners concluding agreements of balanced forest management reaches 30 % during seven years (annual percentages 10,6,6,2,2,2,2);
- The share of state forest area covered by agreements reaches 56% (annual percentages 8,8,8,8,8,8,8)
- The levels of compensation for cutting restrictions are 2,200 euros/ha for class 1 forest and 770 euros/ha for class 1 forest.

3) Market driven Development (MD)

Concentration of population into the settlements of Harju County proceeds without slowing down (immigration). Consuming patterns become less sustainable, and readiness of public sector to pay for PG decreases. At the same time, the readiness of prosperous persons to pay privately for forest scenery and recreation opportunities in woods increases.

Readiness of forest owners and local governments to negotiate forest management issues for providing better PG is low. Use of forests is market-oriented, loosely regulated and intense.

The price of wood supposedly increases because of continuous overexploitation of forests. However, wood is not a prestigious building material because of competition with concrete etc. Technologies of forest management care less than today about forest as an ecosystem. Monoculture “forest plantations”, planting of hybridized trees etc. increase.

In this scenario, the consumption pattern, and technical progress not valuing the sustainable use of nature are the main overall PROVIDE narrative factors that influence Harju County. Increase of the price of timber (we suppose that it increases by 20% during seven years) makes inevitable a move towards higher levels of compensations for cutting restrictions. However, this does not increase remarkably the costs of implementing the strategy as the pace of conclusion of agreements with private forest owners stays lower than in case of BAU.

Provision of good-quality forest scenery and recreation opportunities improves only marginally in woods of the Harju County that belong to the target area of the strategy.

The following values for parameters are implemented for the MD:

- The share of private forest owners concluding agreements of balanced forest management reaches 20% during seven years (annual percentages 7,3,3,2,2,2,2);
- The share of state forest area covered by agreements reaches 56%;
- The levels of compensation for cutting restrictions are 2,200 euros/ha for class 1 forest and 770 euros/ha for class 2 forest.

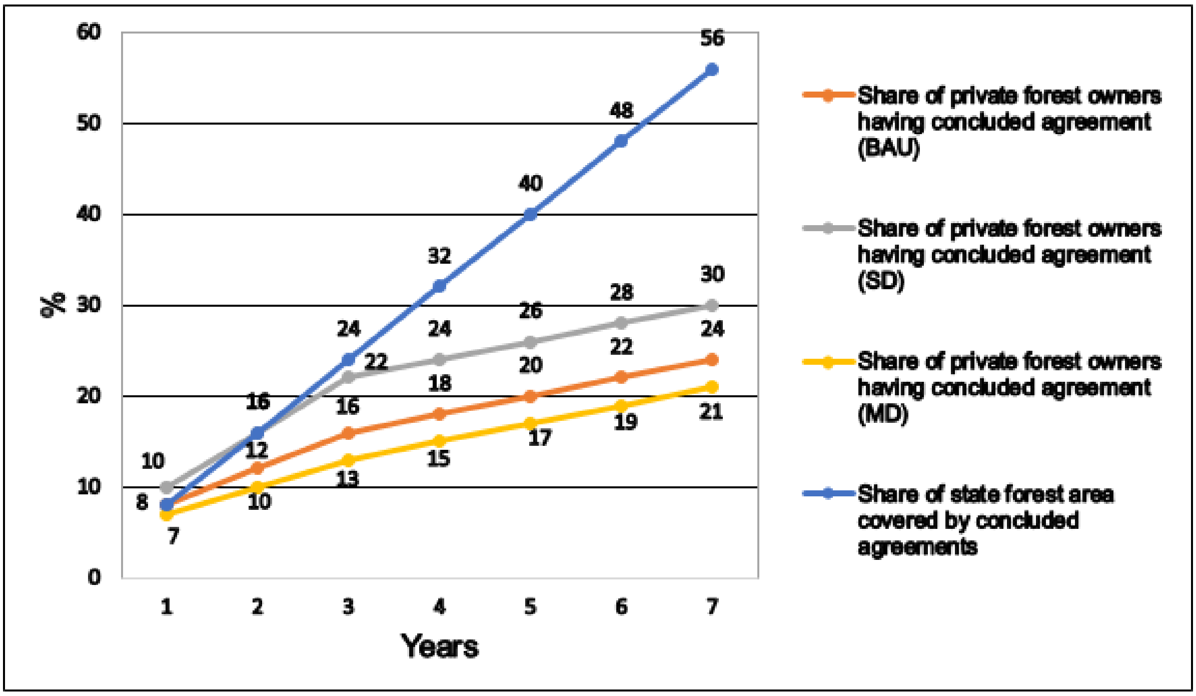

Figure 8. Cumulative percentage values of parameters describing concluding of agreements

9.1.4 Participative approach

The stakeholders input to the PROVIDE process has been extremely important. The individual GMs and general structure of the governance strategy have been mostly designed in result of stakeholder workshops 2 and 3. The discussion was based on recent and ongoing experiences of the SFMC with mapping of the forest areas of high public interest and negotiating agreements of forest management in those areas. Area of forest covered by forest management agreements as the main output indicator for implementing the strategy and its approximate target levels – 20% in ten years and 50% in 20 years have been defined at the workshop 3. At the same workshop it has been decided that the agreements must cover not only present mature forests but also these that will be mature for final cutting during the next 20 years.

The representative of SFMC has provided the first version of forest value classes for modelling. During workshops the stakeholders have also critically assessed the levels of compensation for cutting restrictions proposed by the experts of the Estonian University of Life Sciences and the levels have been adjusted accordingly. They have also provided their opinions about reasonable levels of parameters of the model.

However, the form of the working meeting does not allow a more in-depth discussion of individual issues. Therefore, we used the opinions of stakeholders as approximate orientations and we set the annual values for parameters ourselves, which also influenced the model outputs that describe the achievement of the goals of the strategy. So far, stakeholders have not had the opportunity to discuss the results of modeling. This option will only arise at the next stakeholder meeting. It is possible that, following the discussion, it will be necessary to adjust the model parameters to ensure the best reliability of the results (according to the stakeholders' assessment). The next meeting will also be an opportunity to discuss which segments of the private forest owners community would be more likely to use compensatory measures and which would not do so.

9.1.5 Results and interpretation

Results of modelling are presented in figure 9 and table 1.

The results demonstrate that the governance strategy can improve the provision of the PG of good-quality forest scenery and recreation opportunities in the target area - forest stand compartments in towns, densely populated areas and within a 100-meter-wide surrounding buffer zone. In figure 1 we can see the modelled increase of the main output variable – forest area covered by agreements of balanced forest management separately in private and state forest. In the state forest it reaches more than 500 ha in case of all scenarios. In the private forest it can reach from about 500 to 700 ha depending on scenarios.

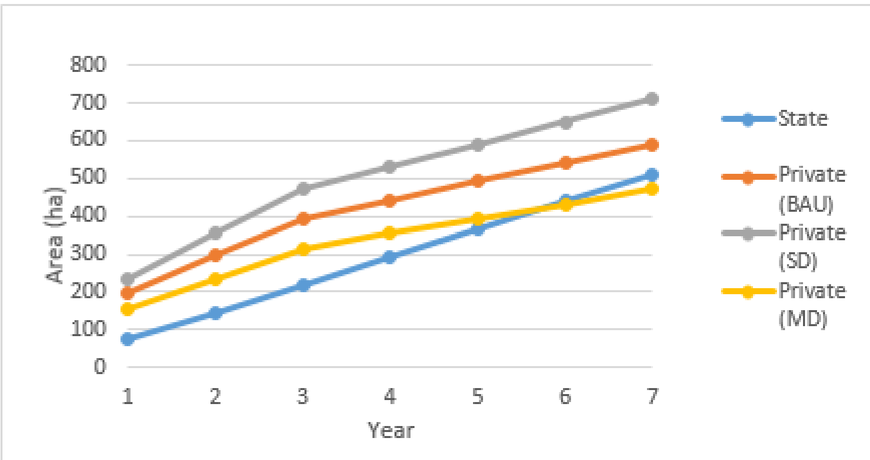

Figure 9. Yearly dynamics of the area of private and state forest covered by agreements of balanced forest management (ha) in case of different scenarios

In table 1 it can be seen that the final coverage of private forest with agreements variates between 20 and 30 % depending on scenarios when the final coverage of state forest stays the same.

Table 1. Areas covered by agreements of balanced forest management and public financial commitments taken by the end of seven years period in case of different scenarios

	Business as usual	Sustainability driven	Market driven
Area of forest in densely populated areas and surrounding buffer zones (ha)	3,273	3,273	3,273
incl: private forest	2,360	2,360	2,360
state forest	913	913	913
Area covered by agreements of balanced forest management (ha)	1,101	1,219	983
incl: private forest	590	708	472
state forest	511	511	511
Area covered by agreements of balanced forest management (%)	34	37	30
incl: private forest	25	30	20
state forest	56	56	56
Public financial commitments to forest owners taken with the forest management agreements(EUR)	38,428,959	45,460,177	39,083,532
incl: private forest	14,492,375	19,129,935	12,753,290
state forest	23,936,584	26,330,242	26,330,242

In the most likely BAU scenario case in about 30% of that area the forest management will avoid major conflicts with interests of the local population. As the value class 1 and 2 forest compartments dominate in mature forests, it is especially important to point out that the clear cut of large areas of those forests - which are also the most valuable PG providers - can be mostly avoided.

So effectiveness of the strategy that is based on voluntary agreements with forest owners can be assessed moderate in perspective of a period about 7-10 years. The judgement bases on the fact that the strategy is able to alleviate the problem but not to avoid it.

At the same time, the calculations demonstrate that even the specific moderate cutting restriction which has been accepted in the BAU case the model forecasts about 38 million euros of financial commitments. Most of the commitments mean decrease of state budget revenues because of reduction of state dividends from SFMC. About 14 million euros are payments of environmental support to private forest owners from the EU funds. Keeping in mind, that all these costs will be beard in form of annual payments/reductions of dividends during the following 20 years and measures for restricting forest management are costly because of the high price of timber, the efficiency of strategy can be assessed satisfactory or good.

Comparing the calculations for different possible futures it can be seen that implementation of the strategy is the most effective in case of SD scenario as it attracts more private forest owners, produces more agreements and covers a larger area with agreements of forest management than BAU. So the provision of PG improves most. But the efficiency of strategy can be lower because of likely increase of timber prices and corresponding raise of costs from GM2 and GM3 per ha.

In case of the MD scenario the prevailing consumption models do not stimulate private forest owners for conclusion of agreements of forest management. Opportunities of reducing dividends still attracts the SFMC, but the local governments have less pressure for providing PG from the population. In the result the effectiveness of strategy implementation can be assessed as lower than in case of BAU. At the same time, costs of GM2 and GM3 per ha are high. The efficiency of strategy is the lowest. However, reaching PG provision improvement on 30% of forest compartments is still high enough for justifying implementation of the strategy.

9.1.6 Discussion

9.1.6.1 Discussion of results

The key issue is how reliable the modeling results can be considered. Uncertainty arises from two sources – the novelty of modelled situation and the simplifications used in the model.

Because of novelty of the modeled situation, it is inevitable that the parameters determining the operation of the model - the coefficients describing activity of concluding contracts, and the compensation levels used for compensation of cutting restrictions are introduced without any test in practice.

The coefficients describing activity of concluding contracts should be just plausible. The activity of private owners can be verified by analogy with the rate of utilization of NATURA 2000 environmental support to private forest owners. In 2014 using of that support scheme has reached 69% of the target area in Estonia[27]. It should be kept in mind that the receipt of NATURA support does not require the applicant to engage in any forestry activities and the prohibition/restrictions of forest management apply regardless of the support. The conclusion of forest management agreement with local governments, however, implies voluntary commitment to forest management and, in many cases, the abandonment of fast income generation because of cutting restrictions.

Hence, the rate of participation in agreements of forest management is likely to be significantly lower than that of NATURA. It is believable that the entry of private owners into contracts goes a slowdown and reaches its limit level within a decade. In our model, it has been selected at least twice lower than for the NATURA grant membership. However, in the case of SFMC, concluding of contracts can be expected to continue to grow, and the speed of this process depends, in essence, on the administrative capacity of the institution.

The levels of compensation for cutting restriction are based on the calculations of the Estonian University of Life Sciences. Therefore, they are credible, but there is no knowledge of their attractiveness to private forest owners. In any case, they are significantly higher than NATURA grant rates, which allows for the assumption of attractiveness.

The model deliberately simplifies the aspects for which we do not have a firm prediction. For example, it is expected that contracts with both private owners and the state will cover all value classes of forest at the same pace. It is also assumed that only one type of cutting restriction is applied and it is automatically applied to all class 1 and 2 forest areas. At the same time, we know that the cutting restrictions that can be agreed in practice may vary greatly. On the one hand, for a certain very valuable forest compartment, a full ban of final cutting may be imposed, in which case the compensation should cover the total value of the forest. On the other hand, clear cut in class 1 and 2 forest may also be permitted at times. Ultimately, a really functioning compensation system should be considerably more flexible than that which is used in our model. Thus, we can interpret the volume of financial liabilities

[27] „Eesti maaelu arengukava 2007–2013“ järelhindamine. Lõpparuanne, p 315. https://www.agri.ee/sites/default/files/content/arengukavad/mak-2007/seire/mak-2007-jarelhindamine-aruanne.pdf

calculated by the model as an approximate estimate of the average value of potential financial liabilities.

In sum, we can consider the values of output indicators calculated by the model to be plausible, but fairly rough estimates of the areas covered by the contracts and the amount of financial liabilities incurred. In particular, this will allow us to give general assessments of the expected efficiency and effectiveness of the studied strategy. This, in turn, can be used as a basis for deciding whether it would be worthwhile considering putting in place technically elaborated and practically implementable governance mechanisms.

9.1.6.2 Discussion of methodological approach

In our chosen approach, we try to quantitatively predict the outcome of implementation of the strategy - the size of area covered by balanced forest management contracts and the financial commitments necessary to achieve this result.

The main strength of this approach is the quantification, which allows a clear distinction to be drawn between the output variables' values achieved in different scenarios. This, in turn, provides a basis for benchmarking the efficiency and effectiveness of the strategy.

However, the weakness of the approach is, first and foremost, describing the behavior of forest owners using parameters values of which can only be determined by expert assessments.

It is likely that the expert estimates of the parameters' values can be improved by analyzing the reliability of results of predictive calculations made on the basis of one estimate and correcting the estimation of the parameters when the results are poorly credible.

9.1.6.3 Discussion of the participative elements in the modelling approaches

The stakeholders' input to any process of designing GMs is extremely important. This is caused by their main strength: the mastery of specialist know-how, which includes both technological, legal, economic knowledge and knowledge of attitudes and behavioral patterns among stakeholders. Stakeholder involvement creates good prerequisites for adapting GM to the needs of implementers and target groups.

However, when it came to the development of a mathematical model, stakeholders who were representatives of businesses and the government sector by their profile, were not asked to participate. As a contribution by them, we first of all expected an opinion on the values of the model parameters.

So far, stakeholders have not had the opportunity to discuss the results of modeling. It is possible that, following the discussion, it will be necessary to adjust the model parameters to ensure the best reliability of results.

9.2 FI-1: Scenery and recreation in forest landscapes in Ruka-Kuusamo in North-Eastern Finland

9.2.1 Introduction

9.2.1.1 Description of case study region

The Finnish case study region, Ruka-Kuusamo, is located in Kuusamo, a town and municipality in north-eastern Finland. Distance to the nearest bigger cities such as Oulu is 217 km, Rovaniemi 195 km and Kajaani 245 km. A flight to Helsinki, the capital of the country, takes about an hour. The acreage of the municipality is 5,809 km^2. As much as 84 percent of the municipality's total land area is forested, and 82 percent of the forest is in non-industrial private ownership (National Forest Inventory 9 2016).

In the beginning of 2016, the population of Kuusamo was 15,688. The population density is low (3.2 inhabitants/km^2), with 70 percent living in the town centre and the rest in sparsely populated rural area. Of employed people about two-thirds work in services such as tourism, one-sixth in processing industries, and about 10 percent in agriculture, forestry and reindeer husbandry.

The nature of the area is rich with hills, fells, lakes and rivers, which has given excellent preconditions to develop tourism as a significant livelihood in the region. Tourism and related services have currently a significant role in the region's economy.

One of the largest ski resorts in Finland, Ruka, is located in Kuusamo (Fig. 1-3). The famous Oulanka National Park locates also in the area (Fig. 4). Annually, around one million tourists visit Kuusamo leaving a total revenue of over 90 million € and providing full-time employment to over 800 persons. About 23 percent of visitors staying overnight are international tourists. The key tourism activities include down-hill and cross-country skiing, snowshoeing, snowmobiling, husky safaris as well as hiking, cycling, canoeing and observation of birds and other boreal species (Fig. 5-6). (Facts about Ruka and Kuusamo 2017).

Figure 1. In Kuusamo-Ruka, one of the largest ski resorts in Finland, ski season lasts annually more than 200 days (Photo: Ruka-Kuusamo Tourist Association)

Figure 2. In the summer, hiking is one of the most popular tourism activities in Ruka-Kuusamo (Photo: Ruka-Kuusamo Tourist Association).

9.2.1.2 Description of public good issue

Due to dominating role of forests, the investigation of public goods was also related to forests. The selected public good of the study was scenery and recreation in Ruka-Kuusamo. This is an interesting study topic because of the fact that most of the forests are in private ownership in this region, which means that commercial forestry is an important source of livelihood for many owners and individual owners are not necessarily able to benefit from the recreational use of their forests. In addition, one of the few industries processing local raw materials is a large saw mill dependent on wood harvesting from private forests. Simultaneously, nature-based tourism is dependent on beautiful forest landscapes and recreation possibilities, which are often negatively affected by forest management practices such as clear cutting, soil preparation and ditching. The present and possible future boom of biorefineries and renewable energy production has been predicted to further intensify the forest harvesting – increased demand together with potentially increasing timber prices may thus encourage owners to cut their forests more. This may potentially damage sceneries for decades as it takes decades until the forest landscapes recover in these boreal conditions and high altitudes.

Figure 3. The possibilities for cross-country skiing in Ruka-Kuusamo are excellent. The total length of cross-country ski trails is 170 km, of which 34 km are illuminated. Ski trails are available for all skiers for free (Photo: Ruka-Kuusamo Tourist Association).

Figure 4. Ruka-Kuusamo has a wide range of walking options, from one-day hikes to the 80 km Karhunkierros (Bear's Trail) in Oulanka National Park (Photo: Ruka-Kuusamo Tourist Association).

9.2.1.3 Description of governance-strategy

In order to take into account the interests of both tourism and forestry sectors, a development of a new PES-system, called Landscape and Recreational Values Trading (LRVT), has been proposed. Under this kind of typically many-to-many system (many sellers, i.e. forest owners and many buyers, i.e. tourists and/or tourism entrepreneurs), forest owners would make voluntary fixed-term contracts. Based on the contracts, they would maintain and increase scenic and recreational values in a certain forest area within their holdings and get monetary compensations. Instead of clear-cutting, for example, that might potentially be prohibited in the LRVT agreement, regeneration may be allowed through patch clear-cutting or small-scale seed tree or shelter wood harvesting only. Funds for the compensations would be collected e.g. from visitors and/or tourism entrepreneurs using the forest areas. In addition to the proposed PES system, it could be supported with landscape oriented forest management recommendations that would inform forest owners on how to manage their forests in a way that is less harmful for landscape and recreational possibilities.

Economic incentives for securing landscape and scenic values in forests within tourism areas are currently missing for private landowners. The landscape management is acknowledged in existing sustainable forest management recommendations and guidelines for private forests. The measures include recommendations to leave, for example, buffer zones and retention tree groups in clear cuttings. In areas where the importance of tourism is high, these actions may not be enough and their implementation is based largely on voluntary actions of landowners. In addition, biodiversity conservation instruments exist, but they are not directly applicable for safeguarding of landscape and recreation values of forests.

Compared to the existing instruments, LRVT has several advantages. For example, with help of LRVT it is possible to improve integration of the activities of two important livelihoods, i.e. tourism and forestry, in the region. In addition, as agreements are voluntary for both parties, the acceptability of the instrument is suggested to be good both among forest owners and tourism entrepreneurs. The ownership of the land remains with the landowner. Moreover, with LRVT, the uncertainty of the tourism entrepreneurs regarding abrupt changes in forest areas, where their business activities take place, will decrease. Typically, the use of forest area for other purposes (hunting etc.) does not change. Moreover, LRVT distributes part of the tourism incomes to the whole region and thus supports the viability of rural areas. Altogether, the effects on social sustainability are positive. The system also encourages tourism entrepreneurs to identify their corporate responsibility and their role in safeguarding environmental quality of forests in the region.

If LRVT would be implemented it would help to maintain adequate quality of forest landscapes for tourism. Furthermore, the system would help to mitigate the most harmful effects of anticipated future cuttings and improve the overall environmental quality of landscape over time. It is also possible that improved landscape management would attract new (nature oriented) groups of tourists to the area giving opportunities to expand the tourism business in the region. It would increase the local acceptability of the tourism sector, improve the integration of forestry and tourism, and enhance co-operation between people working within the both industries. Finally, it would secure and increase the local vitality of the region and decrease the loss of population in the long run.

Figure 5. Husky safaris and visits to husky farms are exciting experiences for families visiting Ruka-Kuusamo (Photo: Ruka-Kuusamo Tourist Association).

Figure 6. The right of common access or every man's right allows all people to go and pick berries in undeveloped areas in Finland (Photo: Ruka-Kuusamo Tourist Association).

9.2.2 Methodological approach

9.2.2.1 Model structure and implementation

The aim of this study is to assess the viability, applicability and cost-efficiency of the implementation of the different versions of LRVT. The following four alternative versions of LRVT were designed by the researchers of the study:

1. **Inclusive LRVT**: The participation of persons with registered overnights into LRVT is obligatory. Payments are charged within the price of accommodation by all companies providing accommodation services in the municipality of Kuusamo (price e.g. 1 € (+VAT)/day). The funds are transferred to a local association that consists at least of the representatives of Kuusamo Forest Management Association, Ruka-Kuusamo Tourist Association and the representative from the municipality. The association uses the funds for making agreements with forest owners. In the targeted sites of the agreements, cuttings are totally prohibited during the contract period. Compensations are determined by bidding prices given by forest owners meaning in practice that the agreements are tendered out between the owners (i.e. leading to a situation where environmental friendly forest owners may participate with a cheaper bid). In the selection of forest areas to the LRVT, forests near important tourist attractions and the roads through which tourists arrive to Kuusamo and Ruka are preferred.
2. **Company specific LRVT**: The participation in the mechanism is voluntary. The companies take care of the collection of funds from their clients with their own LRVT models. Similarly using their own model, the companies independently make contracts with forest owners and prefer the forests and provision of services in neighboring areas where their clients (or the clients of their cooperation partners) usually recreate in the nature.
3. **Diverse LRVT**: Participation into the LRVT system is voluntary both for companies and visitors. Funds are collected diversely with e.g. voluntary payments through companies providing accommodation services as well as with a user friendly mobile application that is promoted all over the tourist attractions of Kuusamo region. The funds are transferred for the use of the managing association that consists at least of the representatives of Kuusamo Forest Management Association, Ruka-Kuusamo Tourist

Association and the representative from the municipality. The association uses the funds for making agreements with forest owners. Forest management practices on the target sites are specifically tailored with the help of Forest Management Association ensuring that landscape values do not suffer. The compensations determined are based on opportunity costs assessed by Forest Management Association. The association makes choices among the available sites favoring the forests including both landscapes and recreational values.

4. **Large LRVT**: The mechanism covers large area that extends to the whole area of Kuusamo municipality and thus allows large participation to LRVT system. In addition to the payments (1 €/day) tourism companies collect from their overnighters, the owners of holiday homes and huts have to pay a landscape fee (e.g. 50 €/year). At an early stage of the implementation of the LRVT system, Kuusamo municipality supports financially the mechanism. The compensations are targeted to forest owners based on the area of their whole forest properties. In an agreement, a forest owner binds oneself to follow landscape friendly forest management practices throughout his/her forest property. These practices include a restriction that clear cuttings larger than 1 hectare are not allowed.

These alternatives were evaluated by a group of experts with a survey using MCA-based method. Their expertise was related to forest management, tourism business, and regional planning. The following criteria and sub-criteria were used in the survey:

1) Cost-efficient allocation
   a. Allocation in forest landscape: the most important sites for tourism and recreational use can be included into the mechanism leading to preservation and improvement of their characteristics
   b. Acreage: with the available sum of money as large forest area as possible can be preserved and improved
2) Easiness and administrative lightness: the participation into the mechanism is easy and the resulting work load, bureaucracy and costs are low
3) Avoidance of leakage of funds: the funds of the mechanism are not used for the protection and improvement of sites that would not have been intensively managed without LRVT

4) Acceptance: the function and principles of the mechanism are fair and create good preconditions for tourism entrepreneurs, forest owners and tourists to participate into the mechanism
5) Funding base: The financial basis of the mechanism is extensive allowing to collect enough funds for protecting landscape and recreational values

9.2.3 Scenarios

The following three scenarios based on the provided more generic future scenarios were developed cooperatively with stakeholders to describe the development of the operational environment and its effects on the tourism sector operating in Ruka-Kuusamo area:

1. **BAU**: Winter-tourism continues to dominate despite the fact that the climatic conditions have shortened the season and increased the between-season variation related to skiing possibilities. The development in the number of visitors and their characteristics (e.g. proportions of domestic/international tourists, average number of nights etc.) remains on current trend.
2. **Environmentally oriented winter tourism:** In Ruka-Kuusamo, the popularity of winter-tourism increases further. General environmental orientation results in increased visits of true nature-oriented tourists (both domestic and foreign), who want to experience nature and untouched wilderness in area's forests. This increases demands for areas that have good environmental quality (nice landscape and possibilities to recreate) and that are easily accessible.
3. **International summer tourism**: The climate change and overall global tourism demand development results in a change of Ruka-Kuusamo tourism more towards summer. The number of international tourists increases notably due to increased far-distance travelling of Asian tourists to Finland. The Asian tourists in particular prefer organized activities near the main tourism resort. Nature near these areas needs to be in good conditions for this purpose.

9.2.4 Methodological approach

9.2.4.1 Theoretical background

The governance strategy, i.e. the properties of the proposed LRVT instrument and supporting forest management recommendations, were evaluated with quantitative approach based on the use of multi-criteria method (MCA). First, a decision hierarchy (Fig. 7) was constructed.

The hierarchy included four levels below the main goal of MCA: scenarios (3), main criteria (4), sub-criteria (2 under only one main criterion) and at the lowest level the alternative PES-systems (4).

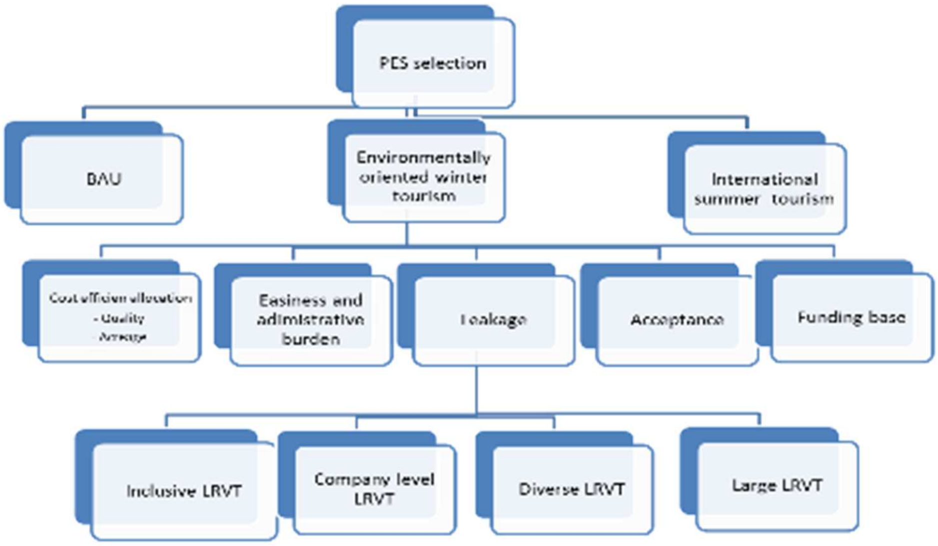

Figure 7. The decision hierarchy for MCA-based evaluation, in which the scenarios are at highest level, followed by main criteria (sub-criteria are shown under main criteria cost-efficient allocation) and finally the four alternatives.

The weighting of the elements of the decision hierarchy was done by using the SMART method. The SMART method is a simple and practical tool to evaluate and rank alternatives (Edwards and Barron, 1994; Kangas et al., 2008). In the method, the items that are evaluated against each other in the specific hierarchy level are given a numerical value that represents the importance of each item relative to other items based on the evaluators' subjective preferences (Kangas et al., 2008). For each weighting phase, the participating experts were asked to give an importance rating for the presented alternative, on a scale from 0-100 points. Firstly, they had to select the most important item among the given item list and give it 100 points. Proportionally smaller values were then given to the other items relative to the most important one. Multiple items can get the same values if the expert thinks that they are equally important. This weighting process was repeated for all hierarchical levels as well as for the evaluation of alternatives against each (sub-)criterion.

The weighting was done in bottom-up order, i.e. the experts were asked to start from the bottom of the decision hierarchy. In addition, the evaluation was performed separately under each scenario, starting from BAU-scenario. Finally, the experts were asked to perform the evaluation concerning the probability of each scenario similarly as explained above, i.e. by giving 100 points to most probable scenario and then evaluation the probabilities of other scenarios. All these phases were performed through a questionnaire (either in paper or directly to word file) prepared for this purpose.

Once the experts had filled the questionnaires that included their preference information, relative priorities were calculated out of them. The calculations were done so that e.g., the points given for evaluations concerning the four main criteria were summed separately for each expert and the priority of each criterion was calculated by dividing the points of the criterion by the sum for each expert (Kangas et al., 2008). This resulted in normalized priorities between 0 and 1 for the main criteria so that their sum was equal to 1. Similar calculations were performed to sub-criteria and evaluations of alternatives against the criteria. The averages among all experts and some relevant sub-groups were calculated and reported.

In addition to phases above, also a holistic evaluation of alternative PES-arrangements was carried out by each expert by using the SMART method too. This evaluation was done before going to more detailed evaluation of alternatives. The aim was partially to validate the adopted criteria: if the holistic evaluation gives clearly different results than the more detailed evaluation, it is possible that some important criteria are missing and/or that wrong criteria has been included in the decision hierarchy.

9.2.5 Participative approach

Participative approach conducted in the development of the governance mechanism and its evaluation included initial phone interviews in late autumn 2015 and early winter 2016 and three workshops with local and regional stakeholders having expertise on forest management, tourism industry and town and regional land-use and forest planning.

The aim of the initial interviews was to gather the preliminary views of key stakeholders about public goods and bads (PGBs) from agriculture and forestry in the county of Northern Ostrobothnia, where Ruka-Kuusamo is located. The first workshop, in February 2016, examined in more detail the stakeholders’ views concerning the use of natural resources of the region, especially the non-material benefits (public goods) of agriculture and forestry in the county. In the workshop organized in winter 2016, the concept of PGBs was further clarified and agreed, and the existence of public goods within the region was elaborated and the hotspots of public goods mapped.

The second workshop, in June 2016, defined the hotspots of public goods that had been chosen for the future analysis. The new policy instruments for smart delivery of public goods, including LRVT, were presented to and discussed with the stakeholders. Related to information needs, future valuation surveys and means for decision making were presented and discussed.

In the third workshop, in May 2017, the preliminary results of two valuation studies, i.e. a supply side survey for forest owners and a demand side survey for tourism related companies, were presented and discussed. The possible alternatives for the implementation of a new policy instrument, LRVT, to manage landscape and scenery values was presented and discussed. Related to the implementation of LRVT in Ruka-Kuusamo, the stakeholders discussed the general aims, scale and special target sites of landscape preservation. More specifically, the following questions were discussed: how landscape values should be increased, what kind of guidelines for forest management should be produced, and what kind of criteria should be used in order to assess the usefulness and applicability of the alternative versions of LRVT. The whole participatory process affected and facilitated the implementation of the evaluation assessment described in this report.

Based on the participative approach described above, the researchers of the project developed a questionnaire to evaluate and compare the four alternative versions of LRVT with respect to the criteria that were found important in the discussion with participating stakeholders. In addition, the above presented three scenarios were included in the evaluation. The survey was sent to a small number of experts in forest management, tourism industry and town and country planning. The experts were asked to prioritize the alternatives, criteria and evaluate the scenario probabilities. The respondents of the survey were partly the same persons participated in the workshops, and partly other relevant experts.

Evaluation responses were received from 13 experts. Seven of them represented forestry sector, four tourism entrepreneurs and two public sector. Five experts represented more the region of Northern Ostrobotnia, whereas the rest (8) were clearly local experts from Kuusamo.

9.2.6 Results and interpretation

Regarding the probabilities of future scenarios, half of the experts expect some changes to take place in the future as the probability of BAU scenario was the lowest among tourism and public sector experts (Fig. 8). Among experts representing forest sector, the differences between scenario probabilities were rather low. Among tourism entrepreneurs, both environmentally oriented winter tourism and international summer tourism got equal probabilities. In fact, several experts indicated (qualitative feedback) that the combination of these two would be desirable.

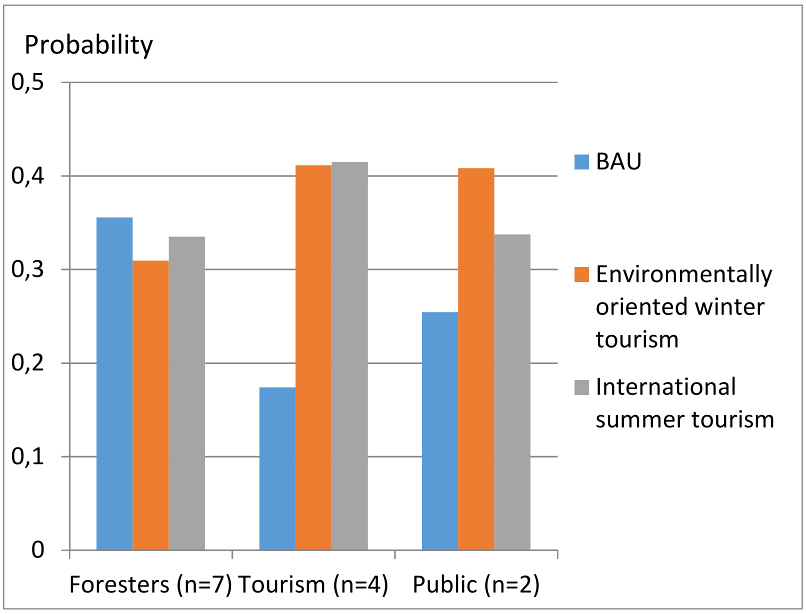

Figure 8. The scenario probabilities (n=13)

The priorities of the five main criteria (Fig. 9) differed rather clearly between the expert groups. In all three groups “leakage” got small priority. Among foresters, the “cost-efficiency” and “acceptability” got the highest priorities. Among the tourism experts, the acceptability got clearly the highest priority followed by cost-efficiency. Among public sector respondents (only two) cost-efficiency and funding base got highest priorities.

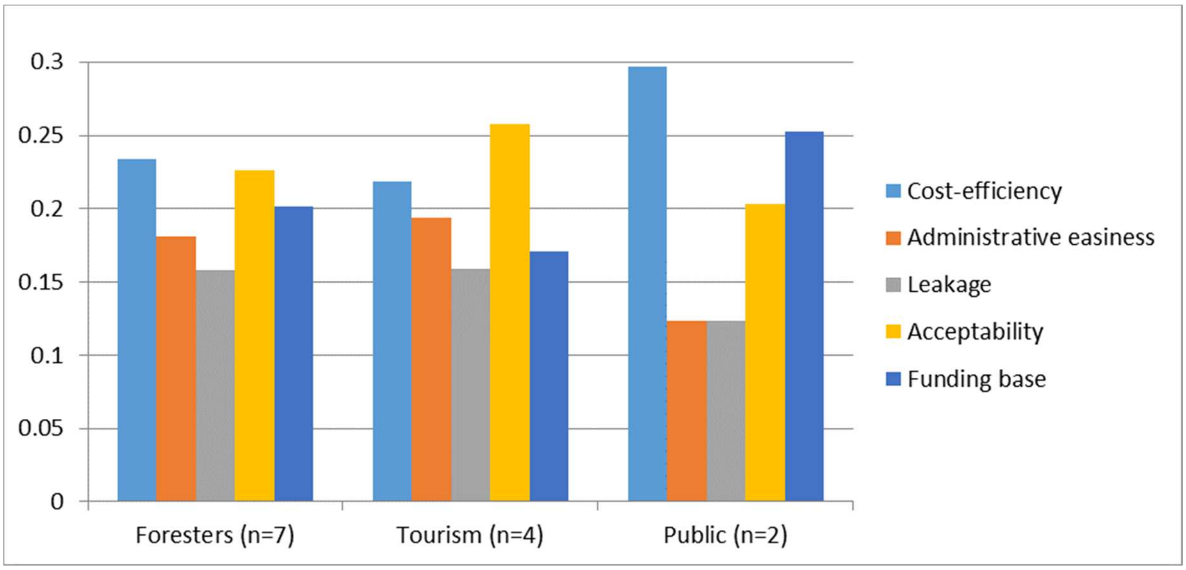

Figure 9. The priorities of the main criteria among the three expert groups.

Regarding the success of PES alternatives against the six criteria (four main criteria and two sub-criteria for one main criterion), the differences between scenarios were rather minor. Under criterion "quality", the "Obligatory" PES had the highest priority in all three scenarios. For criterion "Area", the "Obligatory" as well as "Broad" PES system got highest priorities. Regarding "Administrative easiness", company based got highest priority in all scenarios, which is natural as it can be considered that the scarios do not affect this criterion much. For "leakage", "Company based" PES was prioritized to highest position in two scenarios and to second highes position also in "International summer tourism" scenario. Under criterion "Acceptability", there was some variation(n: "Company based", "Versatile" and even "Obligatory" PES alternatives got highest priorities in some scenarios.

Table 1. The priorities of PES alternative against individual criteria calculated as averages from the responses of 13 stakeholders for each scenario (in each row, the PES alternative having the highest priority in scenario is written in **bold**, if the same PES alterative received the highest priorities in all scenarios, it is shown also in **red**).

	BAU				Environmentally oriented winter tourism				International summer tourism			
	Obligatory	Company based	Versatile	Broad	Obligatory	Company based	Versatile	Broad	Obligatory	Company based	Versatile	Broad
Quality	**0,036**	0,034	0,034	0,029	**0,043**	0,035	0,032	0,033	**0,043**	0,036	0,030	0,035
Area	**0,026**	0,016	0,016	**0,026**	0,028	0,018	0,019	**0,030**	**0,027**	0,022	0,023	0,023
Administrative easiness	0,045	**0,066**	0,040	0,028	0,045	**0,063**	0,040	0,031	0,047	**0,057**	0,038	0,034
Leakage	0,044	**0,045**	0,036	0,034	0,041	**0,043**	0,033	0,035	**0,041**	0,040	0,034	0,038
Acceptability	0,060	0,069	**0,074**	0,041	**0,062**	**0,062**	0,054	0,049	0,059	**0,065**	0,059	0,049
Funding base	**0,063**	0,040	0,034	0,063	**0,064**	0,040	0,043	0,056	**0,062**	0,038	0,042	0,058

The rank order of the four PES alternatives was, however, surprisingly similar in all scenarios. The "Obligatory" PES alternative is in all scenarios and in holistic evaluation in first rank. It is then followed by the "Company based" PES alternative. The third alternative was "Versatile" in BAU and Holistic scenarios. In the other two scenarios the third alternative was "Broad". The differences between the priorities of "Obligatory" and "Company based" PES were rather small in holistic evaluation and in BAU scenario. The differences were clearer in two other scenarios (Fig. 10).

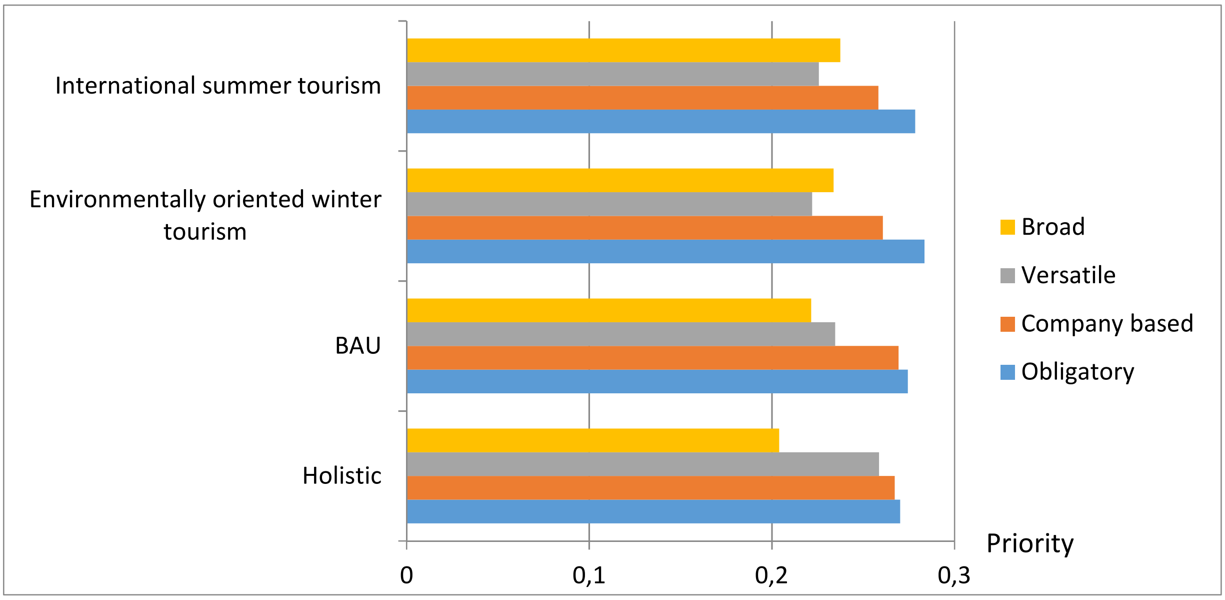

Figure 10. The global priorities of the four PES-alternatives in different scenarios (n=13).

Finally, the global priorities of PES alternatives among three expert groups in the scenario that was assessed to be the most probable by experts mainly repeat the above message. Only in "Public" expert group, the "Company based" PES alternative got the highest weight, followed by "Broad" PES. In two other expert groups, the "Obligatory" PES got highest priority followed either by "Company based" (among forestry experts) or "Broad" (among tourism entrepreneurs) (Fig. 11)

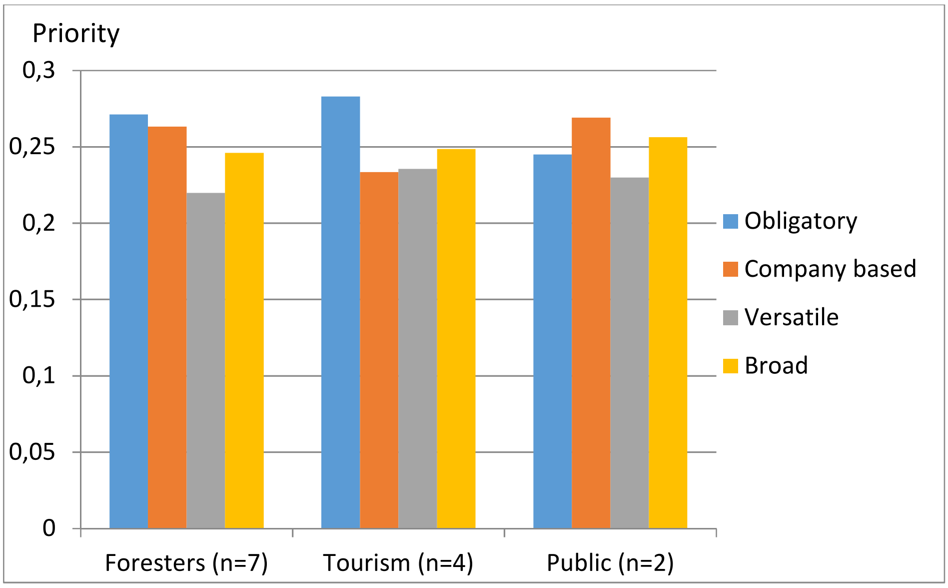

Figure 11. The global priorities of the four PES alternatives in the most probable scenario ("International winter tourism") in three expert groups.

9.2.7 Discussion

9.2.7.1 Discussion of results

The results of MCA evaluations indicated that three expert groups gave different weights to main criteria as well as different probabilities to future scenarios. Tourism related experts emphasized acceptability, whereas two experts from public organizations emphasized cost-efficiency and funding base. Forest-related experts in turn gave rather similar weights to these three criteria. This result is not surprising: the livelihood of tourism sector depends on the visitors and if the potentially implemented instrument is not acceptable to visitors, they lose their livelihoods. For forest owners and their background organizations, LRVT is more an additional tool which can diversify the use of forests and resulting income flows.

Despite differences in main criteria weights, there was not much variation in the global weights of LRVT alternatives. The obligatory LRVT was selected in all scenarios as well as in holistic evaluation. In addition, its global priority was the highest among forest and tourism experts. However, the MCA evaluation was beneficial both for the participating experts and for the development of the LRVT for the future. In the evaluation process, it became evident that the experts started to think the LRVT more practically and they also noticed that different environmental properties and characteristics of LRVT will be emphasized in different futures. In addition to the achieved quantitative results, this was a great additional benefit from the MCA study and it may initiate more solution oriented discussions and development work for the practical uptake of LRVT.

However, regarding the implementation of the LRVT and resulting improved provision of public good(s), a shortage of our MCA-approach is that that the results nor the descriptions of alternatives (e.g. if the “Obligatory” LRVT would be adopted in Ruka-Kuusamo) do not indicate how much important landscapes could be maintained or improved. However, the income and payment flows can be estimated roughly and used to proxy this. For example, if all registered tourists who stay overnight in Kuusamo (574 200, Tilastokeskus 2016) would be charged 1 €/night, there would be over 0.5 M€ available for LRVT-related costs. Obviously, major part of this sum should go to forest owners of the area. If the LRVT would be targeted to forest stands located next to walking and skiing routes in Ruka area (approximately 1500 ha), the average annual payment could be over 300 €/ha of forests, which typically is enough to cover the opportunity costs of delayed cuttings (Mäntymaa et al. 2014).

The scenario descriptions did not consider how the sectors outside tourism develop. Evidently, intensity of forest harvesting has an effect on the provision of landscape and recreational values in forests in which harvesting operations are allowed. Currently, there is almost a “boom” of investment plans related to establishing biorefineries and renewable energy plants also in areas, where timber from Kuusamo area could be delivered. At present, the demand of timber coming from thinnings of young forests has been very limited (with timber prices close to 0 €/m^3). If, for example, a planned pulp mill will be constructed in Kemijärvi, about 140 km north-west from Kuusamo, the situation will change remarkably. Although prices on average might not increase, the demand and harvesting levels will. One might predict that increased demand will further intensify the forest harvesting and encourage owners to cut their forests more (Polojärvi, 2017). This will have visible and wide effects on forest landscapes and sceneries and the prerequisites of nature tourism industry in the region. Increasing cuttings will further increase the need to develop governance mechanisms, such as LRVT, so that forest owners would have alternative uses for their forests and means to earn income from forests.

In addition, the role of the public sector in the development of the LRVT model will probably be important. This was not examined in detail in this study, although it was an element of one LRVT alternative. General support for the development of the PES-system is needed. Supportive funding from public sector during the first years might also encourage forest owners as well as local entrepreneurs to join the PES system.

9.2.7.2 Discussion of the methodological approach

The strength of the applied MCA-based evaluation is that it forced the experts to focus their work and subjective evaluations on the same topic. I.e. instead of discussing minor/irrelevant or only some specific topic related to LRVT, they were demanded to make a holistic assessment of alternatives. In addition, the results are quantitative and they can be tracked to the priorities of the criteria as well as the evaluation of the performances of PES alternatives against the criteria.

The approach also enables the participants to truly express their subjective preferences against the factors of the decision hierarchy. At the same time, the limitation is that the factors that have been left outside the hierarchy are not included in the evaluation. Same holds with the predefined alternatives - only limited number of discrete alternatives could be evaluated.

In practice, a much larger number of different LRVT alternatives could have been combined from the elements that were considered. However, the participatory process enabled to collaboratively build the decision hierarchy. Qualitative feedback was not systematically collected during the MCA-evaluation phase, but the elements that were included in the decision hierarchy (scenarios, PES alterantives) received rather positive feedback from experts who participated to the rather laborious evaluation task.

As always in MCA, there was a need to limit the number of scenarios, criteria and alternatives so that the amount of evaluations would not become infeasible for experts. Still, the assignment was considered difficult and time consuming in some feedbacks from the experts.

As mentioned above, the MCA results do not inform how in practice the provision of the examined public good would change. However, the results clearly indicate that all expert groups assessed that the sub-criterion "acreage" has clearly smaller weight than the sub-criterion "quality". Roughly, the local priority of the former was two times bigger than the latter sub-criterion. This clearly indicates that forests having particularly high recreational /scenic value should be included within the LRVT. Such forests can be found near the walking and skiing routes as well as in the vicinity of some of the most important scenic places.

9.2.7.3 Discussion of the participative elements in the modelling approaches

One limitation of the participative approach conducted in this study is the balance of the parties of the process. The questionnaire was found rather difficult and time-consuming among some experts. For example, actual tourism entrepreneurs were not very willing to participate to the evaluation. Similarly, the representative(s) from nature protection related organization are missing. Filling this kind of questionnaire is probably easier for experts from research, public sector or lobbyist organizations than for entrepreneurs involved into this kind of work for several reasons. Entrepreneurs or business executive may, for example, be too busy or focused only on their own business to participate in this kind of processes if they don't see the direct benefits of the work to their company. In addition, they may sometimes not be so experienced or accustomed to make contributions during the process than public officer or lobbyists are. When trying to minimize this problem, we communicated the entrepreneurs or executives by explaining the backgrounds of the project and motivated them to make their input, but with rather low success rate. This is an important issue as the final objective of LRVT is to co-ordinate the two important industries of the region, commercial forestry and nature tourism.

In addition, the validity of the scenarios and other elements of the decision hierarchy affect the success of participatory approach. The scenarios should fit the realistic future development paths of the local actors, and they should be balanced. If the scenarios are relevant for various stakeholders, their interest to respond to questionnaire will increase. In particular, during the third workshop (spring 2017), the stakeholders gave valuable feedback regarding the contents of future scenarios for Ruka-Kuusamo and they also discussed the potential of different PES alternatives for the area. The discussion was not that much open and present in earlier workshops, because the topics were more conceptual (defining public goods etc.) However, in the last workshop, the discussion was much more open and inventive because the topics were much more practical. Concerning the end result, it can be concluded that the scenarios were found relevant and interesting among experts, and one reason for that was the input from (other) experts. However, the combination of increased winter and summer tourism was missing among alternatives.

Participative approach seems very useful for developing PES-systems as both sectors stressed the importance of acceptability of the mechanisms and the processes behind it. The participatory approach introduced here has created a forum for discussing issues and given further insight to criteria that are important in the design process of PES-system.

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9.3 CZ-2: Recreation services and biodiversity in the National Geopark Ralsko in Northern Bohemia

9.3.1 Introduction

9.3.1.1 Description of case study region

The case study region „Northern Bohemia“ consists of two districts (LAU1): CZ0421Decin and CZ0511 Ceska Lipa. The area of the case study region accounts for 1982 km^2 and there live 235 thousand inhabitants. The average income (in PPS GDP per capita) amounts €11500 in 2012 which is 40% below the EU average and 25% below the national average.

The share of agriculture on the case study region GDP is 2% and the share on the labour force is even lower - only 1.5%. The characteristic feature of the CSR "Northern Bohemia" is its turbulent demographic and socio-economic development. The majority of population in this region were Germans who were expelled after 1945. The new settlements were unstable, people migrated in and out of the region frequently. Because of the lack of people agriculture and manufacturing industry collapsed after WW2, later they both recovered. However, the infrastructure remained fairly underdeveloped comparing to the other parts of the country. Agriculture and textile industry experienced a further shock during the transition period in the 1990s. People moved out again.

The CSR population density of 118 inhabitants per km^2 is 12% below the national average (135 inhab./km^2). The HS area "CZ2" (National Geopark Ralsko) of 29400 hectares (294 km^2) is Predominantly Rural Region according to the OECD methodology. The current average population density in the NGR is only 29 inhab./km^2. Already in the 1920s the area was designated to military use. After World War 2 until the early 1990s there were situated an air force base (in the middle of the north-west corner see **Errore. L'origine riferimento non è stata trovata.**) and a military mechanical engineering research institute. Because of this, number of villages depopulated and disappeared. Between 1968 and 1991 the area was occupied by the Soviet Army; during this period there were housed families of Soviet soldiers - thus the area was temporarily more densely populated but with highly unstable settlement.

After1989, it became clear that the area no longer would be used by the army. There were some attempts to privatize the land, the regional government (Libercky kraj), and local municipalities were but interested in getting the forests in their ownership. Finally, the government decided to keep most of the former military area in the state ownership. Nowadays, most of these land belongs to the state (80% of NGR) under the management of the state company Military Forests and Estates (Vojenske lesy a staky, VLS). The rest of the forest land belongs to the Municipalities Ralsko and Doksy, and some individual owners. The former air force base was transferred to the region "Liberecky kraj" – managed by the regional government.

Figure 1 Forest landscape of Geopark Ralsko

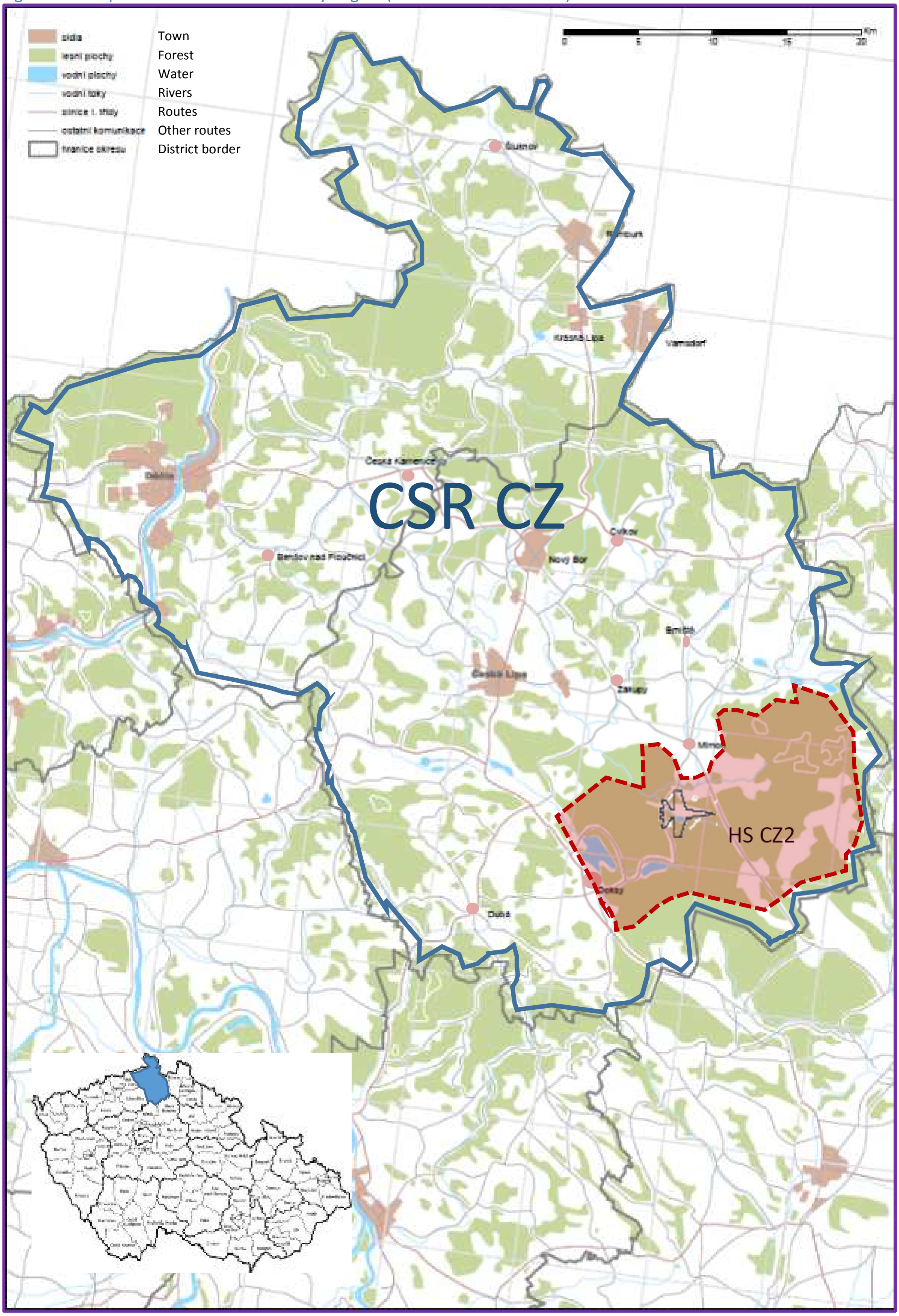
9.3.1.2 Description of public good issue

Since most of the NGR territory is afforested (90%), we concentrate on "forest" public goods: Recreational services of forests and biodiversity conservation. Later we have added "rural animation" as provision of it is one of the objectives of the National Geopark Ralsko.

There are both cultural and semi-natural forests. Cultural forests have here long tradition - production forests were established by the Wallenstein family in the 18 century. Production forests are predominantly mono cultural: spruce tree forests and pine tree forests, while the semi-natural forests are temperate broadleaf and mixed forests with a significant share of beech trees. The "social" value of the NGR forests accumulated for centuries; particularly, between 1948 to 1991, when most of the NGR area was closed to public while marginally used by the army. The low level of human activities provided habitat for wildlife. It was recognised already in the 1960s and biodiversity conservation territories were gradually established there. The closure of the military resulted in only few traffic roads pathing through the forests making the area quiet and comfortable for relaxation. Military activities of the occupation Soviet Army caused serious damages on forests and polluted soils in some parts of the military area, however most natural values continued to enjoy relatively favourable conditions for their preservation and development. After the withdrawal of the Soviet army the Czech Army started decontamination of the polluted spots which lasted roughly 10 years.

About one third of the geopark area is protected in the Protected Landscape Area Kokorinsko-Machuv Kraj. It means that 7056 hectares of forests are under weakly restricted regime of cultivation and recreational use. In the high protection area of 1385 hectares only natural forests exist (no logging is allowed there) and access of visitors is regulated – moving strictly along the marked paths and the number of hiking tracts is limited, no cycling or equestrian routes are permitted.

Figure 2. Hot Spot CZ1 within the Case Study Region (Source: own illustration)



The access of visitors is also moderately regulated in the fenced hunting ground Zidlov in order to protect white dear and European bison – which are raised there.

After the termination of the military use of the HS area a debate on the exploitation of it opened. Several studies on the potential of the former Military Area Ralsko for recreation and tourism (Table 1) appeared during the last decade. They involve the effort of the micro-region Podralsko (a group of municipalities in the broader area) to utilise the potential of quiet forest landscape for the development of the area. It includes building up new social networks and business structures.

A strong recreational place around the lake "Machovo jezero" with the town Doksy is adhered to the today's geopark from the south-west. The landscape around the lake is obviously overused during the season while in the rest of the year the low number of visitors undermine the recreational business. This was probably the reason why the town Doksy joined the initiative of establishing a geopark in 2013 with the expectation that it would provide new recreational opportunities and income from tourism.

Table 1. Review of studies on the development of tourism in the former military area "Ralsko" (Source: own review)

#	Document	year	NGR	Tourism and recreation
1	The strategy of the development of tourism in the Geopark Ralsko	2015	Y	The strategy provides 4 priority areas for the successful development of tourism in the NGR. These priorities built on SWOT analysis. A reference to earlier studies [5 in this table] is evident.
2	The study on the development of the Town Ralsko	2011	N.	Good potential for cycling and hiking, Poor infrastructure (lack of accommodation facilities for the development of tourism. Need to invest in promotion and infrastructure
3	Territorial plan of the Town Ralsko for 2015-16	2014	Y	A plan (intention) to invest in touristic infrastructure and recreational facilities, partly in association with the establishment of the NGR
4	Proceedings of the conference "The former military area Ralsko and its touristic potential" held in Mimon	2006	N	It includes a review of the positions/plans of key stakeholders in the region (private or public). Their commitment to participate on the development of the region is evident. The need for improving general and touristic infrastructure is strongly emphasized.
5	The concept of tourism in the Micro-region Podralsko	2006	N	NGR is not mentioned, but the territory is analysed. Deficiencies in infrastructure and poor offer of leisure activities is identified. On the other hand, great potential for tourism is emphasized.

We consider recreational service of forests/forest landscape as public good. Delivery of such PG depends on the possibility of to access forest landscape in an appropriate way by public; in turn it means there is need for investment in and maintenance of the respective infrastructure like hiking tracks, bike and horse riding routes, parking and rest places etc. In our assessment these are integral parts of the calculated costs of the PG provision.

In the case of biodiversity conservation, we adopted the approach of income forgone due to restriction on forest operations, namely logging.

On the other hand, we found (estimated) that there is considerable demand for recreational services of forests/forest landscape externally as well as locally. The strategy of the development of tourism in the Geopark Ralsko (2015) provides differentiation of customers with great focus on external visitors. This differentiation suggests that although there is demand for (recreational) visits, the supply to meet the demand will need to be tailored to the specific needs or expectations of the identified groups of customers.

9.3.1.3 Description of governance-strategy

A group of three activists (trustees) established a foundation “Geopark Ralsko o.p.s.” (FGR) in 2013 with the objective

1. to initiate the establishment of the National Geopark Ralsko (NGR) and to manage all necessary steps to comply with the requirements of the Ministry of Environment for the certification of the geopark and its inclusion in the National Network of Geoparks.

The NGR was finally approved by the Ministry of Environment spring 2016. Consequently, the objective changed in

2. to promote development of the territory of NGR. In turn it means to carry out activities in the following five directions
    a. promotion of natural, geological, technical and cultural values (amenities);
    b. broad education (popularization) on nature conservation, geology and associated scientific subjects;
    c. geological and environmental research and scientific studies;
    d. promotion of tourism and recreation
    e. promotion and coordination of development projects

In order to gain support of the main stakeholders in the area, the trustees appointed their representatives in the Board of Directors. The board of directors is the highest governing body of the FRG. It has 9 members of which four refer to the local stakeholders. Since the membership in the board of directors is restricted only to physical persons (legal entities are excluded), the members might no longer represent the stakeholders if their position within the stakeholder-organisation changes.

The activities of FGR are manged by the director of the FGR (Geopark Ralsko o.p.s.). The director is appointed by the board of directors and is responsible to it; at present the director of the FGR is no member of the board of directors.

There are two sources for financing the activities of the NGR (FGR):

i. targeted projects (grants) from public funds (including EAFRD)
ii. sponsors' gifts.

The obtained funds from the targeted projects are much bigger than sponsors' gifts. Most of the projects are limited in scope (narrowly targeted to some activities), only short term and very restrictive on what costs can be covered. So far, also sponsors have provided only funds targeted to a certain activity or a material. Before the official registration (approval) of the NGR, the foundation received a small institutional support (approx.€10,000) for the administration of the application.

In the course of project, we realised that cooperation of the local actors with the NGR was rather weak, that the objectives of the two main actors VLS and town Ralsko were not in the sufficient accord with the objectives of NGR and that there were apparent objections to certain NGR activities by some local actors. At the same time, we found that there was a considerable effort for coordination by the NGR management. The problem at least partly rest in the solitude of the FGR in its effort to develop the NGR.

Thus an improvement of the governance might consider two aspects: i) broader participation of local actors, local inhabitants and outside supporters (likely visitors) and ii) more sustainable funding. From the discussion with stakeholders we learned that the foundation had already applied for the membership in the LAG Podralsko and had thought about branded fundraising. In addition, we propose considering an introduction of associated membership to tight closer local volunteers and outside supporters to the NGR.

The associated membership and inclusion in the LAG will provide deeper integration of the NGR in the local social context creating a base for the justification of the foundation activities and coordination efforts. The management of the FGR does not consider turning the organisation in an association or a cooperative with a broad membership of stakeholders and supporter since there are fears of losing operability and flexibility.

Branded fundraising comprising franchise of the NGR label and sale of NGR promotional goods will further strengthen links with local businesses and people, and with outside supporters (visitors). Both will stimulate NGR identity in terms that cooperating stakeholders and interested people become adhered to the NGR.

Large cooperation and more stable funding under the coordination of the FGR will improve access of local inhabitants and visitors to the PG "recreational services of forest landscape". Gradually, the NGR as a framework might allow full utilization of recreational potential of the forests in balance with the demand of visitors. In the effects it will generate income for local businesses and people.

9.3.2 Methodological approach

9.3.2.1 Theoretical background

The starting point of our analysis is that the existing institutional arrangements have had difficulties to rise the provision of the PG "recreational services of the forest landscape". Based on our estimates of supply and demand for that PG we show that the potential for "forest recreation" is underused. We also adopted the assumption (resulting from the interviews and the desk research of materials concerning strategies and plans for the exploitation of the tourism potential in the former Military Area Ralsko) that the effort to establish the NGR has responded to the dissatisfaction with the arrangement which lacked long term strategy and concerted actions. While the FGR has succeeded to provide a strategy and increased considerably the provision of activities attracting dwellers (including pupils of local or neighbour schools) and urban visitors, it has struggled to put together sufficient funds and cooperating organisations to improve access of visitors to potential recreational services/benefits of the forest landscape so far.

In spite of the fact of the assignment of the key stakeholders to the Board of Directors - including the governor of the Liberec Region (NUTS 3), the FRG is disconnected from the communities in the broader area of the former military area Ralsko. The situation can be regarded as a competition of elites to gain power over the territory while provision of PG and consumers (local communities and visitors) stay aside - a situation largely common the postcommunist countries (e.g. Falkowski, 2013 or Furmankiewicz et al. 2010, Brautigam, 2000) and in the developing countries e.g. Bano, 2008).

Against our early expectations FRG appeared to lack clear justification that its activity refer to the voice of citizens and the establishment of the NGR was not an act of community driven development. It is unlikely that the FRG will be positioned on the top of the local hierarchy administratively (for example through the NGR) in the area. Instead, we propose to gain (coordination) power by demonstrating NGR's embedment in local and external social networks. It means "reconnecting" the FGR/NGR with citizens (inhabitants and visitors) and small businesses in the sense of Community Based Organisation (e.g. Tocqueville, 1994). Creating NGR (corporate) identity will be a part of this effort for "reconnection". Tightening local volunteers and external supporters to NGR by any form of associated membership will be another and linked way.

Our approach is qualitative deploying knowledge of experts and local stakeholders. This knowledge is mapped and classified (Grey et al, 2013). We created own routines in Excel Visual Basic for mapping, following closely the web application "mentalmodeler.org" (Gray et al. 2012). Mapping is also used in the evaluation of scenarios. However, we do not follow fuzzy logic for it; we used modified MAPP (Method for the Assessment of Projects and Programmes, see Appendix 6.4 of the Report on the Host Spot CZ 1.).

9.3.2.2 Model implementation

First based of our estimates (WP4 report) we derived equilibrium of the supply and the demand of the "recreational services of the forest landscape" in the NGR. We found that this point is around 300,000 visits a year, i.e. almost four times more than at present. However, in the work with stakeholders we adopted much lower target of 120,000 visits a year, because the stakeholders assumed the calculated figure unrealistic (and perhaps unwelcome) in the medium term at the workshop held in May 2017.

Since the stakeholders like VLS (Military Forests and Estates) or Town Ralsko, exhibited rather loose ownership toward the NGR and the idea of common management of the recreational services of the forest land, the scenarios as well as their assessment were elaborated jointly by the management of FGR and the team. It clearly limits the validity of the results, nevertheless it indicates benefits as they are expected by the management of the FGR. It is worth to stress that the proposed options for governance mechanism improvements are not only realistic, but already considered by the FGR.

9.3.3 Scenarios

As pointed out earlier, the current GM suffers two problems: i) insufficient admission of the idea of the NGR by the key local stakeholders, even they have taken part in the Board of Directors of FGR, and ii) weak funding, entirely relying on short term projects of public providers (from national and EU funds). As we explained in the theoretical part, we argue that the former can be mitigated by involving much larger range of stakeholders in the NGR project. Thus we consider two ways how to achieve it: by introducing associated membership which will be open to anybody (local or external) who likes the idea of NGR and wants somehow support it. The other option is to include NGR in the strategy of the LAG Podralsko while FGR will become a regular member of the LAG.

Concerning the funding, we consider branded fundraising activities and an institutional funding provided either of the national or regional government as plausible alternatives. The both aspects of the improved governance are presented in **Errore. L'origine riferimento non è stata trovata.**.

Table 2. Scenario definitions (Source: own definition)

		Participation options		
		current (limited)	open	through LAG
Funding	Current (short term projects)	1		
	Current + fundraising		2	3
	Current + institutional subsidy	4		

Of the resulting nine combinations in **Errore. L'origine riferimento non è stata trovata.** we selected four illustrative scenarios.

1. Scenario: Baseline - the current GM.
2. Scenario: Open participation and financial stabilisation through branded fundraising.
3. Scenario: Integration with LAG Podralsko and financial stabilisation through branded fundraising.

4. Scenario: Limited (current) participation and financial stabilisation through institutional funding.

All of the scenario aspects (as showed in Table 2) are represented in the analysis by 3 to 4 parameters. These parameters are summarized in Table 3 below.

Table 3. Translation of scenario aspects into parameters.

	Parameter 1	Parameter 2	Parameter 3	Parameter 4
Open Participation	Open participation (Associated members)	Voluntary activists	Associated members suggest priorities	Voluntary contributors
LAG integration	LAG member	NGR is a priority of the LAG	Cooperation in the LAG	LAG contribution
Branded fundraising	Franchise of the NGR label	Sale of promotional products	Fundraising specialist	
Institutional Subsidy	Institutional support	Promotional activities to the NGR label	Additional people in management and administration	
External conditions	Economic growth in NGR	General income growth		

In addition, we present the External Economic Conditions applied to all alternatives to the current situation (baseline). The both conditions (economic growth in the NGR as well as general income growth) have already progressed positively in the region and in the national economy.

9.3.4 Participative approach

9.3.4.1 Stakeholders' input to the development of the set of governance mechanisms:

The workshop in May 2017 disclosed some difficulties in collaboration among stakeholders. Gradually recognising that most of them refer to lack of meaning of the NGR to some stakeholders – perhaps also to the absence of clear benefits of the NGR. In effect we could continue only with FGR in the exercise on the GM.

9.3.4.2 Stakeholders input to the modelling exercise:

The development of the scenarios and their assessment was built on only very roughly structured interviews; in fact it was more brainstorming than interview. The responses and ideas were structured by the team afterwards. Also the values (judgements) were assigned to the scenario variables by the team in reference to what we noted in the interviews.

9.3.5 Results and interpretation

9.3.5.1 Overall results

The proposed improvements of the GM in three alternatives concern the sustainability of the NGR in terms of financial stability and collaborative interaction with local actors (including individuals/dwellers) and visitors assuring NGR embedment in social structures and provision of tangible benefits.

These three ways of improvements of the GM are examined against seven criteria/using seven indicators

i. Migration (in +/out -) or in other words the stability of population
ii. Attractiveness for dwelling which comprises beside the consumption of the NGR activities (recreational services) also an inclusion of the dwellers in the planning and preparation of these activities
iii. Attractiveness for visiting which rests in good access to the forest landscape and complementary services like accommodation, catering, bike rentals and maintenance services, etc.
iv. Diversification of financial sources for NGR development (referring to financial stability)
v. Business opportunities in tourism
vi. Income of local people
vii. Reregistration of the NGR. The Ministry of Environment will conduct a re-examination of the fulfilment of national geoparks objectives in 2022. We, experts and stakeholders will examine to which extent the proposed innovations of the GM increase the chance to pass the re-registration.

Trends of these indicators were assessed and a projection until 2050 was made under the current GM (a baseline) as the first step. Then scenarios were evaluated using the same set of indicators (i) to vii) in respect to the baseline. It means, the reported figures show improvements due to the scenarios assumption relative to the situation without these assumptions.

There is two theoretical assumptions that proposed changes will reduce transaction costs of the coordination of activities in long run:

1. open participation, associated membership: will link the NGR with local social and business structures and with nets of potential visitors. It will mobilise human and capital resources, on one hand and under a better expression of interest it will put pressure on the key stakeholders (forest managers, municipalities and the regional government) to participate in the fulfilment of NGR plans.
2. Integration in the LAG Podralsko will also reduce transaction costs by linking local businesses and public authorities in the effort to fulfill NGR objectives. In addition, some of the LAG resources might be directed on the support of this effort relatively easier than under the current GM.

It is important to emphasize the “long run” of these effect, since the current GM based on the FGR with restricted participation and rather limited interest of the board of managers to intervene in the managerial operations of the director of FGR has been regarded by the FGR management as reducing transaction costs and making the FGR operational (comparing to the efforts of many other organisations based on collective action.

9.3.5.2 Scenarios

Scenarios effects on people and business in the NGR

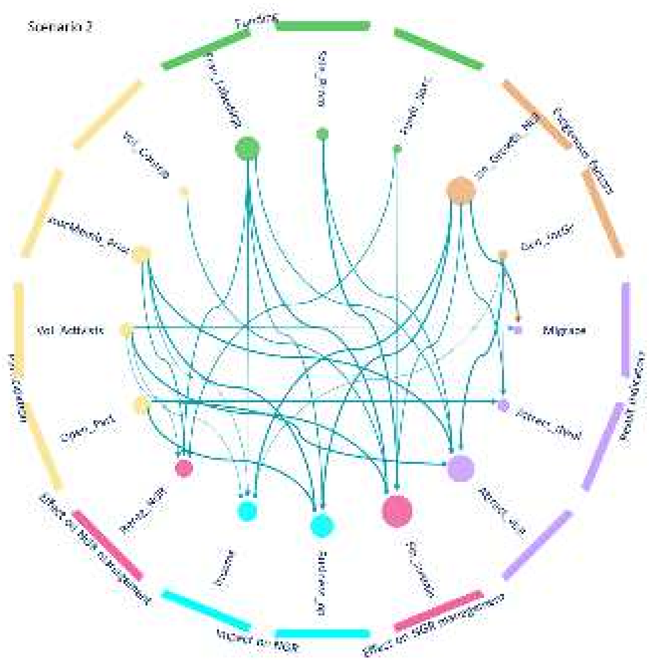
Below we present scenarios evaluation in three ways (Mapping the impact of scenarios’ individual attributes on the selected indicators of effects, Overall impacts of scenarios on the selected indicators of effects, Comparison of the individual effects of scenarios):

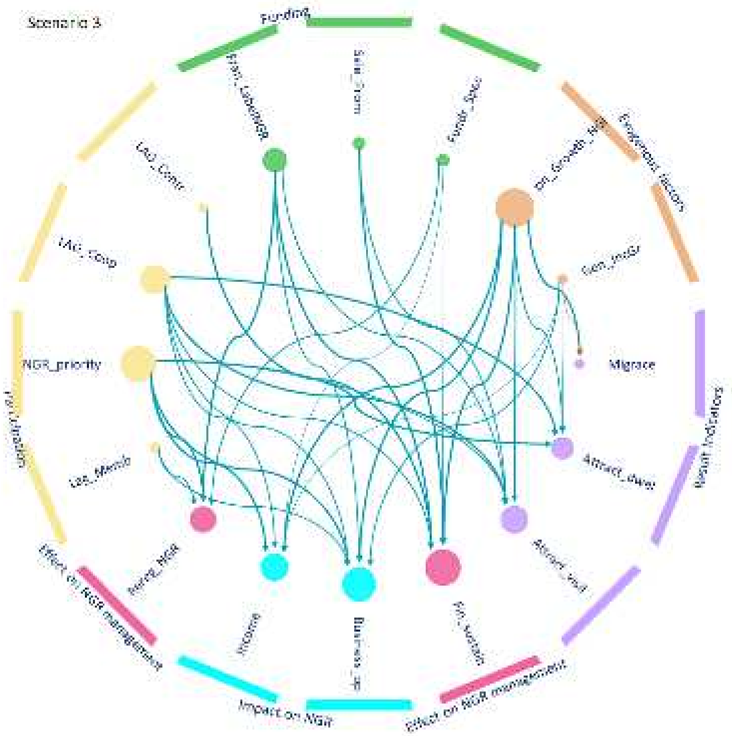
Mapping the impact of scenarios’ individual attributes on the selected indicators of effects (Figure 3):

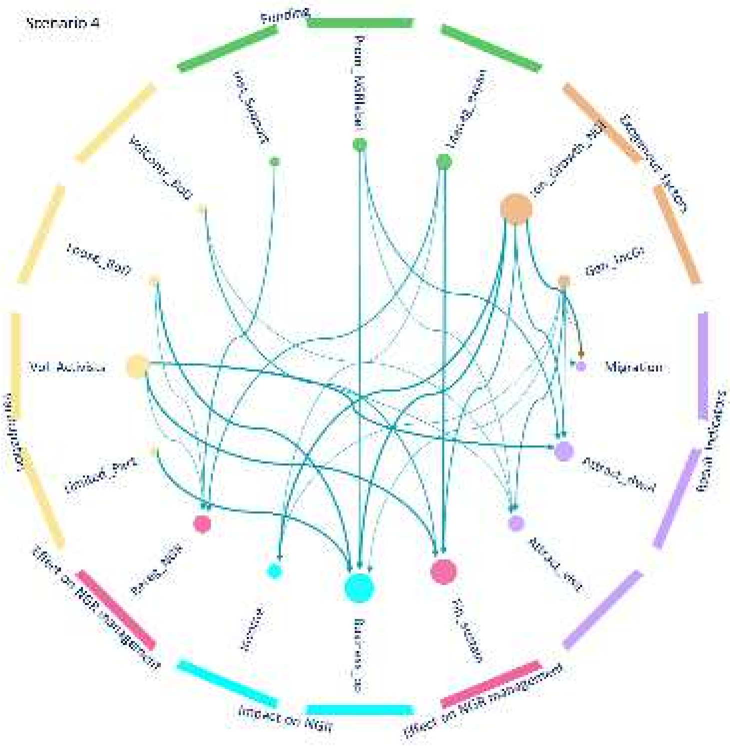
a. the upper hemisphere of the scenario charts (yellow, green and orange sections) represents the attributes of scenarios, while the lower one (violet, red and azure) refers to the indicators of effects;

b. the size of nodes refers to the sum of the appraisals of the influence of a scenario attribute on the selected indicators OR to the concentration of impacts; the bigger nodes the bigger influence or impact;
c. the thickness of edges [oriented curves connecting nodes – mostly scenario attributes with impacts (incl. outputs and results)] refers to the appraisal of experts on the level of influence between nodes in the direction of the arrow;
d. the colour of edges indicates if the influence is negative (orange) or positive (green blue)
e. The level of the provision of recreational services is represented by the indicators attractiveness for visitors” and “Attractiveness for dwellers”; the most important factors affecting them are open participation (Scenario 2) and integration in the LAG Podrlasko (Scenario 3).
f. However, the most affected indicators are financial sustainability of the FGR and business opportunities in tourism in the NGR; the latter is stronger in scenarios # and 4.

Figure 3. Scenario results




Scenario 3
Funding
NGR_priority
Migrace
Attract_dwel
Effect on NGR management
Impact on NGR
Effect on NGR management


Scenario 4
Funding
Migration
Attract_dwel
Effect on NGR management
Impact on NGR
Effect on NGR management

Abbreviation	Definition	Abbreviation	Definition
Migrace	Migration (in +/out -)	Limited_Part	No participation (A No associated members)
Attract_dwel	Attractiveness for dwelling	Vol_Activists	Voluntary activists
Attract_visit	Attractiveness for visiting	Loose_BoM	Loose cooperation of members of the BoD
Fin_sustain	Financial resources for NGR development	VolContr_BoM	Voluntary contributions of the members of BoD
Business_op	Business opportunities in tourism	Inst_Support	Institutional support
Income	Income of local people	Prom_NGRlabel	Promotional activities to the NGR label
Rereg_NGR	Reregistration of the NGR	Manag_expan	Additional people in managemen and administration
		Econ_Growth_NGR	Economic growth in NGR
		Gen_IncGr	General income growth

Source: own mapping

g. The establishment a collective action under the LAG (Scenario 2) enlarges technical measures for water retention and improves the state of the existing ones. Consequently, it improves water retention and availability of water for agricultural production. The effect on water availability on households is regarded as small (and in long term).

1. in contrast to Scenarios 2 and 3 Scenario 4 is weaker in the provision of the recreational services, while financial sustainability will be at the similar level in all scenarios.
2. In all scenarios, external conditions (economic growth) have strong impact on local income, business activities and financial sustainability of the FGR.

Overall impacts of scenarios on the selected indicators of effects

The overall evaluation of scenarios is presented in Table 4. The aggregated scores were categorised in the following way [<-10 – "- -"; <-10,-5) - "- " ; <-5,5> - "-/+"; (5,10> - "+"; >10 – "++"]

a. The three scenarios have the strongest impact of the financial stability of the FGR and on business opportunities in tourism in the NGR (++ in all cases).
b. In contrast, the effect of the three scenarios on in- or out-migration is marginal.
c. Both, broadening the participation (Scenario 2) and integrating the FGR/NGR in the framework of the LAG (Scenario 3) together with branded fundraising will have strong positive on the attractiveness of the area for visitors; it will also markedly stimulate

income of local people and strongly increase the chance for a smooth re-registration of the NGR in 2021.

d. Scenarios 2 and 3 have stronger impact on the indicators than Scenario 4.

Comparison of the individual effects of scenarios

In this part we first sum up the influences of individual parameters (drivers) to the level of the aggregated categories of GM factors (assumptions) and external drivers, and then we look at decomposition of the total effects of the scenarios [as we used them in ii)] in the effects of the aggregated factors by the selected individual indicators.

a. Scenarios 2 and 3 exhibit bigger impact on the attractiveness of the NGR for visitors, particularly due to GM comprising the essence of community based organizations – i.e. open membership and integration in the LAG and to some extent branded fundraising (Figure 4);
b. Figure 4 shows that it is branded fundraising what makes the difference in the impact of scenarios on the financial sustainability of the NGR/FGR;
c. Scenario 3 is supposed to result in more business opportunities in tourism than the other two scenarios (Figure 6). It is because of the integration in the LAG framework which might provide various targeted supports for new tourism undertaking and cooperative environment. The experts also assume better utilization of the economic growth drivers under this scenario. In contrast, open participation might not lead to the same development of the tourism business in the NGR since the networks are predominantly social. The transmission of the economic growth in the region to the tourism business is the lowest in this scenario (2).

Table 4. Aggregated impact of scenarios on the performance of the National Geopark Ralsko; Source: own evaluation using modified MAPP

Indicator	**profile Scenario 2**					**profile Scenario 3**					**profile Scenario 4**					Scenario characteristics with highest impact		
Valuation	**--**	**-**	**-/+**	**+**	**++**	**--**	**-**	**-/+**	**+**	**++**	**--**	**-**	**-/+**	**+**	**++**	Partici-pation	Funding	Exogen
Migration (in +/out -)				+				-/+						+				-/+
Attractiveness for dwelling				+						++					++	+		
Attractiveness for visiting					++					++				+		+		
Financial sources for NGR development					++					++					++		++	
Business opportunities in tourism					++					++					++	++		
Income of local people					++					++				+				++
Reregistration of the NGR					++					++							+	

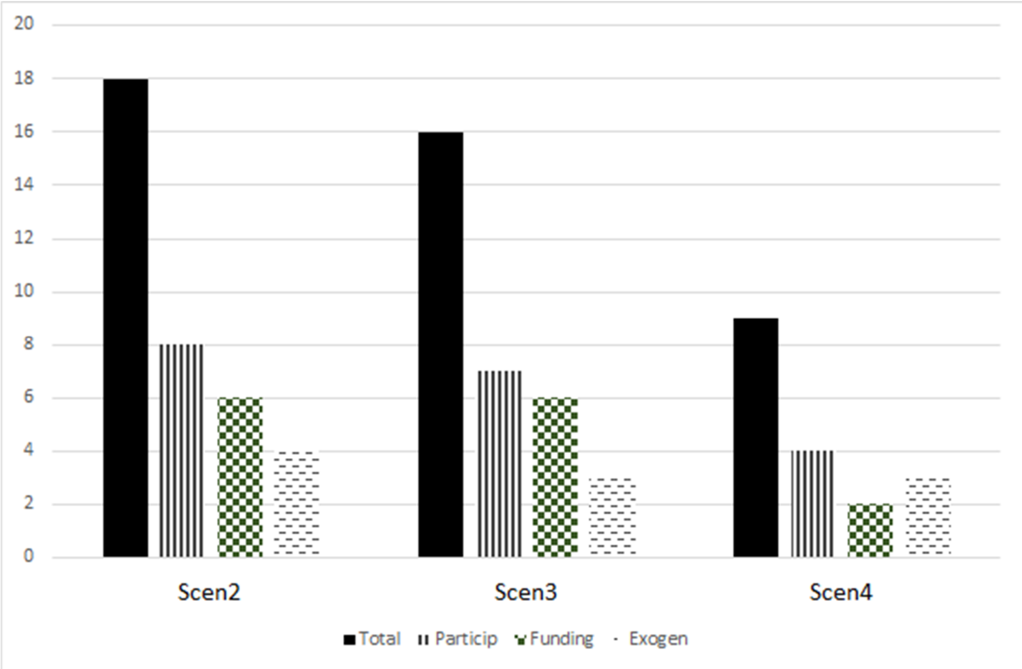


Figure 4. Attractiveness of the NGR for visiting Source: own illustration of the results of the expert assessment of scenarios

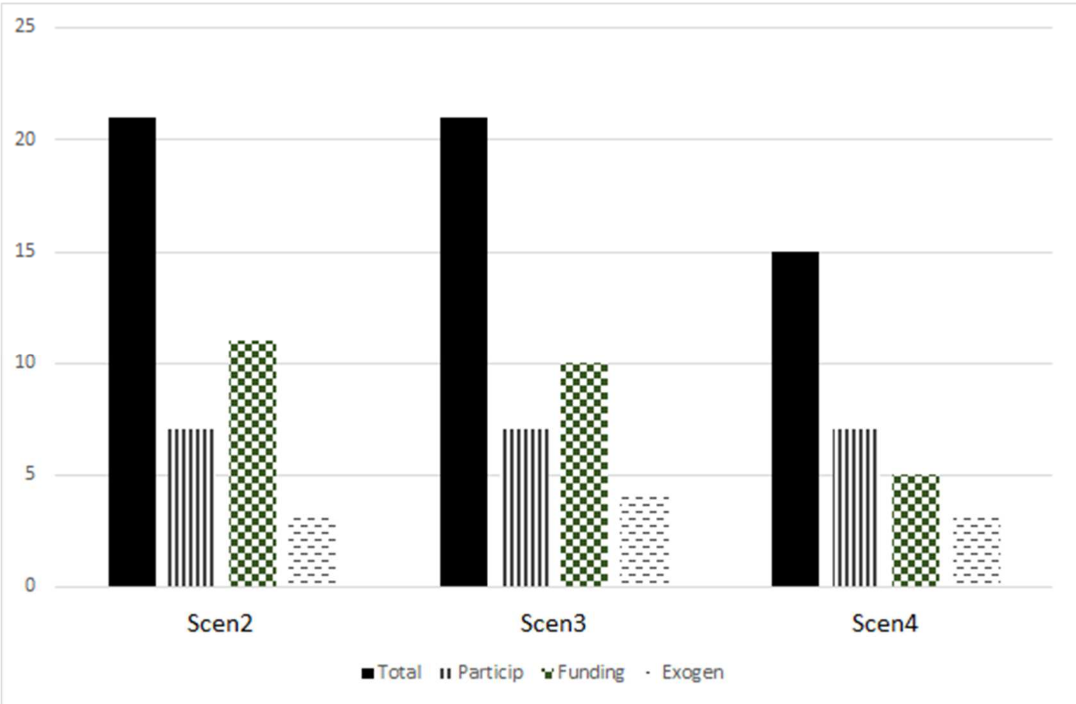


Figure 5. Financial resources for the NGR (financial sustainability of the FGR) Source: own illustration of the results of the expert assessment of scenarios

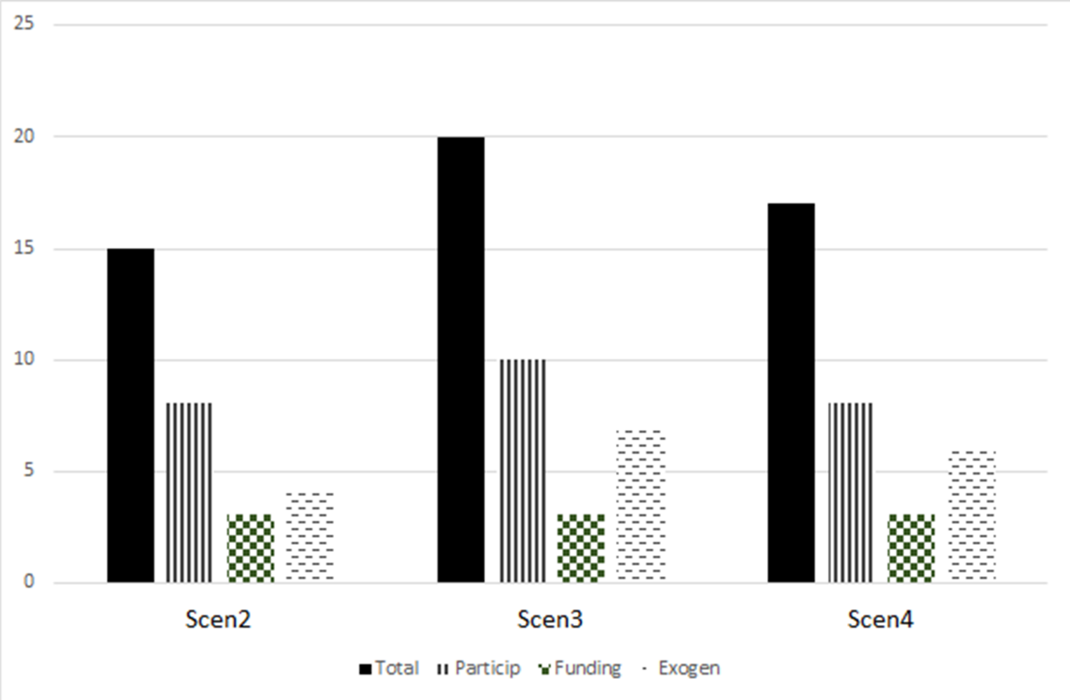


Figure 6. Impact of scenarios on the business opportunities in tourism in the NGR Source: own illustration of the results of the expert assessment of scenarios

9.3.6 Discussion

9.3.6.1 Discussion of results

The scenarios and their evaluation illustrate likely benefits of linking the efforts of the FGR with a broader set of stakeholders – even individuals, either local inhabitants and urban visitors with the aim to create social and business networks (Scenarios 2 and 3). Actually, reconnecting the "elite based" FGR (and its effort to establish the NGR) with people and small and medium size businesses means bringing to it an essence of community based organisation (while maintain its operability).

It has become also apparent that adding other ways of funding improves financial stability of the FGR for developing and maintain the NGR. Institutional funding will provide secure finances and will enable the FGR to broaden its activities. Obtaining financial resources by branded fundraising might be slow and the expected funds small, nevertheless the need to approach donors might go hand by hand with the "reconnection" effort.

9.3.6.2 Discussion of the chosen methodological approach

Since the approach is similar (almost identical) to the approach adopted in the HS CZ1, we refer to that report for most of the discussion.

9.3.6.3 Discussion of the participative elements in your modelling approaches

Here we have to return to the earlier note of limited validity of results because the definition of the scenarios and their evaluation stem from the discussion between the research team and the management of the FGR/NGR, while the other stakeholders stayed aside. It was because these stakeholders remained in the position that the governance of the NGR is out of their scope - while they expressed their lasting will to help the FGR if it asked for it.

Our big mistake was that we assumed that the FGR represented collective interest of actors in the hot spot (the former military area). Too late we realized the solitude of the FGR in their efforts to develop and promote the national Geopark as a framework for cooperation on the improvement of the access of public to recreational services-values of the exceptional forest landscape. It became gradually apparent that the GM deserve (re)connection with the local and broader social and business networks - too late to run a survey or to gather new stakeholders to workshops/focus groups.

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ANNEX 1: LIST OF ABBREVIATIONS

Abbreviation/ Acronym	Explanation
CBO	Community Based Organisation
CSR	Case Study Region
CZ1	Hot Spot of the Sluknov area
GM	Governance mechanism
HS	Hot Spot (in this report referring to the Sluknov area),
LAG	Local Action Group (in the study “MAS Cesky Sever”)
FGR	Foundation Geopark Ralsko o.p.s.
NGR	National Geopark Ralsko
VLS	Military Forests and Estates (Vojenske lesy a statky)