Civil-Public-Private-Partnerships (cp³):
collaborative governance approaches for policy innovation to enhance biodiversity and ecosystem services delivery in agricultural landscapes

Production practices and ecosystem services: synergies and trade-offs

Milestone M.11

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Version: final

Submission date: 30/04/2017

cp³ partners:

cp³ funding scheme:

cp³ national funders:

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1. Introduction: focus of the milestone and of the cp3 project

This milestone delivers a methodological approach, which allows assessing synergies and trade-offs between agricultural production practices on the one hand side and ecosystem services (ES) on the other hand side. The method is based on 'Milestone M.05' (Inventory of agricultural production practices) and 'Deliverable D.03' (Production practices framework). However, given that synergies and trade-offs are often connected to or occur because of spatial and/or temporal balances or imbalances, our methodological approach also takes into consideration 'Milestone M.10' (Spatial and temporal flows of ES in rural landscapes).

The cp³ project in general focuses on governance approaches to steer land use, especially agricultural land use, with the aim to improve the provision of ES, including biodiversity. The provision of ES is related to the preferences of concrete ES users (e.g. consumers of agricultural products, recreational requirements of local people or of tourists) or it is related to the societal demand for ES in more general terms (e.g. protect and sustain clean water, fertile soils, biodiversity, or specific and aesthetic valuable landscapes). The overall framework of the cp³ project (see Figure 1) further shows that synergies or trade-offs can occur between production practices as part of the ´human landscape´ and the ES as part of the ´physical landscape´ (see area with red dashed line in Figure 1). In the following section, we focus on this specific aspect of the project.

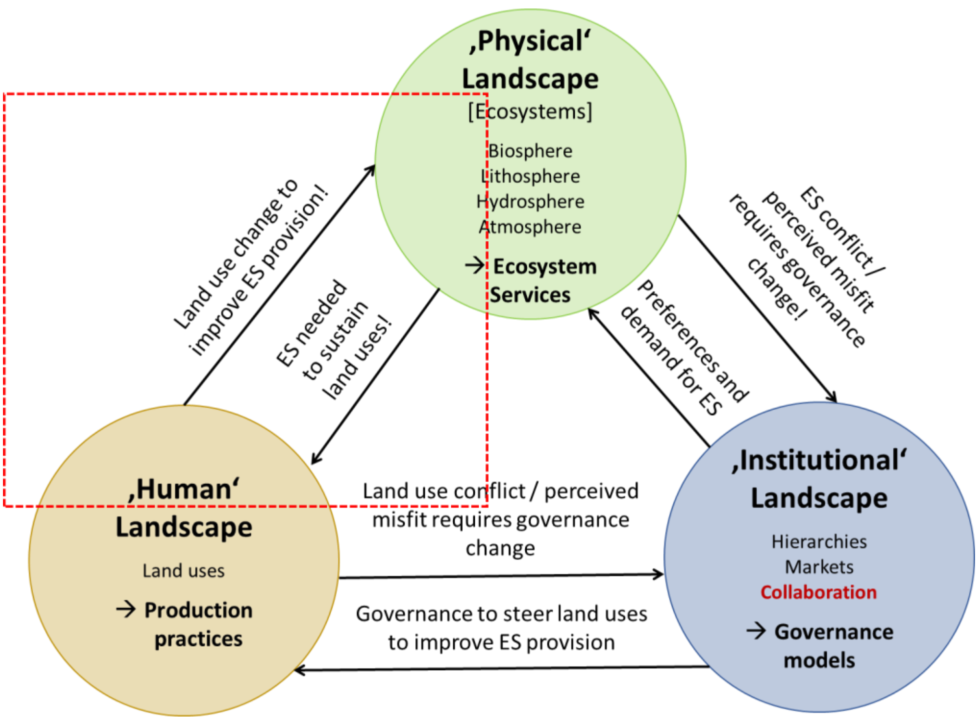

Figure 1: The overall framework of the cp³ project with three analytical perspectives. The area with the red dashed line shows the focus of the methodological approach developed in this milestone M.11. Source: www.cp3-project.eu (About the project/Links between the work packages).

The milestone is structured as follows:

In section 2, an overview of different concepts on ES synergies and trade-offs is given, with focus on the specificities of synergies and trade-offs between agricultural production practices and the provision of ES. In section 3, we present our approach of assessing synergies and trade-offs between agricultural production practices and the provision of ES with the help of agricultural location theory (Kuhlmann 2015). In section 4 we apply the developed approach to the three project case study regions[1]. In section 5, some implications for governance are discussed.

2. Concepts discussed in the literature addressing synergies and trade-offs between production practices and ES

Production practices and ES provision closely interact with and depend on each other. They can be positively correlated, negatively correlated or be indifferent, i.e. compatible to each other. So, according Grunewald and Bastian (2013), we define:

Synergies (=def.) as a positive correlation between the production practices and ES provision.

Trade-offs (=def.) as a negative correlation between the production practices and ES provision.

Compatibility (=def.) as a coexistence between the production practices and the provision of ecosystem services without mitigating or enhancing their functionality.

According to TEEB (2010a), trade-offs are related to choices that involve losing one quality or service (of an ecosystem) in return for gaining another quality or service. Many decisions affecting ecosystems involve synergies and trade-offs. This definition underpins that the outcomes of production practices, agricultural provisioning ES (e.g. food), can be produced in line with other provisioning services (e.g. drinking water), regulating services (e.g. water filtering), supporting and habitat services (e.g. biodiversity protection) and cultural services (e.g. an aesthetic landscape due to diverse land use pattern). However, here we focus especially on the relation between agricultural production practices (meant to provide, in the first place, agricultural provisioning ES) and their impact on other ES (i.e. other provisioning services, as well as regulating, supporting and habitat, and cultural services).

Typical trade-offs between agricultural production or provisioning services of agriculture and regulating services, supporting services/biodiversity and cultural services are related to soil quality (e.g. soil structure, soil fertility, soil organic matter, protection from soil erosion), water quality (e.g. protection from nitrate leaching, protection from phosphorus entries) and water supply (e.g. available water quantity, water holding capacity of soils), air quality (e.g. protection from gaseous ammonia emissions), climate regulation (soil carbon sequestration, protection from greenhouse gas emissions), biological diversity (e.g. pollinators, birds) and cultural services (sense of place, landscape aesthetics, agricultural landscapes as a place for leisure activities) (Dale and Polasky 2007, Zhang 2007, Nelson et al. 2009, Power et al. 2010, Firebank et al. 2013, Williams and Hedlund 2014, Kragt and Robertson 2014, Balbi et al. 2015, Field et al. 2016).

Several studies (e.g. Balbi et al. 2015, Field et al. 2016) highlight that agricultural landscapes always generate bundles of ES, not only restricted to agricultural products, i.e. agricultural provisioning services (TEEB 2010b), but also extending to regulating, supporting and cultural services, where the relations can be either positive (synergies) or negative (trade-offs). To characterize them (cf. Figure 2) we will use the scheme of Iverson et al. (2014):

- Win-win (synergy): maximization of agricultural provision and maximization of other positively correlated services (other provisioning, regulating, supporting/ biodiversity and cultural services), +/+ (e.g. yield and pollination, yield and soil fertility)
- Win-lose (trade-off): maximization of agricultural provision and minimization of other typically negatively correlated services with agricultural production (other provisioning, regulating, supporting/ biodiversity and cultural services), +/- (e.g. yield and provision of clean water)

[1] Berg en Dal (The netherlands), Biosphere Reserve Spreewald (Germany), Nature Park Jauerling-Wachau (Austria)

- Lose-win (trade-off): minimization of agricultural provision and maximization of other negatively correlated services, (other provisioning, regulating, supporting/ biodiversity and cultural services), -/+ (e.g. yield and clean water)
- Lose-lose: minimization of agricultural provision and minimization other positively correlated services, (other provisioning, regulating, supporting/ biodiversity and cultural services), -/- (e.g. ground-water formation on agricultural land)

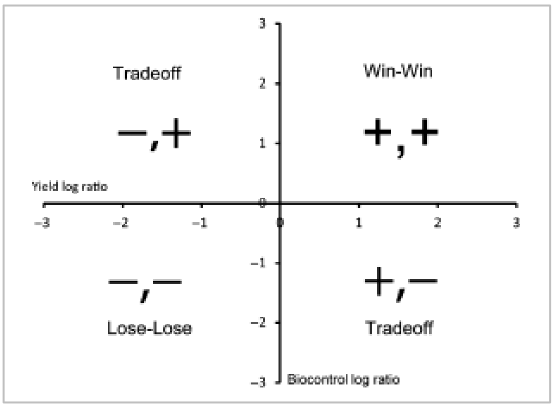

Figure 2: Outcome scenarios for log-response ratios of yield and biocontrol (source: Iverson et al. 2014).

As far as trade-offs are concerned, we can use the classification system of trade-offs between different ES elaborated by the TEEB initiative (TEEB 2010b). The authors differentiate between temporal trade-offs (benefits now – costs later), spatial trade-offs (benefits here – costs there), beneficiary trade-offs (some win – others lose), and service trade-offs (manage one service – lose another, cf. also Iveerson et al. 2014). It is obvious that the mentioned trade-off types require specific governance approaches, to address each trade-off in a suitable manner.

The temporal trade-offs can occur at different speeds. Here we can use the scheme from TEEB (2010b, cited in Elmqvist et al. 2010) shown in Figure 3:

Type A: accelerated, i.e. an increase in provisioning services produces a rapid loss of regulating services
Type B: constant, i.e. an increase in provisioning services leads to a linear decrease of regulating services
Type C: delayed, i.e. an increase in provisioning services produces only a slow loss of regulating services

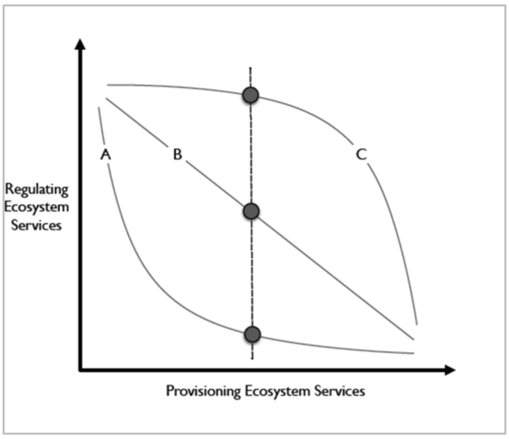

Figure 3: Temporal trade-offs between provisioning services and regulating services (source: TEEB 2010b, cited in Elmqvist et al. 2010).

Power (2010) also emphasized that trade-offs need to address durability: short-term, long-term, as well as reversibility (after Rodriguez et al. 2006).

The spatial trade-offs can occur, (see Figure 4):

- on-site, e.g. provision of soil fertility, habitat provision on the field,
- off-site, in the field surrounding specific-directional, e.g. input of nutrients in water-courses,
- off-site, in the field surrounding omni-directional, e.g. soil erosion,
- in the further surrounding decoupled, e.g. greenhouse gas emission.

The beneficiary trade-offs and service trade-offs can also be assessed with the -/+ and +/- combination of Figure 2 if the respective services are linked to specific users. We extend this scheme to the links between production routines in agricultural production, regulating services, supporting and habitat services, as well as cultural services.

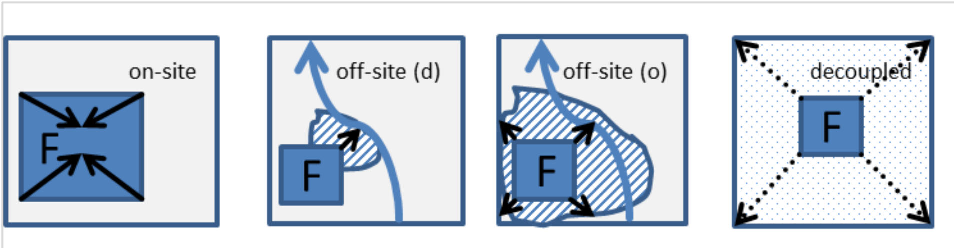

Figure 4: Spatial trade-offs between provisioning services on regulating services, habitat and supporting services and cultural services. The impacts of agricultural production occur on the field (F) = 'on-site', occur off-site directional to specific areas or structures = 'off-site (d)', off-site the field omni-directional = 'off-site (o)' or decoupled from the field = 'decoupled' (Source: adopted from van Bussel 2017, M.12).

3. Conceptual approach for an evaluation of synergies/ trade-offs between production practices and ES

The general approach for an evaluation of synergies and trade-offs between production practices and ES is based on agricultural location theory as outlined by Kuhlmann (2015). We use this approach and extend it further by linking the production practices to governance on one hand side and to ecosystem service provision and biodiversity conservation on the other hand side, as described in 'Deliverable D.03' (Production practices framework) (see Figure 5). Here, we focus on the right side of the production practices framework, i.e. on the area with the red dashed line.

We hypothesize: i) The region-specific agricultural land-use programs and intensities in the case-studies influence the ES needed and provided by agriculture, as well as the synergies and trade-offs between the single ES. ii) Low intensity crops expand the synergies and decrease the trade-offs among different ES, whereas high intensity crops reduce the synergies and enhance the trade-offs among different ES. iii) Furthermore, changes in the management practice can shift synergies and trade-offs to a certain extent per each individual crop. To some extent, switching to lower land-use intensity is also in the farmer`s own interest, as this helps to sustain their resources for production, such as maintaining soil fertility.

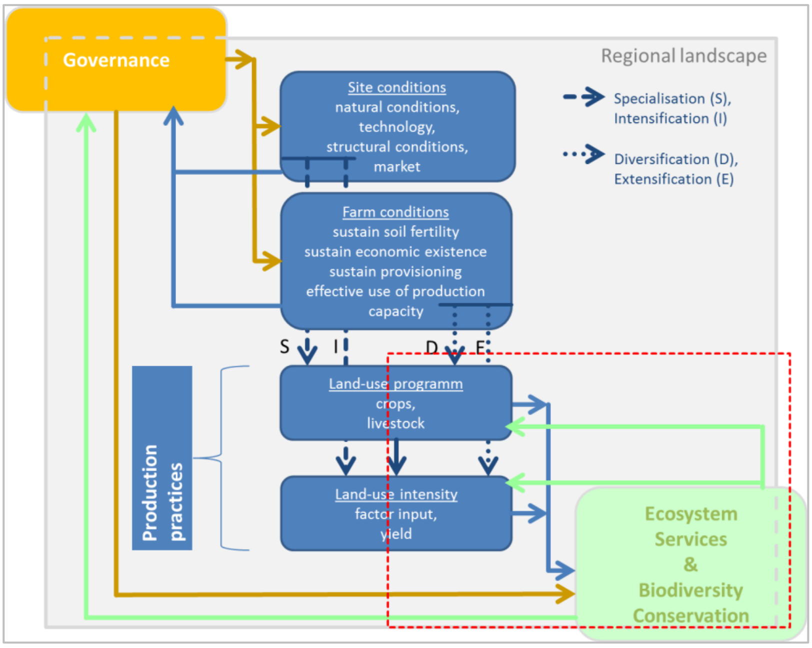

Figure 5: Scheme of production practices on a landscape scale in the context of their governance requirements and possibilities and their suitability for ES provision and biodiversity conservation. The area with the red dashed line shows the focus of this milestone M.11.

Production practices of a region comprise the so-called land-use program and the land-use intensity. The first (the land-use program) is defined by the regional share of cultivated crops and livestock. The second (the land-use intensity) is mainly determined by farmers' decisions on the applied management practices to grow crops or raise livestock and about the crop and/or livestock specific factor-inputs, such as used machinery/technology, energy, and labour input, fertilizers, manure and pesticides, forage etc.). Moreover, agricultural production processes consist of successive production routines, including soil preparation, sowing, applying fertilizers or manure, spraying pesticides, harvesting. For each routine, a range of opportunities is available. Below, we give some examples of such routines for crop production. These routines can then be related to an individual crop. However, not every routine is relevant for each crop.

Examples of production routines in agricultural crop production:

- soil tillage (conventional tillage, conservation tillage: mulch sowing, ridge-tillage, strip tillage, no-tillage system and direct sowing)
- sowing (e.g. row crops, such as maize, potatoes, sugar beet, including options for narrow sowing, e.g. for maize)
- fertilization (mineral fertilizers, manure, including the amount and the timing)
- plant protection (e.g. insecticides, herbicides, fungicides, growth regulators, including the amount and the timing)
- intercropping and under-sowing, catch crops as green-manuring crop and fodder plant
- irrigation
- specifics:
    - specific machinery
    - grassland intensive, extensive (pasture, moving)
    - greening measures (greening of the European CAP (= common agricultural policy, period 2014-2020)

These components of the agricultural production processes can be positively (+++, ++, +), or negatively correlated (-, --, ---) with regard to specific ES. They can also have no positive or negative effect (0). Furthermore, there can have synergies and trade-offs between different ES. To account for every possible relation, we developed the following matrix displayed in Tables 1-3, which shows the potential correlation of production routines in agricultural production with different ES. Table 1-3 is a further development of the matrix PP x ES already developed for Deliverable D.03. By comparison, it better specifies the kind, extent and time of the single production routines. These complex interactions comprise several areas of research, so we included expert knowledge of each specific field to evaluate a range of suitable regional management strategies to support ES, especially those with the potential to create synergies between several ES.

For doing so, we integrated regional knowledge from local stakeholders as well as scientific knowledge from peer-reviewed literature to identify and assess the synergies and trade-offs between agricultural production and regulating, habitat and supporting and cultural ES for the application to the cp³ project case study regions.

4. Application to the case study regions

The matrix for the case study region 'Biosphere Reserve Spree-Forest' is shown in Table 1, the one for the case study region 'National Park Jauerling-Wachau' in Table 2, and the one for the case study region Berg en Dal in Table 3, respectively. The matrices compile relevant regional ES and allocate examples for supporting production routines. The combinations shown in Table 1-3 form the bases for planned expert interviews to derive synergies (+/+), compatibilities (+/-), and trade-offs (-/-). The aims of the interviews are to find out:

- what is the status quo of the management practice for each production routine (interviews with agricultural experts from the agricultural departments of the counties, farmers),

- what are their synergies and trade-offs (interviews with scientists with expertise in the specific service) and

- what regional management options to enhance synergies and reduce trade-offs do exist and what are the priorities and limitations for their application (interviews with experts in agricultural departments of the counties and the state).

5. Implications for governance

Temporal trade-offs (benefits now – costs later) have implications for the urgency for an adjustment in governance: the more immanent and the higher the costs linked to a trade-off situation, the more urgently a decision on a governance adjustment is needed, even under data uncertainty. Of course, also, more gradual and slower trade-offs need attention, but here there is more leeway to collect further information to improve the science and knowledge base to allow for better informed decisions. In consequence, the urgency for an adjustment in governance efforts and a change in the priorities for specific measures decreases from irreversible to reversible effects and from more immediate to more gradual effects. Temporal trade-offs therefore can be referred to the issue of temporal fit of governance approaches (Vatn and Vedeld 2012).

Spatial trade-offs (benefits here – costs there) have implications for the appropriate scale of a governance approach. Thereby the scale can range from very local, e.g. a governance change at site or farm level, to a rather broad scale approach at the regional, national up to the international and global level. It addresses the question of choosing appropriate system boundaries to prevent spill-over or leakage effects to other areas. Naturally, a governance change at higher levels is way more difficult to initiate as the number of involved stakeholders increases and interests in terms of ES needed get more diverse and harder to reconcile. Synergies between different ES can then help to reduce the governance efforts. In this sense, our analysis would help in making such synergies more transparent. Spatial trade-offs therefore can be referred to the issue of spatial fit of governance approaches (Vatn and Vedeld 2012).

Beneficiary trade-offs (some win – other lose) have implications for justice aspects in the horizontal and vertical interplay of actors in governance, when trade-offs occur for different stakeholder groups in different societal sectors or in different hierarchical spheres of society. They give rise to negotiation processes between parties and possible compensation claims. The beneficiary trade-offs therefore can be referred to issues of horizontal and vertical institutional fit of governance approaches within the social system (Vatn and Vedeld 2012).

Finally, service trade-offs (manage one service – lose another) have implications for setting priorities in governance when different stakeholder groups have different preferences for those ES. They give rise to societal discourse on priorities. To satisfy the demand for a broad range of ES, an integrated management of the whole system and transparency about the prioritized ES, specific goals for targeted ES and also thresholds for non-targeted ES is needed. Therefore, service trade-offs can be referred to governance approaches, which can take into regard cascading effects (Vatn and Vedeld 2012).

Table 1: Ecosystem services and examples of supporting measures in the case-study-region "Biosphere Reserve Spree-forest"

Category	Sub-category	Specific service	Parameter	Measures			
				management practice/technique	Cropping system	Landscape (on-field, off-field)	other contributors
Provisioning	Food/Fodder	Agricultural products (from)	Crops, vegetables, fruits - natural yield - sales, costs - revenues, income - gross margin	no	no	no	no
	Water	Irrigation water (to)	Quantity	irrigation system	irrigation worthiness - crops with high gross margins (potatoes, sugar beets, fruits, vegetables water requirements - crops with high water demand	no	no
		water quantity (from)	Quantity	conventional tillage	minimize time of soil cover: - bare fallows, root crops,	no	no
Regulating	Hydrological funct.	water balance (to/from)	drought: - useable field capacity humidity/flood: - on fields, workability, trafficability	drought: - narrow sowing (reduced evapotranspiration) in maize humidity/flood: - minimize pressure - mulch seeding, direct seeding	drought: - crops with high water use efficiency humidity/flood: - late seeding	no	no
		water quality (from)	- N, P - pesticides - iron hydroxide Potential entry	tillage: - conventional tillage (less fertilizer, less herbicides, insecticides, fungicides) - conservation tillage (reduced run-off and N, P transport), sandy soils after rape seed, intercrops seeding: - narrow sowing (enhanced N-efficiency, reduce N-loss, reduce application of pesticides) in maize fertilization: - site-specific fertilisation - partial applications - application technique (boundary spreading devices, manure cultivator	- crop and yield specific N-requirements - crop specific treatment indices - crop with deep roots enhance the N-effiency	landscape elements (off field): -riparian strips	Complex (waste water, industry, agriculture)

Category	Sub-category	Specific service	Parameter	Measures			
				injection)			
	Pedological funct.	Soil erosion, wind(to/from)	- wind erosion Potential	tillage: - strip till (I), spirit strip till (I); no-till (I) seeding: - mulch seeding (P), direct (I) - narrow sowing measures for stable aggregates: - calc, support biological activity	maximize time of soil cover - crop rotation, intercrops, undersown, mulch	Erosion protection by landscape elements (on/off field): -woody plants, field margins, minimizing wind exposure elements	no
		Soil fertility (to/from)	- Soil structure - humus balance - micronutrients	Soil structure/stable aggregates: Tillage: - conservation tillage Seeding: - mulch sowing (P) Fertilisation: - manure application Humus balance: Tillage: - conservation tillage Seeding: - mulch sowing (P) fertilisation: - manure application Harvest: - remain crop residues	humus balance - crop rotation	no	no
	Climatological funct.	Carbon sequestration (from)	- gleyic soil - peaty mineral soils - peat soils	- less intensive use (1-2 cuts, late cuts) vs high intensity (3-4 cuts, early cuts) - two-side water regulation - high ground water levels in summer	- intensive grassland (3-4) - wet pastures (2-3) - wet pastures (1-2) - wet meadows (2) - wet meadows (1)	no	no
		Air quality (from)	- large livestock farming stables (marginally)	no	no	no	Complex: industry, traffic
Supporting		Habitats for plants and animals (from)	- soil fauna - segetal flora - pollinators - breeding birds, mammals, amphibians	Soil fauna tillage: conservation tillage, no-tillage Segetal flora: Pollinators - see pollination Breeding birds, mammals, amphibians all measures - timing and intensity of	- crop specific kinds, frequency, timing of all measures	- habitats partly off-site	Complex: habitats partly on-site and off-site, migrating phases, disturbances by predators, by off-site events

Category	Sub-category	Specific service	Parameter	Measures			
				management measures to minimize spatial and temporal coincidence in sensitive life stages (breeding, migration)			
		Pollination (to)	Specific crops, vegetables, fruits	plant protection: - site-specific fertilisation - partial applications - application technique	- rape seed, legumes, clover (04-07) - undersown, intercrops (07-08) - fruits (e.g. strawberries) & vegetables (e.g. cucumbers, asparagus)	on-site: Flowered areas off-site: other landscape elements (trees, shrubs)	No
		Biological pest control (to)	Specific crops, vegetables, fruits	No	No	on-site: Flowered areas off-site: other landscape elements (trees, shrubs)	No
Cultural		Landscape aesthetics	Crop diversity, mosaics of extensive grasslands, cultivated fields	No	No	other landscape elements forest elements, streams, lakes for mosaic	Complex (access transportation, touristic infrastructure
		Recreation, tourism		No	No		Complex (access transportation,)

Table 2: Ecosystem services and examples of supporting measures in the case-study-region "nature park Jauerling-Wachau"

Category	Sub-category	Specific service	Parameter	Measures			
				management practice/technique	Cropping system	Landscape (on-field, off-field)	other contributors
Provisioning	Food/Fodder	Agricultural products (from)	Crops, fruits, vine, Christmas trees - natural yield - sales, costs - revenues, income - gross margin	no	no	no	no
	Water	Irrigation water (to)	Quantity	irrigation system	irrigation worthiness - crops with high gross margins (fruits, ?) water requirements - crops with high water demand (fruits, ?)	no	no
		water quantity (from)	Quantity	conventional tillage	minimize time of soil cover: - bare fallows, root crops,	no	no
Regulating	Hydrological funct.	water balance (to/from)	drought: - useable field capacity flood: - flood risks areas?	drought: - narrow sowing (reduced evapotranspiration) in maize flood: - prevention from mainly other contributors	drought: - crops with high water use efficiency humidity/flood: - late seeding	no	- flood prevention by - technical solutions - retention areas
		water quality (from)	No	no	no	no	no
	Pedological funct.	Soil erosion, water(to/from)	- water erosion Potential	enhance degree and duration of soil cover Tillage: - conservation tillage - no-tillage Seeding: - mulch sowing (P) Cover crops Catch crops	- Grassland systems - fallows - perennitial forage crops - adapted tillage and cover and catch crops in cereals and row crops		no
		Soil fertility (to/from)	- Soil structure - humus balance - micronutrients	Soil structure/stable aggregates: Tillage: - conservation tillage Seeding: - mulch sowing (P) Fertilisation:	humus balance - crop rotation	No	No

Category	Sub-category	Specific service	Parameter	Measures			
				- manure application Humus balance: Tillage: - conservation tillage Seeding: - mulch sowing (P) fertilisation: - manure application Harvest: - remain crop residues			
	Climatological funct.	Carbon sequestration (from)	No	no	no	no	no
		Air quality (from)	No	no	no	no	no
Supporting		Habitats for plants and animals (from)	- pollinators and other insects - birds, - flora	all measures - timing and intensity of management measures to minimize spatial and temporal coincidence in sensitive life stages (breeding, migration)	- crop specific kinds, frequency, timing of all measures	- habitats partly off-site	Complex: habitats partly on-site and off-site, migrating phases, disturbances by predators, by off-site events
		Pollination (to)	Specific crops, vegetables, fruits	plant protection: - site-specific fertilisation - partial applications - application technique	- rape seed, legumes, clover (04-07) - undersown, intercrops (07-08) - fruits (e.g. strawberries) & vegetables (e.g. cucumbers, asparagus)	on-site: Flowered areas off-site: other landscape elements (trees, shrubs)	
		Biological pest control (to)	Specific crops, vegetables, fruits	No	No	on-site: Flowered areas off-site: other landscape elements (trees, shrubs)	
Cultural		Landscape aesthetics	world heritage area (vineyuards, Marillen)	No	No	No	Complex (access transportation, touristic infrastructure) historic sights
		Recreation, tourism		No	No	No	Complex (access transportation,)

Table 3: Ecosystem services and examples of supporting measures in the case-study-region "Berg en Dal"

Category	Sub-category	Specific service	Parameter	Measures			
				management practice/technique	Cropping system	Landscape (on-field, off-field)	other contributors
Provisioning	Food/Fodder	Agricultural products (from)	Crops for food and fodder, orchards, vine - natural yield - sales, costs - revenues, income - gross margin	No	No	no	
	Water	Irrigation water, depends on the year (to)	Quantity	irrigation system	irrigation worthiness - crops with high gross margins (potatoes, sugar beets) water requirements - crops with high water demand	no	no
		water quantity (from)	Quantity	conventional tillage	minimize time of soil cover: - bare fallows, root crops,	no	no
Regulating	Hydrological funct.	water balance (to/from)	flood: - flood risks areas?	flood: - prevention from mainly other contributors	humidity/flood: - late seeding	no	- flood prevention by - technical solutions - retention areas
		water quality (from)	- N, P - pesticides	tillage: - conventional tillage (less fertilizer, less herbicides, insecticides, fungicides) - conservation tillage (reduced run-off and N, P transport), sandy soils after rape seed, intercrops seeding: - narrow sowing (enhanced N-efficiency, reduce N-loss, reduce application of pesticides) in maize fertilization: - site-specific fertilisation - partial applications - application technique (boundary spreading devices, manure cultivator injection) Husbandry: - P and N	- crop and yield specific N-requirements - crop specific treatment indices - crop with deep roots enhance the N-effiency	landscape elements (off field): -riparian strips	Complex (waste water, industry, agriculture)

Category	Sub-category	Specific service	Parameter	Measures			
	Pedological funct.	Soil erosion, wind and water(to/from)	- wind erosion Potential (low risk)	tillage: - strip till (I), spirit strip till (I); no-till (I) seeding: - mulch seeding (P), direct (I) - narrow sowing measures for stable aggregates: - calc, support biological activity	maximize time of soil cover - crop rotation, intercrops, undersown, mulch	Erosion protection by landscape elements (on/off field): -woody plants, field margins, minimizing wind exposure elements	no
			- water erosion Potential (low risk)	enhance degree and duration of soil cover Tillage: - conservation tillage - no-tillage Seeding: - mulch sowing (P) Cover crops Catch crops	- Grassland systems - fallows - perennial forage crops - adapted tillage and cover and catch crops in cereals and row crops		no
		Soil fertility (to/from)	- Soil structure - humus balance - micronutrients	Soil structure/stable aggregates: Tillage: - conservation tillage Seeding: - mulch sowing (P) Fertilisation: - manure application Humus balance: Tillage: - conservation tillage Seeding: - mulch sowing (P) fertilisation: - manure application Harvest: - remain crop residues	humus balance - crop rotation	No	No
	Climatological funct.	Carbon sequestration (from)	- gleyic soil - peaty mineral soils - peat soils	- less intensive use (1-2 cuts, late cuts) vs high intensity (3-4 cuts, early cuts) - two-side water regulation - high ground water levels in summer	- intensive grassland (3-4) - wet pastures (2-3) - wet pastures (1-2) - wet meadows (2) - wet meadows (1)	No	No
		Air quality (from)	?				

Category	Sub-category	Specific service	Parameter	Measures			
Supporting		Habitats for plants and animals (from)	- soil fauna - segetal flora - pollinators - breeding birds, mammals, amphibians	Soil fauna tillage: conservation tillage, no-tillage Segetal flora: Pollinators - see pollination Breeding birds, mammals, amphibians all measures - timing and intensity of management measures to minimize spatial and temporal coincidence in sensitive life stages (breeding, migration)	- crop specific kinds, frequency, timing of all measures	- habitats partly off-site	Complex: habitats partly on-site and off-site, migrating phases, disturbances by predators, by off-site events
		Pollination (to)	Specific crops, vegetables, fruits	plant protection: - site-specific fertilisation - partial applications - application technique	- rape seed, legumes, clover (04-07) - undersown, intercrops (07-08) - fruits (e.g. strawberries) & vegetables (e.g. cucumbers, asparagus)	on-site: Flowered areas off-site: other landscape elements (trees, shrubs)	
		Biological pest control (to)	Specific crops, vegetables, fruits	No	No	on-site: Flowered areas off-site: other landscape elements (trees, shrubs)	
Cultural		Landscape aesthetics	Crop diversity, mosaics of extensive grasslands, cultivated fields	No	No	other landscape elements forest elements, shrups, streams, for mosaic	Complex (access transportation, touristic infrastructure
		Recreation, tourism		No	No		Complex (access transportation,)

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Impressum

This milestone is an outcome of the research project cp³ [ ]:

'civil-public-private-partnerships (cp³): collaborative governance approaches for policy innovation to enhance biodiversity and ecosystem services delivery in agricultural landscapes'

is funded through the 2013-2014 BiodivERsA/FACCE-JPI joint call for research proposals

with the national funders BMBF (Germany), FWF (Austria), and NWO (Netherlands)

has three project partners:

Leibniz-Centre of Agricultural Landscape Research (ZALF)

Organisation for International Dialogue and Conflict Management (IDC)

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