Civil-Public-Private-Partnerships (cp^3):
collaborative governance approaches for policy innovation to enhance biodiversity and ecosystem services delivery in agricultural landscapes

Maps on ecosystem services (ES): How spatial characteristics of ES provision and ES beneficiaries can inform governance

Deliverable D.06

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cp³ = civil-public-private-partnerships

ES = ecosystem services

1. Introduction

Ecosystem services assessments address the complex relations between humans and ecosystems. To fully acknowledge the interactions between humans and ecosystems, it is essential to include both the capacity of ecosystems to deliver ecosystem services (ES) to society, i.e. the supply-side, as well as the demand from society for certain ES, i.e. the demand side (Haines-Young and Postchin, 2010; Luck et al., 2009).

In this deliverable, examples of ES maps are presented for each of the cp³ case study areas: the biosphere reserve Spreewald in Germany; the Berg en Dal region as part of the national landscape de Gelderse Poort in the Netherlands; and the nature park Jauerling-Wachau in Austria. These maps show where a selected ES is provided and give an indication about the spatial relationships between the service providing area and the service benefiting or demanding area of that ES.

Thereby, ES are often consumed at a different place and time than produced: this can be considered as the spatio-temporal lags in ES provision (Fremier et al., 2013). For the spatial lags different situations can be identified (see Figure 1 for a schematic overview, for more details, also for a schematic overview of temporal lags, please see Van Bussel, 2017). Recognizing these lags and their heterogeneity among ES can help to identify appropriate governance models for ES management, which includes their spatial scale (cf. Fremier et al., 2013; Hein et al., 2006).

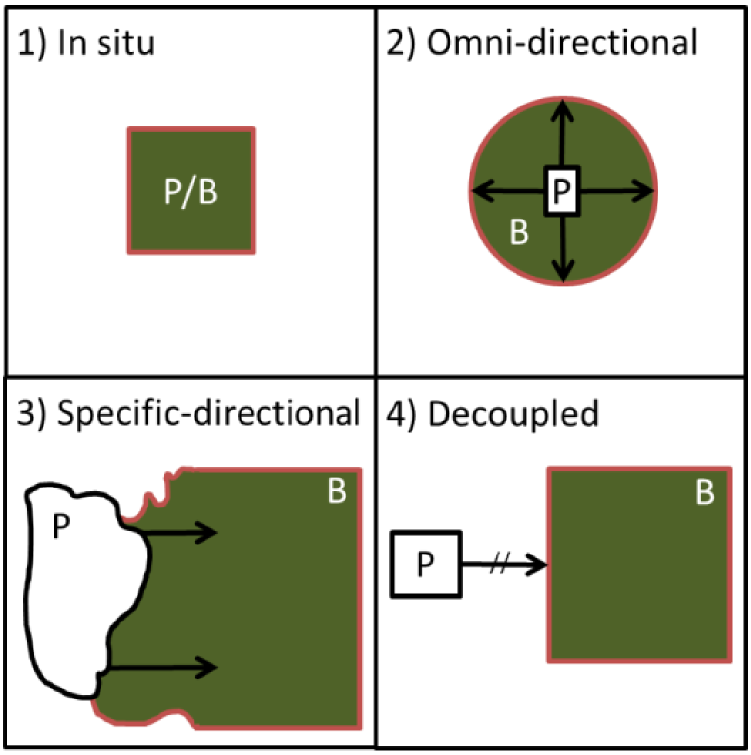


Figure 1: Possible spatial relationships between service production areas (P) and service benefit areas (B). In panel 1, both the service provision and benefit occur *in situ*, i.e. at the same location (e.g. soil formation, provision of raw materials). In panel 2 the service is provided *omni-directionally* and benefits the surrounding landscape (e.g. pollination). Panel 3 demonstrates services that have *specific-directional* benefits (e.g. storm and flood protection). Panel 4 indicates that a service providing area can be located (far) away from the benefiting area (e.g. food production). Adapted from: Fisher et al. (2009).

Spatial fit in relation to ES governance often refers to congruence between the management area of a governance model and the geographical extent of a biophysical system providing an ES (Cox, 2012). In line with other studies (Fremier et al., 2013; Hein et al., 2006; Raudsepp-Hearne and Peterson, 2016) we argue that for effective ES governance there should also be a spatial alignment between the demand for an ES and its governance. This is important, because if, for instance, an ES is provided at a scale much smaller than the scale of demand, suitable incentives for management might not be in place to spur enhanced provision to satisfy the existing demand. By contrast, if the ES is provided at a larger scale than demanded, there is a potential for a "tragedy of the commons" problem.

In this deliverable, besides presenting examples for ES maps for each case study area, we also elaborate on how the spatial relationships from Figure 1 in combination with the generated ES maps can serve as an important tool to inform governance choices, referring to existing governance models as examples. We will especially assess if and to what extent the different types of governance approaches (command-and-control or top-down, market-based, or collaborative) contribute to the spatial fit in ES governance.

2. Data and methods for mapping the spatial characteristics of ecosystem services and assessing the implications for governance models in the case study areas

2.1 Mapping of spatial relationships of ecosystem services

To illustrate the spatial relationships between ES production and benefit areas we mapped the following ES for the different case studies:

- ***Recreation*** *and* ***food production*** by means of the indicator *restrictions to fishing per canal* and ***moderation of extreme events*** by means of the indicator *infiltration* for biosphere reserve **Spreewald**;
- ***Atmospheric composition*** *and* ***climate regulation*** by means of the indicator *carbon sequestration* (t C/ha) for nature park **Jauerling-Wachau**;
- ***Food production*** by means of the indicator *crop productivity* (combination of potato, cereals and other crops for human consumption) (t/ha) for the municipality **Berg en Dal**.

Details for the applied methodologies to map the ES provision can be found in a recent report by Remme et al. (2018). The main input data were:

- Ecosystem types maps: derived from Statistic Netherlands (2017) for Berg en Dal, from data of the state of Brandenburg provided by the State Office of Environment for Spreewald, and CORINE for Jauerling-Wachau;
- Soil maps: derived from RIVM (2017) for Berg en Dal, and from data of the state of Brandenburg provided by the State Office of Environment for Spreewald;
- Water course map: A map of the network of water courses for Brandenburg State from the State Office of Environment was used to map fishing possibilities for Spreewald.

The scales of production and benefits and their spatial relationships for the above stated ES and for other important ES were defined by literature research and based on expert knowledge.

2.2 Assessment of the implications of spatial characteristics of ES for existing governance models

We define the spatial characteristic of a governance model as the level it has been designed for, ranging from international (i.e. EU) to local (i.e. municipality) level. Meyer et al. (2016) made an inventory of existing governance models in the three case study areas, including the level for which each governance model was mainly designed for. Meyer et al. (2016) also indicated for every identified governance model if (i) it can be clearly identified as a hierarchical command-and-control (or top-down) approach, a market-based approach or a collaborative approach (marked with 2), it can only be partly identified with one of these three basic governance approaches (marked with a 1), or (iii) it cannot be identified (marked with a 0). In this deliverable, we complemented the inventory by Meyer et al. (2016) with the main targeted ES per governance model.

3. Spatial characteristics of ES provision and governance models and resulting implications

3.1 Maps of selected ES

Because of the more than 200 small navigable canals in Spreewald fishing is an often made recreational activity by tourists, but the canals are also used by local professional fishermen. Two ES are provided: provision of fish where the processed fish is marketed in the whole of Germany (decoupled); and recreational fishing where mainly tourists, e.g. from the Brandenburg region, including the city of Berlin, are the beneficiaries (local omni-directional).

Figure 2 shows these spatial relationships.

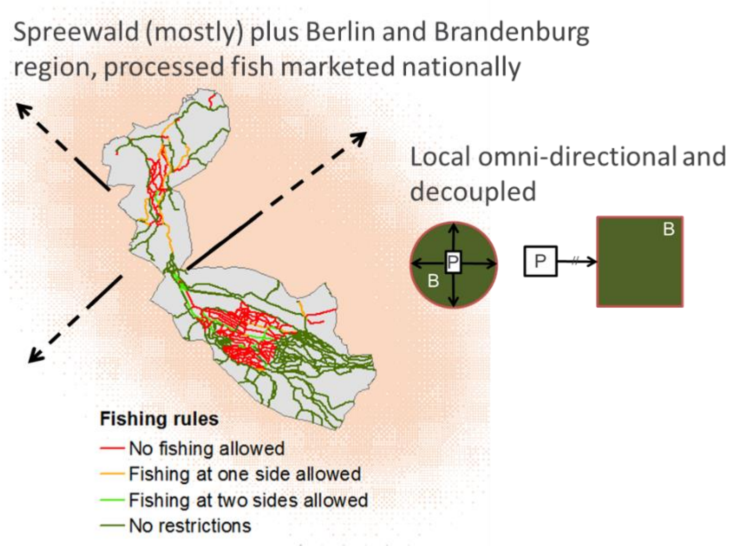


Figure 2: Fishing possibilities in Spreewald.

For **Spreewald** we also mapped the ES moderation of extreme flooding events. We have mapped this ES with help of the indicator potential infiltration, which has as unit mm infiltration in the first hour of rainfall (Figure 3). Because of this infiltration capacity, Spreewald (in-situ) and its surroundings (omni-directional) can be protected from flooding.

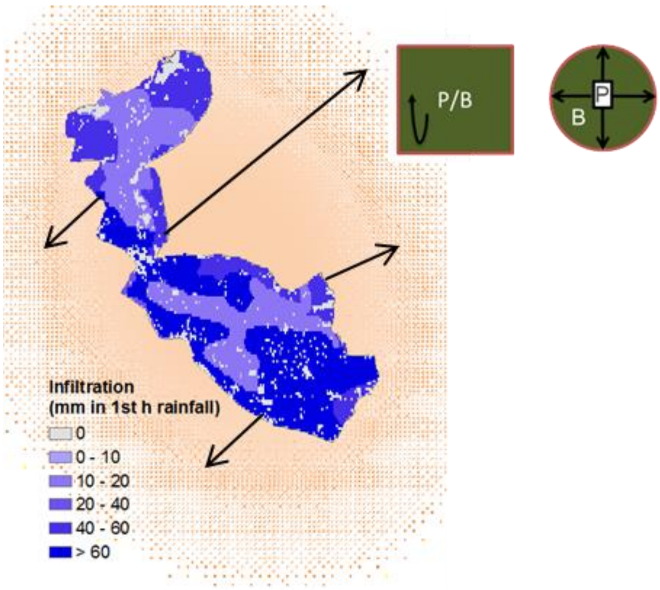


Figure 3: Total potential infiltration in one hour in Spreewald (mm in 1st h rainfall)

For **Jauerling-Wachau** we modelled the regulating ES atmospheric composition and climate regulation in the form of carbon sequestration (t C/ha, Figure 4). Carbon sequestration is a decoupled ES, because it is demanded by the global population following its role in the regulation of the global climate.

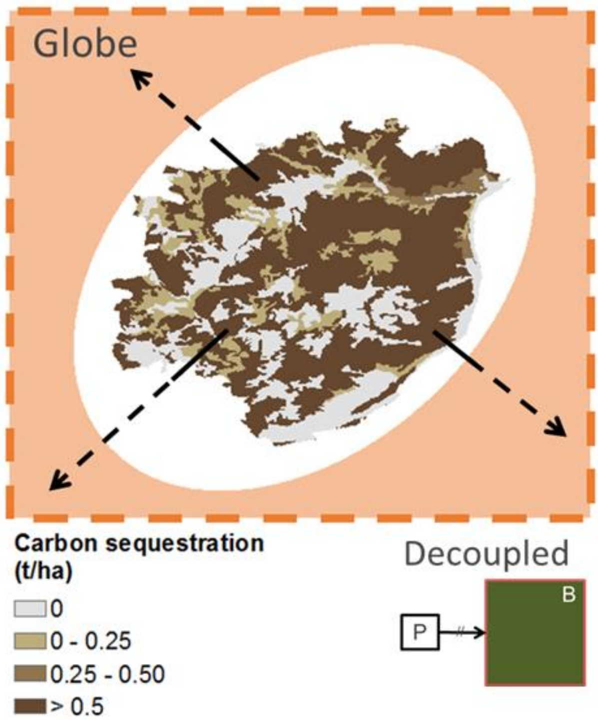


Figure 4: Carbon sequestration in Jauerling-Wachau (t/ha)

The municipality of **Berg en Dal** consists of a varied cultural landscape in which agriculture plays an important role. In Figure 5 we show the crop productivity (mainly potato and cereals in t/ha) in Berg en Dal to illustrate the ES food production. The crops produced in Berg en Dal are marketed in the whole of the Netherlands and beyond, so its provision is decoupled from the service benefiting area.

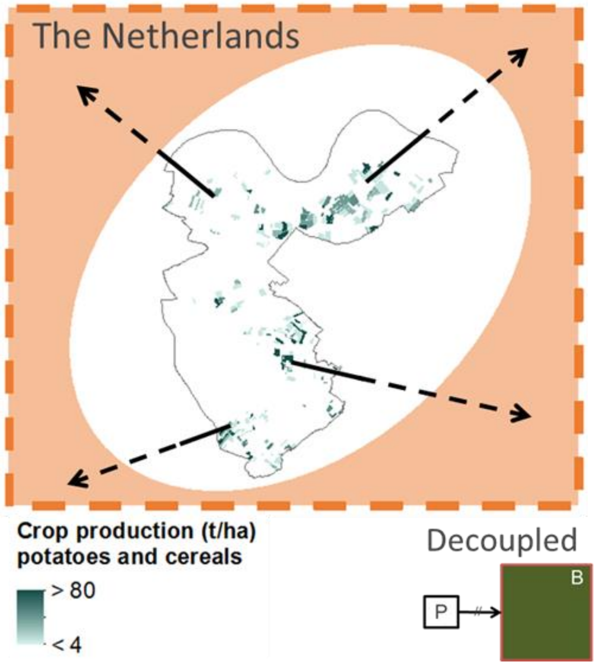


Figure 5: Crop production (t/ha): potatoes and cereals in Berg en Dal

3.2 Spatial relationships of selected ES in the case study areas

Linking to the ES maps displayed in Figures 2, 3, 4 and 5, Tables 1, 2, and 3 indicate also the spatial relationships of other important ES in the three case study areas of cp³: Spreewald, Jauerling-Wachau and Berg en Dal, respectively. In addition to the spatial relationships as displayed in Figure 1, we included the spatial scales local, regional and national to the relationships to clarify the magnitude of the spatial lags.

For Tables 1, 2 and 3 it becomes clear that most of the ES in our case study areas are produced either at the site or at the local scale. Some ES depend on the regional, i.e. landscape, scale of the case study areas, such as the cultural services and the regulating service flood regulation. Most ES are consumed at the site to local scale. However, a number of ES also have a wider demand, ranging from inhabitants in nearby areas to areas further away from the place of production (e.g. in the case of Jauerling-Wachau inhabitants of Vienna buying Christmas trees or tourists coming from other Austrian regions or from outside Austria).

Table 1: Spatial relationships of the most relevant ecosystem services for Spreewald

Category	Specific services	Scale of production	Primary scale of consumption	Additional scales of demand	Spatial relationships
Provisioning	Fish (different kinds)	Site to regional	Site: local fishermen selling fish	Regional to national: processed fish is sold at the national market	Local omni-directional, decoupled
Regulating	Flood regulation	Regional	Regional	None	Regional specific-directional
	Water retention	Local	Local to regional	None	In situ, regional specific-directional
Habitat	Habitat for rare species (esp. orchids, butterflies, birds)	Local	Site to local: recreation by local inhabitants (birding, wildlife viewing)	Global: genetic diversity	In situ, local omni-directional, decoupled
Cultural	Possibilities for canoe	Regional	Site to local	National: German tourists	In situ, national omni-directional
	Possibilities for barges	Regional	Site to local	National: German tourists	In situ, national omni-directional
	Cycling	Regional	Site to local	National: German tourists	In situ, national omni-directional

Table 2: Spatial relationships of the most relevant ecosystem services for Jauerling-Wachau

Category	Specific services	Scale of production	Primary scale of consumption	Additional scales of demand	Spatial relationships
Provisioning	Christmas trees	Site	Site (farmers selling trees)	Regional: inhabitants from Vienna and Lower Austria	In situ, regional omni-directional
	Reared animals (livestock meat)	Local	Site (farmers selling meat)	Regional to national: consumers in Vienna, Lower Austria, including local area (local restaurants), wider Austrian market	In situ, regional to national omni-directional
Regulating	Carbon sequestration	Site	Global	None	Decoupled
	Pollination by bees	Local	Local: farmers (cropland (partly) dependent on pollination)	None	In situ
Habitat	Habitat for rare species (esp. orchids, butterflies, birds)	Local	Site to local: recreation by local inhabitants (birding, wildlife viewing)	Global: genetic diversity	In situ, local omni-directional, decoupled
Cultural	Recreation through walking and hiking	Local to regional	Site to local	International: European tourists	In situ, local omni-directional, decoupled
	Educational services	Local	Site to local: local inhabitants	None	In situ, local omni-directional

Table 3: Spatial relationships of the most relevant ecosystem services for Berg en Dal

Category	Specific services	Scale of production	Primary scale of consumption	Additional scales of demand	Spatial relationships
Provisioning	Livestock products (milk)	Site	Local: farmers	National: milk is sold at national market	In situ, decoupled
	Agricultural produce (vegetables, grains, potatoes)	Site	Local: farmers	National: Agricultural produce are sold at national market	In situ, decoupled
Regulating	Flood regulation	Regional	Regional	None	Regional specific-directional
	Water retention	Local	Regional	None	In situ, regional specific-directional
Habitat	Habitat for rare species (esp. orchids, butterflies, birds)	Local	Site to local: recreation by local inhabitants (birding, wildlife viewing)	Global: genetic diversity	In situ, local omni-directional, decoupled
Cultural	Recreation through walking and hiking	Local to regional	Site to local	National: Dutch tourists	In situ, national omni-directional
	Cycling	Local to regional	Site to local	National: Dutch tourists	In situ, national omni-directional

3.3 Spatial characteristics of governance models

Tables 4, 5, and 6 give an overview of the existing governance approaches and if they can be clearly identified as either a hierarchical command-and-control or top-down (C&C), or a market-based (M-B), or a collaborative (COL) approach (marked with a 2), or if they can only be partly identified with one of the three basic governance approaches (marked with a 1), or if they cannot be related at all to one of the three governance types (marked with a 0) for Spreewald, Jauerling-Wachau, and Berg en Dal, respectively. Also displayed is the main targeted ES, where sometimes governance models aim to increase the provision of multiple ES. In this case, based on expert knowledge, we indicated the most important ES per governance model. Finally, we also list the level for which the governance models were mainly designed for (local to EU level).

Table 4: Governance models in Spreewald

Name	Main targeted ES	Level	C&C	M-B	COL
Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora	Habitat for rare species	EU	2	0	0
Council Directive 2009/147/EC on the conservation of wild birds	Habitat for rare bird species	EU	2	0	0
Water Framework Directive	Water retention, fresh water availability	EU	2	0	0
Bundesnaturschutzgesetz	Habitat for rare species, preservation of cultural landscapes	Federal	2	0	0
Brandenburgisches Naturschutzgesetz	Habitat for rare species, preservation of cultural landscapes	State	2	0	0
Landschaftsrahmenplan (Landscape framework)	Habitat for rare species	Regional	2	0	1
Pflege- und Entwicklungsplan (Care and development plan)	Habitat for rare species	Regional	0	0	0
Kulturlandschaftsprogramm (Agri-environmental programs in Brandenburg state)	Different ES depending on the specific program	EU/State	1	2	1
Spreewaldwiesenprogramm (Spreewald meadows program)	Preservation of the Spreewald cultural landscapes, traditional land use management	EU/State/ Regional	1	2	1
Entwicklungsprogramm Ländlicher Raum (Rural area development program)	Improvement of environmental conservation and animal welfare, improvement of quality of life in rural areas	EU/State	1	2	1
Dachmarke Spreewald (Umbrella trademark label)	Regional/local food production	Regional/Local	1	2	1
Spreewaldwiesenaktie (Spreewald meadows share)	Preservation of the Spreewald cultural landscapes, traditional land use management of Spreewald meadows	Local	1	2	2
Gewässerrandstreifenprojekt (riparian strips projekt)	Habitat for rare species, fresh water	Regional	1	0	2
LEADER ('Liaison Entre Actions de Développement de l'Économie Rurale')	Food production, tourism	EU/ local	1	1	2

Table 5: Governance models in Jauerling-Wachau

Name	Main targeted ES	Level	C&C	M-B	COL
Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora	Habitat for rare species	EU	2	0	0
Council Directive 2009/147/EC on the conservation of wild birds	Habitat for rare species	EU	2	0	0
Water Framework Directive	Water retention, fresh water availability	EU	2	0	0
Niederösterreichisches Naturschutzgesetz (State nature protection law)	Habitat for rare species	State	2	0	0
Management Plan 'Wachau - Wachau-Jauerling'	Habitat for rare species	State	2	0	0
AMA Gütesiegel (Label)	Food production	Federal	2	2	0
AMA Bio Gütesiegel (Label)	Food production	Federal	2	2	0
Bio Austria - Gütesiegel (Label)	Food production	Federal	0	2	2
Wachauer Marille (Wachau apricot)	Food production	Local	0	2	2
Österreichische Programm für umweltgerechte Landwirtschaft (Austrian agri-environmental program)	Habitat for rare species	Federal	2	2	2
Jauerlinger Saftladen (School project 'Juice shop')	Education	Local	0	0	2
Volunteering for Natura 2000/ Wachau Volunteers	Education, habitat for rare species	Local	0	0	2

Table 6: Governance models in Berg en Dal

Name	Main targeted ES	Level	C&C	M-B	COL
Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora	Habitat for rare species	EU	2	0	0
Directive 2009/147/EC on the conservation of wild birds	Habitat for rare species	EU	2	0	0
Water Framework Directive	Water retention, fresh water availability	EU	2	0	0
Omgevingsvisie and Omgevings-verordening Provincie Gelderland	Aesthetic appreciation of landscape, food production	Provincial	2	0	2
Landschapsontwikkelingsplan (Landscape development plan)	Habitat for rare species	Local	2	1	2
Landscape fund Via Natura	Aesthetic appreciation of landscape, food production	Local	0	2	2
'Pilot area green-blue services'	Habitat for rare species, recreation	Local	0	0	2
Water stream expansion in Groesbeek	Flood protection	Local	2	0	2
Room for the River Program	Flood protection	National	2	0	0
Designation of National Landscape	Aesthetic appreciation of landscape	National	2	0	0

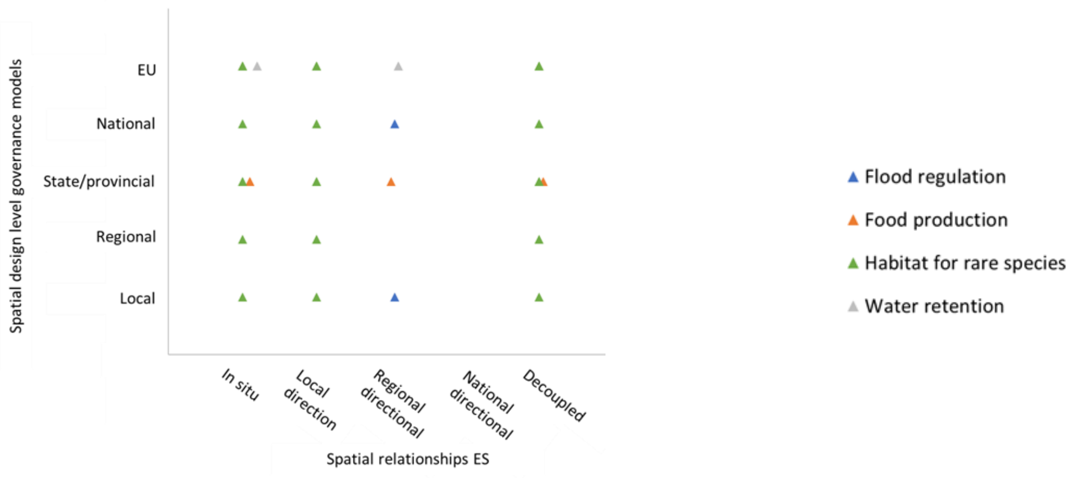
Tables 4-6 indicate that governance models focussing on habitat services are mainly designed at the EU level and then translated into federal and more regional policies. There is a tendency that local governance models have a more collaborative approach.

3.4 Comparison of spatial characteristics of ES provision and demand and governance models

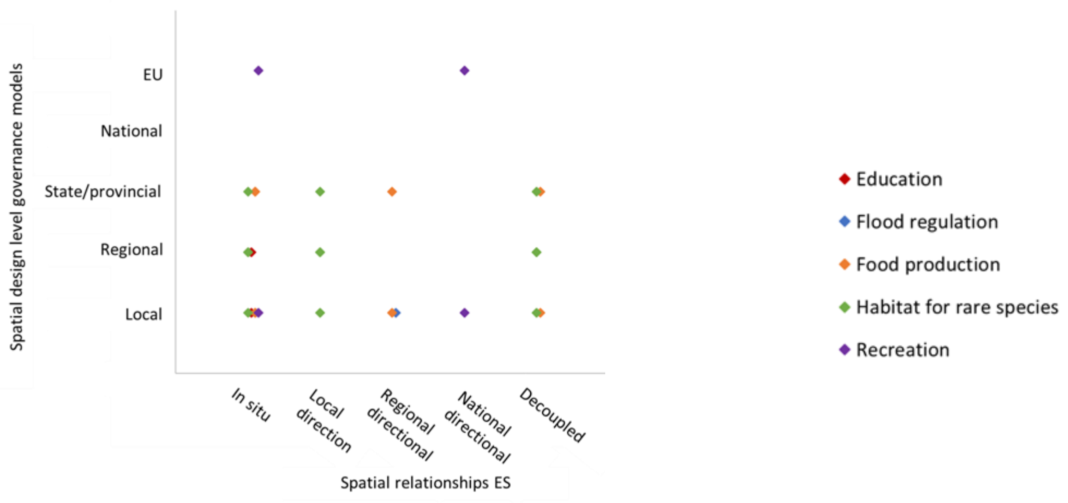
Below, Figure 6 shows the relation between the spatial relationships of the ES and the spatial design levels of their existing governance models, separately for a) hierarchical command and control, b) for collaborative, and c) for market-based governance approaches.

It can be seen from Figure 6, that the different governance approaches (a), (b), or (c) show different patterns with respect to their spatial design and the spatial relationships of the ES they govern. While most market-based approaches (c) exist at the state and provincial level, by comparison most collaborative approaches (b) are designed for the local level. Hierarchical command and control approaches (a) exist for all levels, due to the fact that higher level policies issued at EU-level typically get translated into respective national and sub-national legislation following the subsidiary principle.

a) Command & control governance approaches



b) Collaborative governance approaches



c) Market-based governance approaches

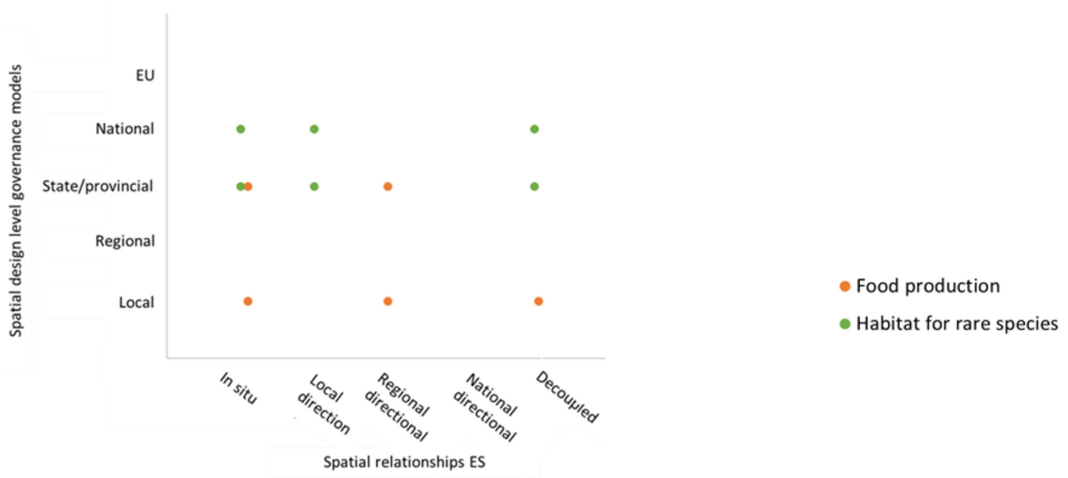
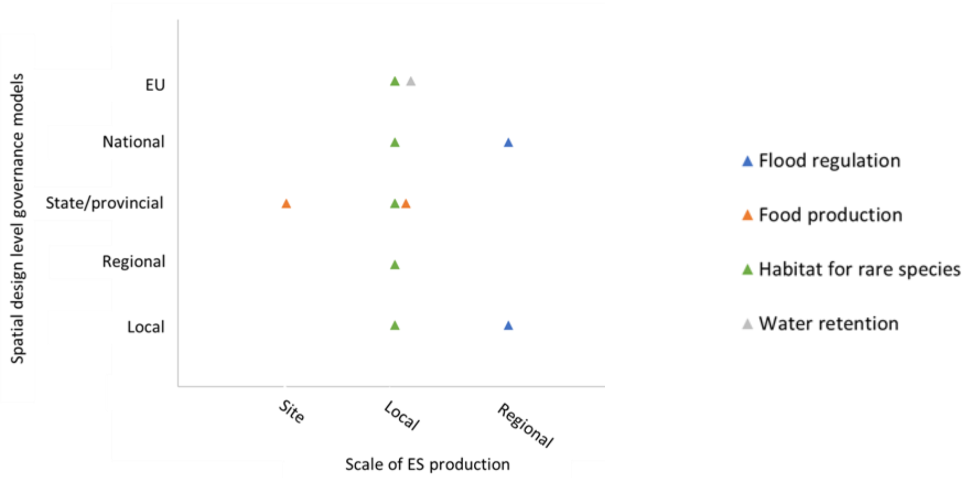
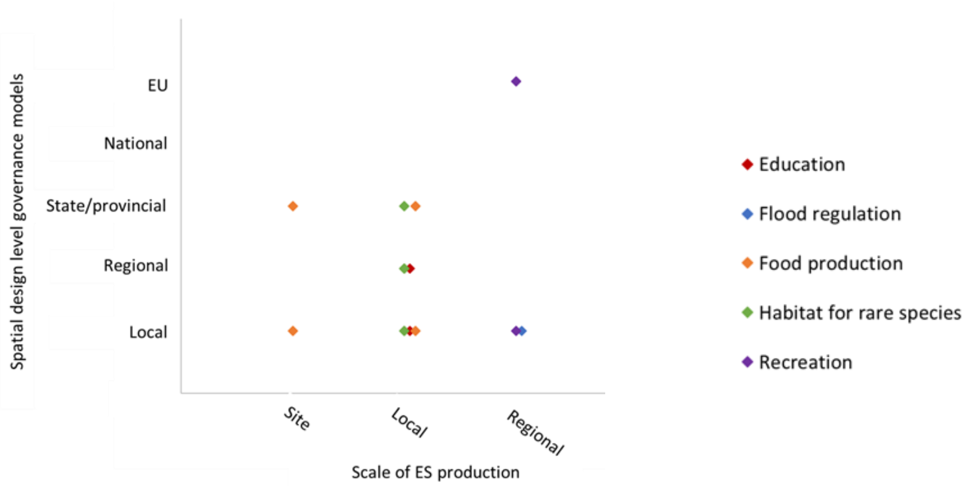


Figure 6: Graphs displaying ES spatial relationships (cf. Figure 1) and the spatial design level of related governance models: a) command & control, b) collaborative, and c) market-based governance approaches. From Tables 4-6 we only selected the governance models that could clearly be identified as a command-and-control (or top-down) approach, a market-based approach, or a collaborative approach.

a) Command & control governance approaches



b) Collaborative governance approaches



c) Market-based governance approaches

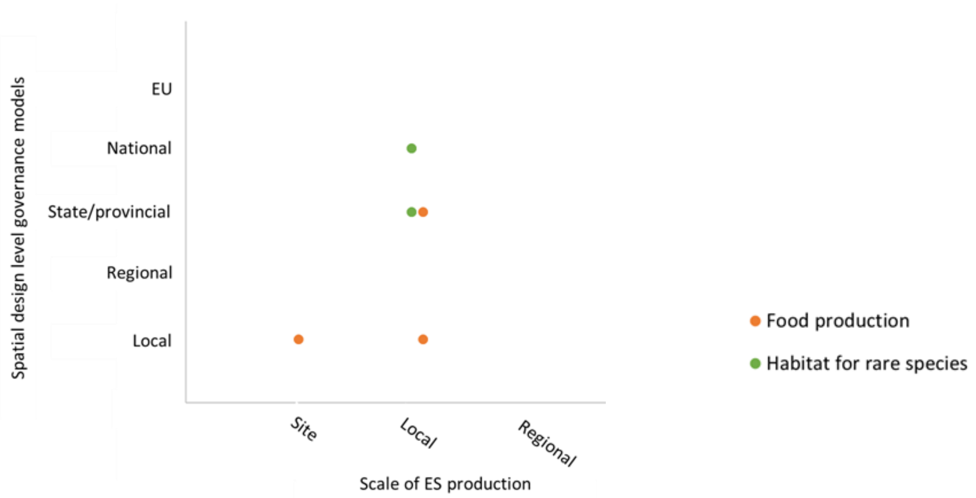


Figure 7: Graphs displaying the ES scale of production (cf. Tables 1, 2, and 3) and the spatial design level of their governance models: a) command & control; b) collaborative; and c) market-based governance approaches. From Tables 4-6 we only selected the governance models that could clearly be identified as a command-and-control (or top-down) approach, a market-based approach or a collaborative approach.

Figure 7 finally highlights how the spatial design levels of the existing governance approaches are divided over the spatial scales of ES production. Figure 7 indicates that some generalized patterns can also be identified between the spatial level of ES production and the level for which the governance approaches were designed. Looking in particular at the ES provided at the local and regional level, it is evident that by comparison more collaborative governance models (b) exist for their management in comparison to hierarchical command and control (a) or market-based (c) governance models.

4. Conclusions

In this deliverable we presented exemplary ES maps for each cp³ case study area, showing their spatial relationships. Visualizing these spatial relationships helps to communicate about who provides these ES and who benefits from them. Thus, ES maps can support in identifying which stakeholder groups should be considered for the design of the respective governance approaches. We have also assessed, if a specific governance approach (hierarchical command-and-control, market-based, or collaborative) of existing governance models contributed to the spatial fits in ES governance at a particular scale. From our results there is a tendency that especially the collaborative governance models are designed to further ES that are produced at the lower levels thus help to support fit of governance solutions at the local to regional level.

5. Acknowledgements

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