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

Inventory on spatial and temporal ranges of ecosystem service supply in rural landscapes

Milestone M.12

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cp³ = civil-public-private-partnerships

1. Introduction

The supply of ecosystem services varies across the landscape due to the configuration of ecosystems and varying biophysical characteristics within the landscape, such as (micro)climate, soil type and species composition. As important for the supply of ecosystem services is the social heterogeneity within a landscape, because this determines the use of the land and the applied management strategies by different stakeholders. The human geography within a landscape (composition and configuration) determines where a specific service is provided and where this service is consumed. The time and distance between the supply of an ecosystem service and its consumption can be considered as the temporal and spatial lag, respectively (Fremier et al., 2013). To arrive at appropriate governance approaches for effective ecosystem service management information about these temporal and spatial lags is essential (Chan et al., 2006; Fremier et al., 2013).

The objective of milestone 12 (M.12) is to elaborate on the spatial and temporal scales of ecosystem services (supply and demand) that can be found in the rural landscapes of the three case study areas: the biosphere reserve Spreewald in Germany, the nature park Jauerling-Wachau in Austria, and the Berg en Dal municipality in the Netherlands. The information presented in M.12 has been retrieved from desk top research, discussions with project partners and stakeholder input.

M.12 is structured as follows: first some basic concepts and definitions are explained, next these concepts are applied for selected ecosystem services per case study and in the last section I have elaborated how these selected ecosystem services can be mapped, which includes localization of the beneficiaries per ecosystem service.

2. Basic concepts and definitions

2.1. Spatial aspects of ecosystem service supply and demand

Based on the literature review carried out for M.10 I have selected the approach by Fisher et al. (2009) to characterize the spatial relationships between areas providing an ecosystem service and areas receiving this ecosystem service, expanded with the spatial relationship *decoupled*, following Burkhard et al. (2014).

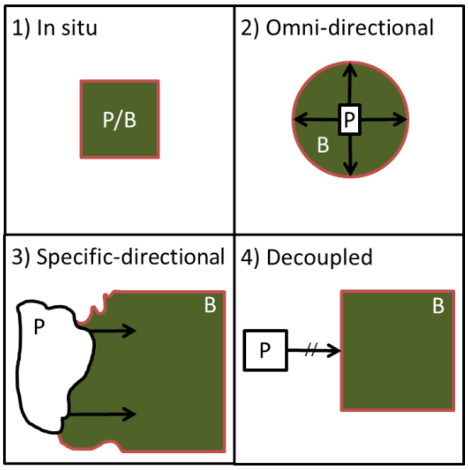

Figure 1: Possible spatial relationships between service production areas (P) and service benefit areas (B). In panel 1, both the service provision and benefit occur at the *same location* (e.g. soil formation, provision of raw materials). In panel 2 the service is provided *omni-directionally* and benefits the surrounding landscape (e.g. pollination, carbon sequestration). 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)

In situ: The service is provided and the benefit is realized in the same location.

Omni-directional: The service is provided in one location, but benefits the surrounding areas without directional bias.

Specific-directional: The service benefits a specific location due to the flow direction.

Decoupled: The service can be traded or benefits people over long distances.

2.2. Temporal aspects of ecosystem service supply and demand

Ecosystem service supply can vary over different temporal scales, including short-term, seasonal, annual, medium-term and long-term periods (Burkhard et al., 2014). Variations over time can be caused by changes in biophysical conditions like long-term climatic changes (Burkhard et al., 2012; Holland et al., 2011) or short-time changes, for example as a result of seasonal changes; an example is the variation in supply and demand of cultural ecosystem services among tourist season and non-tourist season (Burkhard et al., 2014).

Currently, insights in the temporal aspects of ecosystem service supply and demand are only slowly emerging and the integration into ecosystem service assessments is lacking to a large extent (Serna-Chavez et al., 2014). Following Serna-Chavez (2014) I will obtain some understanding of the time difference between the service produced and received, from the (ecological) processes resulting in the ecosystem service provision. For instance, natural pest control takes place at a very short time scale (< 1 year), because the time between the provision of the service (predation of pest by natural enemy) and the receipt of the service (prevention of crop losses) is short. On the other hand, the benefits of carbon sequestration to regulate the global climate are segregated from provision in time, because of the long term required for atmospheric mixing (Pielke et al., 1998).

In line with the framework of Fisher et al. (2009) I have developed Fig. 2 to characterize the different possible time lags.

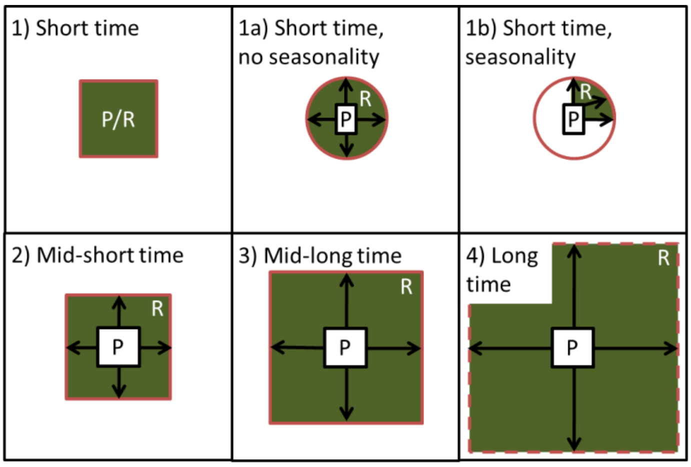

Figure 2: Possible temporal relationships between the provision of service (P) and the receipt of the service (R). In panel 1, both the service provision and benefit occur at the approximately the same time (i.e. short time, e.g. regulation of air quality). Panel 1 has been split to indicate that a service can be provided and received year round (i.e. no seasonality, e.g. maintenance of genetic diversity) (panel 1a) or received in a specific season (i.e. seasonality, e.g. natural pest control) (panel 1b). In panel 2 the time between the service provision and receipt is mid-short-term (e.g. provisioning of drinking water), in panel 3 the time lag is mid-long-term (e.g. water flow regulation) and in panel 4 the time lag is long term (e.g. regulation of global climate).

Short-time: The service is provided and the benefit is realized within 1 year.

Mid-short time: The service is received after 1-10 years of the provisioning of the service.

Mid-long time: The service is received after 10-100 years of the provisioning of the service.

Long time: The service is received more than 100 years after the provisioning of the service.

No seasonality: The service is received year round.

Seasonality: The service is only received in a particular season.

3. Selected ecosystem services per case study area and their spatial and temporal relationships

For each case study area the responsible partner of the cp³ project has selected the most important ecosystem services. In Fig. 3 the spatial and temporal aspects of these ecosystem services, following the frameworks depicted in Figs. 1 and 2, are indicated. See Tables 1-3 for more details on the selected ecosystem services.

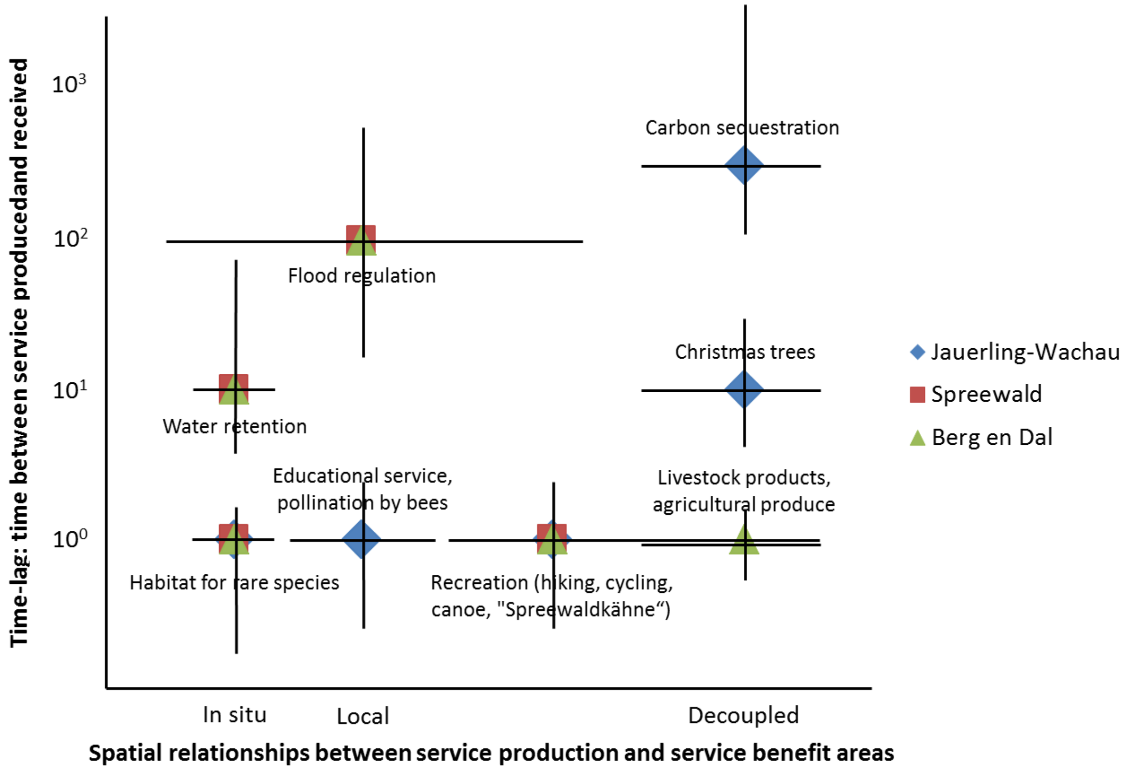

Figure 3: Temporal and spatial aspects of selected ecosystem services per case study area, based on Fig. 1 of Fremier et al. (2013).

Table 1: Spatial and temporal relations of the most relevant ecosystem services for Jauerling-Wachau, Austria

Category	Sub-category	Specific services	Unit	Service benefit area	Spatial relationships between service production and service benefit areas	Time-lag: time between service produced and received
Provisioning	Ornamental resources	Christmas trees	# of trees cut/y	Vienna and Lower Austria	Decoupled	Mid short term, seasonality
	Food	Reared animals (livestock meat)	tons of meat/y	Vienna, Lower Austria, including local area (local restaurants), wider Austrian market.	Local to decoupled	Mid short term, no seasonality
Regulating	Climate regulation	Carbon sequestration	kg C/ha	Globe	Decoupled	Long term, no seasonality
	Pollination	Pollination by bees	Prevented yield losses (%)	Cropland (partly) dependent on pollination	Local omni-directional	Short term, seasonality
Habitat	Habitats for species	Habitat for rare species (esp. orchids, butterflies, birds)	# of different kind of habitats/ha	Local (e.g. for birding, wildlife viewing) to global (genetic diversity)	In situ	Short term, no seasonality
Cultural	Recreation and tourism	Recreation through walking and hiking	km of hiking trails/ha, # of visitors Naturparkhaus	Local villages and Europe	Local omni-directional and decoupled	Short term, some seasonality
	Information for cognitive development	Educational services	# of projects/ha, such as e.g. Saftladen	Local villages	Local omni-directional	Short term, some seasonality

Table 2: Spatial and temporal relations of the most relevant ecosystem services for Spreewald, Germany

Category	Sub-category	Specific services	Unit	Service benefit area	Spatial relationships between service production and service benefit areas	Time-lag: time between service produced and received
Provisioning	Food	Fish (different kinds)	kg fish/ha (for fish ponds) or kg fish/km (for rivers)	Spreewald (mostly) plus Berlin and Brandenburg region, processed fish marketed nationally	In-situ (local fish consumption) and decoupled (fish in cans)	Short term, seasonality (because of reproduction cycle)
Regulating	Moderation of extreme events	Flood regulation	unitless (capacity)	Spreewald and surroundings	Local specific-directional and decoupled	Mid long term, seasonality
	Regulation of water flows	Water retention	m^3/ha	Spreewald	In situ	Mid short term, no seasonality
Habitat/ supporting	Habitats for species	Habitat for rare species (esp. orchids, butterflies, birds)	different kind of habitats/ha	Local (e.g. for birding, wildlife viewing) to global (genetic diversity)	In situ and decoupled (genetic diversity)?	Short term, seasonality (e.g. for migratory birds) and no seasonality
Cultural	Recreation and tourism	Possibilities for canoe	km water way/ha	Local villages and the states of Berlin, Brandenburg, Saxony	Local omni-directional and decoupled	Short term, some seasonality
		"Spreewaldkähne"	persons/y	Local villages and the states of Berlin, Brandenburg, Saxony	Local omni-directional and decoupled	Short term, some seasonality
		Cycling	km cycle courses/ha	Local villages and the states of Berlin, Brandenburg, Saxony	Local omni-directional and decoupled	Short term, some seasonality

Table 3: Spatial and temporal relations of the most relevant ecosystem services for Berg en Dal, the Netherlands

Category	Sub-category	Specific services	Unit	Service benefit area	Spatial relationships between service production and service benefit areas	Time-lag: time between service produced and received
Provisioning	Food	Livestock products (milk)	kg/ha	the Netherlands	Decoupled	Short-term, no seasonality
		Agricultural produce (vegetables, grains, potatoes)	kg/ha	the Netherlands	Decoupled	Short-term, no seasonality
Regulating	Moderation of extreme events	Flood regulation	unitless (capacity)	Berg en Dal and surroundings	Local specific-directional and decoupled	Mid-long term, seasonality
	Regulation of water flows	Water retention	m^3/ha	Berg en Dal	In situ	Mid-short term, no seasonality
Habitat	Habitats for species	Habitat for rare species (esp. orchids, butterflies, birds)	different kind of habitats/ha	Local (e.g. for birding, wildlife viewing) to global (genetic diversity)	In situ	Short-term, no seasonality
Cultural	Recreation and tourism	Hiking	hikers/ha	Local villages and Europe	Local omni-directional and decoupled	Short-term, some seasonality
		Cycling	cyclists/ha	Local villages and Europe	Local omni-directional and decoupled	Short-term, some seasonality

4. Implications for governance

Identifying the time-lags and spatial relationships of ecosystem services can help policymakers to develop effective governance approaches for ecosystem service provision (Fremier et al., 2013). With help of this information, the degree of governance that is needed, as well as the spatial and temporal scales of the governance can be matched to the time-lag and spatial relationship of the ecosystem service(s) of interest. Ecosystem services with a short time-lag and which are consumed locally will probably require less governance (the bottom left of Fig. 3), because it is likely that, if the service is truly beneficial for the beneficiaries, it is easy for them to recognize the service and they are probably more willing to conserve it (Cerdán et al., 2012). In contrast, ecosystem services which are consumed (far) away from where they are produced and for which the time-lag is large (the upper right part of Fig. 3) will require more governance, because the direct beneficiary effect is not visible for land managers (Ostrom et al., 1999). In addition, when the same ecosystem service is provided at different locations over time (e.g. habitats for migratory species), governance needs to be consolidated between these areas to make sure that the flow of ecosystem service between these areas does not get disrupted/blocked (e.g. if in one location it is allowed to hunt this species while it is protected at the other location). Finally, information on time-lags and spatial relationships of ecosystem services can be useful to explain to stakeholders when and where a project, law or rule will have impact.

5. References

Burkhard, B., Kandziora, M., Hou, Y., Müller, F., 2014. Ecosystem Service Potentials, Flows and Demands – Concepts for Spatial Localisation, Indication and Quantification. Landscape online 34, 1-32.

Burkhard, B., Kroll, F., Nedkov, S., Müller, F., 2012. Mapping ecosystem service supply, demand and budgets. Ecological Indicators 21, 17-29.

Cerdán, C.R., Rebolledo, M.C., Soto, G., Rapidel, B., Sinclair, F.L., 2012. Local knowledge of impacts of tree cover on ecosystem services in smallholder coffee production systems. Agricultural Systems 110, 119-130.

Chan, K.M.A., Shaw, M.R., Cameron, D.R., Underwood, E.C., Daily, G.C., 2006. Conservation Planning for Ecosystem Services. PLOS Biology 4, e379.

Fisher, B., Turner, R.K., Morling, P., 2009. Defining and classifying ecosystem services for decision making. Ecological Economics 68, 643-653.

Fremier, A.K., DeClerck, F.A.J., Bosque-Pérez, N.A., Carmona, N.E., Hill, R., Joyal, T., Keesecker, L., Klos, P.Z., Martínez-Salinas, A., Niemeyer, R., Sanfiorenzo, A., Welsh, K., Wulfhorst, J.D., 2013. Understanding Spatiotemporal Lags in Ecosystem Services to Improve Incentives. BioScience 63, 472-482.

Holland, R.A., Eigenbrod, F., Armsworth, P.R., Anderson, B.J., Thomas, C.D., Gaston, K.J., 2011. The influence of temporal variation on relationships between ecosystem services. Biodiversity and Conservation 20, 3285-3294.

Ostrom, E., Burger, J., Field, C.B., Norgaard, R.B., Policansky, D., 1999. Revisiting the Commons: Local Lessons, Global Challenges. Science 284, 278-282.

Pielke, R.A., Sr, Avissar, R., Raupach, M., Dolman, A.J., Zeng, X., Denning, A.S., 1998. Interactions between the atmosphere and terrestrial ecosystems: influence on weather and climate. Global Change Biology 4, 461-475.

Serna-Chavez, H.M., Schulp, C.J.E., van Bodegom, P.M., Bouten, W., Verburg, P.H., Davidson, M.D., 2014. A quantitative framework for assessing spatial flows of ecosystem services. Ecological Indicators 39, 24-33.

Impressum

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- Organisation for International Dialogue and Conflict Management (IDC)
- Wageningen University, Department of Environmental Sciences (WUR)

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