Payments for Ecosystem Services (PES) design characteristics

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Summary
This literature research gives an overview of the various design characteristics of Payments for Ecosystem Services (PES) schemes and discusses their advantages and drawbacks. In order to do so, nineteen PES case studies have been examined.

Motivation for this research is the Vecht project, which aims to develop and apply an ecosystem services (ES) approach within the transboundary Vecht catchment. This includes the development of a PES scheme related to a planned floodplain restoration.

Spatial scale is an important aspect of PES schemes. A small program may have little environmental impact and can be costly, whereas the ES targeted are often not clearly defined in large-scaled schemes. These moreover tend to lack in-situ monitoring of ES provision. Secondly, although privately financed schemes are in theory more cost-effective (i.e. achieve maximum ES provision improvements for a given limited financial budget) than public schemes, this is not evident from this research – perhaps due to the limited number of relevant case studies.

Because links between input land use or management and ES provision are often unclear, PES payments are preferably output-based. Basing schemes on individual agreements with specific ES sellers may be cost-effective as well, because locally tailored measures can then be implemented and payments aligned with the services delivered.

Although compliance monitoring may not always be necessary, ES provision should be monitored so the environmental benefits of PES schemes can be quantified. Lastly, involvement of a trusted intermediary organization and sufficient program duration both promote the participation in and effectiveness of PES schemes.

The results of this research can be kept in mind by the stakeholders of the Vecht project when designing a PES scheme for their project area.

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Contents

1 Objective and scope

Recently the second phase of the Vecht project has started[1]. Within this project an ecosystem services (ES) assessment, which makes clear how the provision of ecosystem services will change following area redevelopment, will be developed and applied within the transboundary Vecht catchment. The project includes a detailed quantification and valuation of relevant ES and the development of a “Payments for Ecosystem Services” (PES) scheme.

A common difficulty in ecosystem restoration projects is that the party profiting from the resulting ES provision is in some cases not the same party that carries the (financial) burden for this. For example, floodplain restoration (achieved through dyke realignment) can be targeted at increasing peak water storage. All downstream inhabitants then benefit from reduced flood risk, whereas farmers within the water retention area may loose land or production capacity. Such imbalances in costs and benefits can be solved by implementing a PES scheme, with which the users of an ES pay to its providers. This financial motivation can safeguard present and future ES provision.

Numerous PES schemes have been implemented worldwide, differing with respect to various design characteristics. For example, in private PES schemes the direct users of an ES also pay for its provision, whereas in a public scheme a third party funds ES provision on behalf of the users. Other features of PES schemes include their spatial scale, whether ES provision in- or output is paid for and how the environmental benefits are measured.

Some efforts have been made to compare different PES schemes with respect to their effectiveness in achieving environmental objectives (e.g. Pagiola et al. 2005, Pattanayak et al. 2010, Wunder et al. 2008). However, such research is based on limited numbers of PES case studies and often focuses on developing countries (e.g. Pattanayak et al. 2010) or on the effects of PES schemes on poverty (e.g. Pagiola et al. 2005). In order to assess how a PES scheme may be optimally designed for use within a Western European watershed, more targeted research was thus needed.

The objective of this literature research is therefore to deduce from practical, relevant PES scheme examples what the benefits and drawbacks of various PES design characteristics are. The results of this review can be taken into account by stakeholders of the Vecht project when designing a PES scheme for their project area.

This report starts with a background chapter (Chapter 2) in which the concepts of ecosystem services and PES are defined, and an overview is presented of the various design characteristics of PES schemes. PES-like initiatives, which are often termed PES but do not meet the definition used in this research, are also briefly reviewed. In Chapter 3, the considered PES case studies are summarized and discussed. The analysis of the benefits and drawbacks of the different PES design characteristics follows in Chapter 4. This report ends by concluding what the advantages and drawbacks of the different PES design characteristics are in different situations (Chapter 5). The full descriptions of the case studies can be found in Appendix 1.

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[1] *The first phase is described in the report:*
Van der Meulen, S, Neubauer, L., Brils, B., Borowski-Maaser, I., 2012. Towards practical implementation of the ecosystem services (ES) concept in transboundary water management. Deltares report 1204644-000-BGS-0004

2 Background

This chapter defines the concepts Ecosystem services and Payments for Ecosystem Services (PES), and presents and explains the most important design characteristics of PES schemes. PES-like initiatives, which are often termed PES but do not meet the definition used in this research, are also briefly discussed.

2.1 Ecosystem services

Ecosystem services (ES) are the benefits that people obtain from ecosystems (Millennium Ecosystem Assessment 2005). They can be divided into four main categories: provisioning, regulating, cultural and supporting services. Table 1 shows some examples of services for each category.

Table 1. Types and examples of ecosystem services

Type	Example of ecosystem service
Provision	Food production
	Drinking / irrigation water
	Mining
	Construction materials
Regulation	Climate regulation
	Water regulation
	Pollination
	Water purification
Culture	Recreation
	Aesthetic value
	Education
Support	Nutrient cycle
	Water cycle
	Transport
	Habitat

2.2 Payments for Ecosystem Services

Because of the rapid growth of the world population and economy over the last decades, demands for ecosystem services have also increased strongly (Engel et al. 2008). Because many ecosystem services are considered free public goods, natural resources are quickly being depleted as a result. Implementing Payments for Ecosystem Services (PES) schemes, which translate the non-market values of the environment into financial incentives (Engel et al. 2008), can help solve this problem.

Wunder (2005) defined PES as follows:

1. A *voluntary* transaction where
2. A well-defined *ecosystem service* (or land use likely to secure that service)
3. Is being 'bought' by a (minimum one) *service buyer*
4. From a (minimum one) *service provider*
5. If and only if the service provider secures service provision (*conditionality*).

However, the term “PES” is in practice used for various kinds of payments that are somehow intended to promote ES provision, but do not meet the definition above; from charging entrance fees to nature reserve visitors to wages for people working in conservation projects (Engel et al. 2008, Wunder 2005). Especially the conditionality criterion (criterion 5) is seldom met: payments are generally upfront and independent of actual ES provision, which is often monitored only loosely or not at all (Wunder 2005).

In this literature research, the Wunder (2005) definition of PES will therefore be adopted with exception of criterion 5. All selected case studies thus deal with a voluntary transaction for a well-defined ecosystem service or multiple services between service buyers and service providers.

2.3 PES design characteristics

PES schemes can be characterized by a variety of design characteristics.

Buyers and sellers

This literature research refers to the people from which the money involved originates as the *buyers* of an ES. This isn’t necessarily the same party that carries out the payments to ES providers; sometimes this is arranged by an **intermediary organization** such as a landscape fund. ES *sellers* are generally land owners, mostly farmers, because specific kinds of land use or (agricultural) management are often expected to generate desired ES (Engel et al. 2008).

Public versus private schemes

In a *private* PES scheme, the buyers of the ES are the same people that use the service. A good example is the case of bottled water company Vittel, which pays farmers in their source area to abandon intensive dairy farming so both drinking water quality and Vittel’s existence are safeguarded (Perrot-Maître 2006). In many other cases, a third party (often a government agency) buys ES on behalf of the users; this is referred to as a *public* PES scheme. For instance, many national governments subsidize farmers to adopt environmentally friendly management practices because this is supposed to yield ES from which all inhabitants can benefit (e.g. Claassen et al. 2008, D’Haene et al. 2010, Dobbs & Pretty 2008). *Public-private* schemes are financially supported by both the direct users of the ES as well as at least one public agency. For example, both water company South West Water, the British national government and NGOs pay for water regulation within the Exmoor Mires Restoration Project (Mills et al. 2010).

Scale

In this literature research, the size of the area to which PES contracts apply is referred to as the spatial *scale* of a scheme. This differs widely among programs: whereas the U.S. Conservation Reserve Program covers 15.9 million hectares (Claassen et al. 2008), farmers in the Dutch Gooi- en Vechtstreek are paid for the environmentally friendly management of two hectares of ditch banks (Hoogheemraadschap Amstel, Gooi en Vecht 2012). Large-scale nationwide programs often have multiple objectives, address several ES and encompass various measures (Appendix 1). Finer scaled schemes can be more targeted, i.e. address a specific ES with measures tailored to local conditions and needs (Wunder et al. 2008).

Input- versus output-based payments

Most PES payments are not directly based on ES provision, because that is often difficult to monitor and quantify (Engel et al. 2008). However, in some cases an *output* indicator of the provided ES is used: participating farmers in the Northeim-Model, which aims to promote biodiversity within an agricultural area, for example receive payments when their managed grasslands and arable lands meet predefined floristic criteria (Ulber et al. 2011). Most PES schemes are however *input-based*: providers are paid for adopting a certain land use (e.g. converting cropland to grassland) or management practice (e.g. limiting agrochemical use) which is expected to deliver the desired ES (Engel et al. 2008). **Amount paid**

Three main ways can be distinguished to determine the price for ES provision within a PES scheme. Firstly, the price can be *fixed* by the ES buyer. For example, farmers participating in the Functional Agro-Biodiversity (FAB) program are paid €0.50 per meter of agricultural field edge converted from cropland to grassland (Scheele et al. 2007). Downside of a fixed price is that participation may not be equally profitable to all potential ES providers (Ulber et al. 2011). Secondly, the amount paid can be based on *individual agreements* between the ES buyer and specific providers. In this way, the amount paid can possibly balance the costs of ES provision exactly. Lastly, the price can be fixed by means of an *auction mechanism* in which potential sellers submit bids for ES provision.

Payments are generally in the form of cash; other possibilities are receiving advice, technical assistance, tax discounts or other in-kind benefits (Engel et al. 2008).

Monitoring

In PES schemes which employ input-based payments, monitoring can be split into two components (Engel et al. 2008):

- **Monitoring compliance**; i.e. whether the ES sellers actually adopt the land use or management paid for (Engel et al. 2008). Especially in large-scaled PES programs this is often achieved through (random) site visits (Wunder et al. 2008). Another tool is cross-compliance; i.e. eligibility to other subsidies is linked to PES compliance (Wunder et al. 2008). Sanctions, such as exclusion from the PES program and repayments, can be imposed for non-compliance (Wunder et al. 2008).
- **Monitoring ES provision**. This for example involves vegetation and fauna mapping for programs targeted at the ecosystem’s habitat function (Van den Akker et al. 2011) and water sampling for programs aiming to improve drinking water quality (Quirin et al. 2011). Although this type of monitoring is crucial for making sure PES funds are well spent, it is often lacking (Engel et al. 2008, Ferraro & Pattanayak 2006, Kleijn & Sutherland 2003).

For output-based PES schemes, only the second type of monitoring is relevant.

Baseline

Establishment of a baseline is important to correctly interpret PES scheme effectiveness, as it expresses how ES provision would develop through time in the absence of payments (Wunder 2005). Adopting an example from Wunder (2005): in many tropical countries deforestation is continuously taking place; the baseline for forest carbon stocks is thus deteriorating. In such a situation, a PES scheme can be successful even if it achieves only a halt or slow-down in deforestation. This concept is visualized in figure 1 from Wunder (2005).

Baselines can be established by prolonged monitoring of ES provision before PES implementation. Such data are absent in most cases; changes in ES provision are then often interpreted by comparing them to trends outside of the PES area or to larger-scale changes.

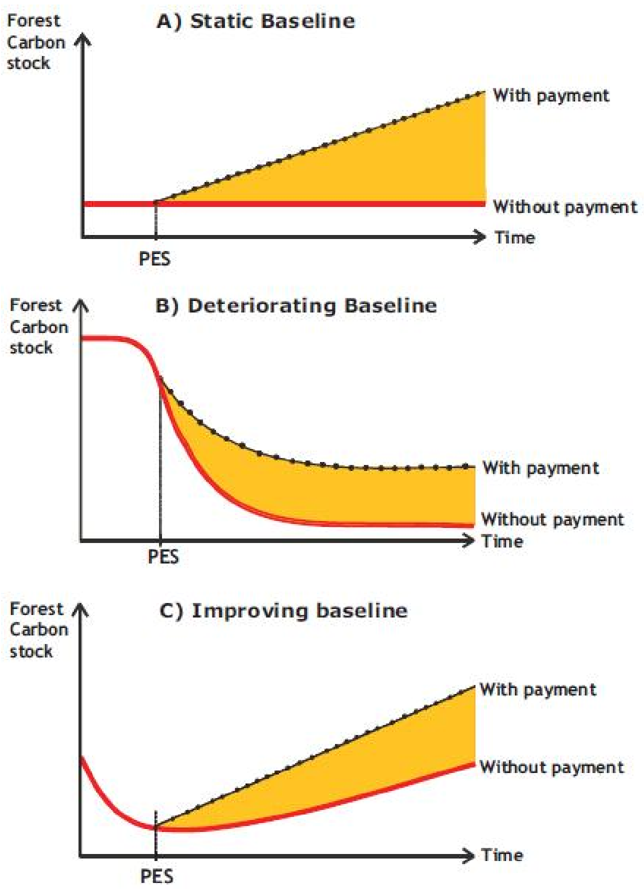

Figure 1. Three different baseline scenarios. The red line visualizes how ES provision develops through time in the absence of PES payments. The orange part of the graph depicts the effect of the PES payments on ES provision. Figure from Wunder (2005).

Additionality

Additionality indicates the extent to which extra ES are provided as a result of PES payments (Wunder et al. 2008) and is thus directly linked to PES cost-effectiveness (i.e. the ability to achieve maximum ES provision improvements for a given limited financial budget; Klimek et al. 2008). Quantifying additionality is however complicated as it requires comparing ES provision during a PES program with a fictitious business-as-usual scenario (Wunder et al. 2008). Wunder et al. (2008) further suggest that a lack of additionality (i.e. paying for activities that would have been undertaken anyway) is more likely in public than in private PES schemes, because ES users have a clear incentive to ensure that the program is cost-effective.

Leakage

Leakage refers to the displacement of environmentally damaging activities outside the PES zone (Engel et al. 2008). For example, land owners retiring part of their property to receive payments within the U.S. Conservation Reserve Program (CRP) could take new land into production (Claassen et al. 2008). If leakage is significant, the environmental benefits of a PES will be overestimated (Engel et al. 2008).

Permanence

Permanence refers to the ability of PES schemes to enduringly improve ES provision (Engel et al. 2008). According to Engel et al. (2008), an intrinsic feature of PES schemes is that ES supply is enabled by payments. They therefore assume that ES provision stops as soon as payments from ES buyers to sellers are terminated; permanence is therefore dependent on PES contract length. Exceptions form cases where short-term payments can induce a permanent shift to environmentally friendly management, because initial investment costs must be overcome or acceptance among potential ES providers must be gained (Engel et al. 2008). For example, limiting agrochemical use could eventually become profitable for farmers because of decreasing expenses on pesticides. Such measures may thus persist after PES contracts have ended (Engel et al. 2008). Lastly, not all measures undertaken within PES programs are equally reversible; some changes can therefore be long-lasting. Contract length, profitability and irreversibility thus all contribute to PES permanence.

2.4 PES-like initiatives

Several other initiatives have been termed “PES” because they involve payments somehow intended to promote ES provision; however, many do not meet the definition of PES used in this research (Engel et al. 2008, Wunder 2005). These initiatives can be divided into three main categories:

- *Involuntary payments*: The costs that drinking water companies, water boards and governments incur for the production, purification and management of water are (partly) earned back via a rate per m^3, levies and taxes. Although Almaši (2005) uses this cost recovery for water services as an example of a PES mechanism, these transactions are not voluntary: using water and paying taxes can hardly be avoided.
- *Poorly defined ecosystem services*: Charging entry fees to nature reserves is often termed a PES mechanism (Almaši 2005, Engel et al. 2008, Wunder 2005). However, although visitors probably pay mainly for getting access to a recreational area, much of the reserve’s income may be invested in nature management measures unnoticed by the majority of visitors. It is thus unclear which ecosystem service is precisely involved in such transactions.
- *Poorly defined service buyers and/or providers*: Investments in green funds are often tax-free (Almaši 2005); investors are thus paid via tax savings for choosing green funds (e.g. CO_2 forest certificates) over conventional funds. Although this has been termed a PES example (Almaši 2005) it is unclear who is providing ES and in what way: the investors financially supporting green funds, the funds providing opportunities for investments, or the government offering tax reductions?

3 Case studies

Nineteen practical examples of PES case studies (as defined in chapter 2.2) are examined. Some of these were found by searching the scientific literature; others were supplied by the Vecht project partners. Examples are selected based on their relevance for the Vecht project; they are all located in developed countries and lack side objectives such as poverty alleviation. The full descriptions of each case are printed in Appendix 1.

The case studies can be divided intro three main categories:

1. Small-scaled (public-)private schemes;
2. Small-scaled public schemes;
3. Nationwide agro-environmental schemes.

“Small-scaled” here means that a PES scheme does not apply to an entire country.

3.1 Summary of the case studies

Table 2 shows a summary of the case studies. The column *ES monitoring* indicates whether the provision of all (*Yes*), some (*Partly*) or none (*No*) of the ES targeted is monitored during the program. *Baseline* indicates whether baseline establishment is absent (*No*), explicit (*Yes*) or whether ES provision changes are interpreted by a comparison with trends elsewhere (*Partly*). Lastly, *Additionality* indicates whether additionality is *High* (measures would not have been adopted without payments), *Low* or *Unclear* (i.e. this cannot be concluded from the case study documentation).

3.2 Design characteristics of the case studies

In all considered case studies the ES sellers are land owners; mostly farmers. Most cases are examples of public schemes (categories 2 and 3), where public institutions (from the municipal to the European level) buy ES on behalf of their inhabitants and the actual users of the ES are not involved. In most examples within category 1 (private and public-private schemes), the ES user involved concerns a water company which is dependent on nature’s drinking water provision function.

As shown by this selection of case studies, PES schemes function at a wide variety of spatial scales. The nationwide agro-environmental schemes within category 3, such as CRP/EQIP in the U.S. and ESA/CSS in the U.K., cover up to 15.9 million hectares (Claassen et al. 2008). On the other hand of the spectrum, categories 1 and 2 comprise small programs often targeted at a specific local issue. For example, the Salland Waterproof project assesses the effects of water storage on four hectares of agricultural land (De Vos & Hoving 2005).

In the large majority of case studies, payments are based on input land use and/or management. The two exceptions are the Northeim-Model and the Wimmera Groundwater Salinity Auctions: payments are in these schemes based on an indicator of the ES provided (Ulber et al. 2011, Shelton & Witten 2005). In both cases, an auction mechanism is implemented to determine the price paid for this. Interestingly, only one other PES case study applies an auction mechanism, which is the U.S. CRP/EQIP scheme (Claassen et al. 2008). Except from these examples, prices for ES provision are fixed in roughly 50% of the cases and depend on individual agreements in the other half (Appendix 1).

Table 2. Summary of the case studies. The column *ES monitoring* indicates whether all (*Yes*), some (*Partly*) or none (*No*) of the ES targeted are monitored during the program. *Baseline* establishment can be absent (*No*), explicit (*Yes*) or consist of a comparison to trends elsewhere (*Partly*). Additionality indicates whether additionality is *High* (measures would not have been adopted without payments), *Low* or *Unclear* (i.e. this cannot be concluded from the case study documentation).

Name	Country	Category	Scale [ha]	Paid for	ES monitoring	Baseline	Additionality
Adopt a field edge	The Netherlands	1	36	Input	Partly	No	Unclear
EMRP	U.K.	1	300	Input	Partly	No	Low
Vittel	France	1	5100	Input	Yes	High	High
Pure Water in the Bommelerwaard	The Netherlands	1	15700	Input	Yes	No	Unclear
SCaMP	U.K.	1	20000	Input	Yes	No	Unclear
CRP	U.K.	1	245500	Input	Partly	No	High
Farmers as Water Managers	The Netherlands	2	2	Input	Partly	Medium	Unclear
Salland Waterproof	The Netherlands	2	4	Input	Yes	High	High
Farmers for Nature	The Netherlands	2	119	Input	Partly	No	High
FAB	The Netherlands	2	440	Input	Yes	Medium	Unclear
Northeim-Model	Germany	2	774	Output	Partly	Medium	High
Clean Water for Brabant	The Netherlands	2	7000	Input	Yes	Medium	Unclear
Wimmera Salinity auctions	Australia	2	28000	Output	Yes	High	High
Groundwater Protection Cooperation	Germany	2	314000	Input	Yes	Medium	Unclear
PDPO	Belgium	3	67873	Input	No	No	Low
ECA	Switzerland	3	120000	Input	Yes	No	Low
Green-blue services Overijssel	The Netherlands	3	332000	Input	No	No	Unclear
ESA / CSS	U.K.	3	640000	Input	No	No	Low
CRP / EQIP	U.S.A.	3	15900000	Input	No	No	Low

With regards to monitoring compliance, a rough division of the cases can be made: formal checks (e.g. site visits) are often implemented within the nationwide schemes from category 3, whereas the issue is not considered in the case study documentation of most smaller-scaled programs. Cross-compliance is often deployed as a tool within the category 3 schemes (e.g. Claassen et al. 2008, Shelton & Witten 2005), but also in the small-scaled Exmoor Mires Restoration Project (Mills et al. 2010).

It is not always clear whether the provision of the targeted ES is indeed being promoted by PES scheme implementation. In-situ monitoring of ES provision even lacks completely in almost all category 3 case studies (Table 2). Their effectiveness is therefore only supported by previously established links between land use and ES provision (see e.g. Foley et al. 2005, Kleijn et al. 2009, Klein et al. 2007). However, because the shapes of these relations are often unknown (Kleijn et al. 2009), the exact local environmental benefits of the implemented measures remain uncertain (Ferraro & Pattanayak 2006, Kleijn & Sutherland 2003, Pattanayak et al. 2010).

Case studies within categories 1 and 2 on the other hand all encompass ES provision monitoring to some degree; however, the applied monitoring method does not always cover all the ES targeted by the PES scheme. For instance, the “Farmers as Water managers” program is targeted at the ecosystem services water regulation, purification, nutrient regulation and habitat provision; however, only habitat monitoring is performed (Hoogheemraadschap Amstel, Gooi en Vecht 2012).

Further, baselines are generally not assessed explicitly. One of the exceptions forms the Vittel scheme: in that case study, four years of research prior to the program start demonstrated a deteriorating water quality baseline (Perrot-Maître 2006). In most other programs, the expected trend in ES provision through time in absence of PES payments is not taken into account (Table 2; Wunder et al. 2008). At best, changing ES provision is compared to trends in other regions. For example, improvements in water quality in the Clean Water for Brabant program exceed those in groundwater protection areas elsewhere, supporting the effectiveness of this program (Joosten et al. 2009). In many other cases, measurements performed before or at the program start form the sole reference point for the monitoring data. Worse, in some cases reference data lack completely; this is especially common within the considered category 3 PES schemes which rarely implement in-situ monitoring of ES provision (Table 2).

In some of the considered case studies it seems possible to receive payments for land use or management that were already adopted. This especially applies to the category 3 schemes; Wunder et al. (2008) also noted that a lack of additionality is more likely in publicly financed schemes that do not require explicit land use changes. To illustrate this, Swiss farmers must manage part of their land as Ecological Compensation Areas (ECA) in order to receive agricultural subsidies; most locate these areas in zones with little agricultural potential (e.g. on steep hills) or that are already used as extensive agricultural areas (Aviron et al. 2009, Jeanneret et al. 2010). Further, to the Belgian PDPO program applies that 44% of the measures would also have been implemented without financial support (Maertens 2011). But also in the small-scaled Exmoor Mires Restoration Project, some participating farmers hardly needed to adapt their management practices: they were already enrolled in the nationwide agri-environmental ESA scheme (Dobbs & Pretty 2008) which encompasses similar measures (Mills et al. 2010).

The Northeim-Model is the only PES program considered for which additionality was explicitly investigated: participating arable fields were matched with similar “business-as-usual” control fields not enrolled in the payment scheme. Additionality was tested for by quantifying the difference in ecosystem service provision between PES and control sites. This turned out to be significant: plant species richness was almost three times higher in PES fields than in the control fields (Ulber et al. 2011).

Overall, additionality seems higher in the schemes which are based on individual agreements (Appendix 1). This might be explained by the fact that these schemes entail that locally tailored measures are agreed upon with specific ES providers.

The only case study that explicitly considers leakage is the U.S. CRP program: this could amount up to 21% (Claassen et al. 2008). Leakage may be high in this program because bids are accepted or not based on a cost-benefits index of the field concerned; this index is in turn calculated from soil and land cover databases (Claassen et al. 2008). Farmers may thus submit bids for the land retirement of parts of their property with a high index and therefore a high probability of being accepted in the CRP program, and intensify production on other parts with a low cost-benefits index. Whether leakage also threatens the environmental effectiveness of the other PES schemes depends on whether ES sellers are able to displace environmentally damaging activities outside the PES zone (Engel et al. 2008). This is at least not the case for most category 3 schemes, as their measures are applicable nationwide.

Contract lengths of the examined PES schemes differ widely: from one to thirty years (Appendix 1). Although ES provision is generally expected to end as soon as payments are stopped, in some cases short-term PES schemes can induce a permanent shift to environmentally friendly management by overcoming investments costs or gaining acceptance among ES providers (Engel et al. 2008). For example, the Cornwall Rivers Project is now lucrative for the participating farmers as they work more efficiently and profit from increased tourism (Le Quesne 2005). It is therefore unlikely that they will return to their former practices. Further, not all measures are equally reversible: some participating farmers of the Exmoor Mires Restoration Project felt for example that the agricultural value of their land was permanently altered (Mills et al. 2010). The probable permanence of ES provision thus differs strongly among case studies.

4 Analysis of PES design characteristics

In this chapter, the benefits and drawbacks of the various PES design characteristics are analysed based on both the case studies and theoretical literature.

Intermediary organizations

Sometimes an intermediary organization mediates between ES buyers and sellers and further takes care of the paperwork. In the case studies considered this is often seen as a large advantage by ES selling land owners, because they gladly avoid extra administration. For example, a survey among farmers in Flanders demonstrated that paperwork is one of the main reasons for farmers not to participate in the Belgian PDPO program (Maertens 2011). On the contrary, participants in the Farmers as Water Managers program were pleased with the fact that the local water board arranged all their paperwork (Hoogheemraadschap Amstel, Gooi en Vecht 2012).

Another benefit of an intermediary organization can be trust-building among potential ES providers, especially if this is a local organization in close contact with the agricultural business. Bottled water company Vittel founded the intermediary organization Agrivair specifically for this purpose, which had a key role in the establishment of the PES scheme: Agrivair mediated between farmers and Vittel, gave tailored advice and performed part of their practical work (Perrot-Maître 2006).

Private versus public schemes

In most cases considered, the actual users of the ES are not involved in the PES schemes; these are exclusively financed through public institutions. However, Engel et al. (2008) state that private PES schemes are likely to be more efficient because users have the best information about the value of an ES, can observe whether the service is actually being delivered and have a clear incentive to ensure the scheme is functioning well. Private schemes are most likely to succeed if individual users have sufficiently large ES benefits that participating in a PES scheme is profitable even when bearing the costs involved, and/or if users have a sufficiently large share of ES benefits that it is realistic to expect them to contribute financially (Engel et al. 2008). However, it is often difficult to identify and delimit who exactly are the users of an ES; in that case government involvement is necessary for PES scheme establishment (Engel et al. 2008). Such public schemes may be more cost-effective due to economies of scale, but they can also be subject to political pressure and therefore not targeted exclusively at efficient ES provision (Engel et al. 2008, Wunder et al. 2008).

Although private schemes are thus in theory more favourable than public schemes (Engel et al. 2008, Wunder et al. 2008), this is not apparent from the case studies considered. Comparing the category 1 (small-scale [public-]private schemes) and 2 (small-scale public schemes) cases shows that the extent of ES provision monitoring and probable additionality are similar between these categories, whereas baseline establishment is more thorough within the category 2 schemes. The involvement of ES users as buyers does thus not noticeably promote PES effectiveness. This discrepancy between theory and practice may be due to the fact that only two of the considered case studies are financed exclusively by ES users whereas the other category 1 examples are funded by a mix of private and public money (Appendix 1). One of the truly private PES examples, the Vittel program, has even been used to illustrate a fictitious “perfect” PES scheme (Perrot-Maître 2006).

Spatial scale

The largest scaled PES programs are the category 3 nationwide agro-environmental schemes. Wunder et al. (2008) state that public schemes typically address multiple ES; this is indeed the case in the considered category 3 case studies. As a result of their large scale and scope the category 3 schemes face a number of problems: they are often poorly targeted and lack in-situ monitoring of ES provision; additionality can therefore rarely be quantified (Table 2; Wunder et al. 2008). Their environmental benefits are thus often unclear.

Small-scale programs may be more effective because they can address a specific objective and their results are more easily monitored (Wunder et al. 2008). The category 1 and 2 PES schemes that have been analysed in this research were indeed better organized with respect to monitoring of ES provision and baseline establishment (Table 2). However, smaller is not always better; for example, watershed problems may only be efficiently addressed by a PES scheme if a sufficient part of the area is included (Dobbs & Pretty 2008). Further, costs of small programs are often disproportionally high (Wunder et al. 2008). PES schemes should thus be large enough to be cost-effective and achieve results, but small enough to be targeted and measurable.

Input- versus output-based

In almost all of the considered case studies, ES buyers pay for input land use or management instead of (an indicator of) the output ES. This is not incidental, but applies to PES schemes in general (Engel et al. 2008, Wunder et al. 2008). Although land use is evidently related to the provision of ES such as water provision and disease regulation (Foley et al. 2005), pollination (Klein et al. 2007) and biodiversity[2] (Kleijn et al. 2009), the shapes of these links are generally unclear (Kleijn et al. 2009). These effects may for example vary between geographical areas, or can depend on the scale at which the PES measures are implemented. For example, the environmental benefits of the Swiss ECA scheme differ strongly between lowland and mountain regions (Jeanneret et al. 2010). Many input-based PES schemes are thus based on a shaky scientific foundation (Wunder et al. 2008).

It therefore seems more desirable to directly base PES payments on ES provision. A difficulty related to such output-based payments is that ES provision can often not be perceived by land users, preventing them from managing their land properly (Engel et al. 2008); further, it may discourage potential ES providers as they cannot be sure in advance whether their efforts will pay off. To illustrate this, in the output-based Northeim-Model requirements for arable land biodiversity were not met for up to 40% of the fields enrolled. This was attributed to both management problems as well as the fact that external risk factors (e.g. extreme weather) influence ecosystem service provision (Ulber et al. 2011).

Determining a price: the efficiency of auction mechanisms

Fixed-price PES schemes can suffer from information asymmetry; i.e. the ES sellers know more about the actual costs of ES provision than the buying party (Ulber et al. 2011). As a result, payments can either be too high (reducing cost-effectiveness) or too low (reducing participation). Auction mechanisms have been put forward as a solution to this problem, as individual ES providers can then submit bids of which the height is dependent on their costs (Wunder et al. 2008). However, bid prices likely not only reflect different costs but also the ES providers' expectations about the maximum price accepted (Ulber et al. 2011). This especially

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[2] There is debate about biodiversity being an ecosystem service or not. See for example:
De Weert en Van Wirdum, 2010. SO-project Duurzaam gebruik ecosysteemdiensten: Relatie biodiversiteit en ecosysteemdienten. Deltares rapport 1002-0094. (In Dutch)

occurs when participants can learn from previous auction outcomes, i.e. if the program involves multiple auctions through time, or from each other. Auction mechanisms can thus not be considered a “silver bullet” to the information asymmetry problem. Another potential advantage of auction mechanisms is that they provide flexibility; applicants can respond to external conditions (e.g. crop prices) by taking them into account in their bids (Ulber et al. 2011, Wunder et al. 2008).

Whether the implementation of auction mechanisms promotes PES cost-effectiveness cannot be assessed in this research because of the limited number of relevant case studies. In one of these cases, the Northeim-Model, bid prices were found to exceed individual farmers’ opportunity costs substantially (Ulber et al. 2011). The authors conclude that more research is needed to analyse the respective cost-effectiveness of auction-based payments versus fixed amounts (Ulber et al. 2011).

Determining a price: individual farm plans

An alternative solution to the information asymmetry problem could be basing PES schemes on individual agreements with distinct ES providers. Several of the considered case studies encompass individual farm plans, which contain tailored measures to be implemented at a specific farm and in which payments are based on the costs of these measures (Appendix 1). In order for such a plan to succeed, the buying party must arrange site visits, perform research on locally feasible solutions and advise each participant. The participating farmers have to give insight into their business and income. Except from solving the information asymmetry problem, individual agreements may be more successful in targeting specific ES with locally optimized solutions and exploring win-win solutions (see e.g. the Cornwall Rivers Project; Le Quesne 2005). A last advantage of individual agreements is that potential ES sellers are more likely to participate in a PES scheme if they can partly decide themselves what measures will exactly be implemented on their land. This was mentioned by participating farmers in both the Clean Water for Brabant (Joosten et al. 2009), Pure Water in the Bommelerwaard (Hoekstra et al. 2002) as well as the Farmers as Water Managers (Hoogheemraadschap Amstel, Gooi en Vecht 2012) case studies. However, the necessary advice, site visits and research could also lead to high program costs.

Monitoring

Formal compliance monitoring is implemented in the category 3 schemes but absent in category 1 and 2 schemes (Appendix 1). Compliance monitoring may be essential in large-scaled schemes where participation can be rather anonymous, whereas social control might ensure compliance in smaller schemes.

Regarding the monitoring of ES provision (output) the opposite is the case: as in-situ ES monitoring lacks within most category 3 schemes (presumably because its implementation is problematic due to the large scale and scope of these programs), their effectiveness is only supported by previously established relations between land use and ES provision (see e.g. Foley et al. 2005, Kleijn et al. 2009, Klein et al. 2007) of which the exact shapes are often unknown (Kleijn et al. 2009). Although the category 1 and 2 PES schemes do implement ES provision monitoring (Table 2), the relation between what’s measured and the targeted ES is often not straightforward. For example, although many PES schemes target multiple ES the applied monitoring method often only concerns one of these services (Table 2).

Compliance monitoring may thus not always be necessary, whereas ES provision monitoring is indispensable to demonstrate the environmental benefits of a PES. However, this is only valid if the relation between what’s measured and ES provision is well supported.

Permanence

Longer running programs have a number of advantages. Firstly, the effects on ES provision can be more clearly demonstrated in a long-running scheme (Appendix 1); for example, it takes time for a change in agrochemical use to significantly alter groundwater quality. To illustrate this, improvements in water quality could only be assessed through models in the brief Pure Water in the Bommelerwaard project (Hoekstra et al. 2002) whereas measurements have clearly demonstrated such effects in the long-running German Groundwater Protection Cooperation (Quirin et al. 2011). Secondly, participation in a short-term program may often be unprofitable for potential ES sellers because of necessary implementation costs; they are therefore more likely to participate if payments will certainly last for some years to come. For example, the measures covered in the Green-blue services for Overijssel program are also encompassed in a national scheme; land owners prefer the former program because of its longer contract length (20-30 instead of 6 years; Van Cooten 2010). Thirdly, measurements, payments and monitoring can potentially be optimized during the course of a longer running program.

Long-lasting programs are thus probably more effective, profitable as well as popular among ES sellers. They are therefore more likely to be continued, ensuring that ES provision is enduringly improved.

5 Conclusions

How a PES scheme can be optimally designed depends on the aim of the scheme and the context of application. Based on the 19 examined PES case studies and theoretical literature, it is nevertheless possible to deduce what the advantages and drawbacks of the various PES design characteristics are in different situations. If the stakeholders of the Vecht project will design a PES scheme, the lessons learnt from this can be kept in mind when deciding on its key characteristics. This includes spatial scale, duration and which public and private parties to involve. Another important aspect to consider is what potential ES sellers will be paid for: specific land use or management practices (input) or ES provision (output). Further, this review provides insight in potential indicators for quantifying of ES provision (Appendix 1).

A PES scheme preferably has a clear objective and effects that are readily measurable, but is also cost-effective and has significant environmental benefits. The geographical area covered should therefore not be too large or too small. Among the considered case studies, the medium-sized examples (400-28.000 ha) all seem to be highly additional and implement monitoring of the ES provided (Table 2); further they are generally well targeted at the provision of only one or two clearly defined ES (Appendix 1). This group for example comprises programs aiming to achieve environmental improvements within delineated geographical areas such as the Hoeksche Waard (Scheele et al. 2007) or the Bommelerwaard (Hoekstra et al. 2002).

Schemes exclusively financed by ES users are likely to be cost-effective (Engel et al. 2008). However, this can only be achieved if the individual ES users can be identified and delimited, and if their ES benefits are sufficiently large that they are willing and capable to finance ES provision independently (Engel et al. 2008). Often this is not the case, and public financing is indispensable. Complementing these public funds with money from private ES users does not noticeably promote PES effectiveness (Table 2).

Because the assumed links between input land use or management and ES provision are often only weakly supported (Wunder et al. 2008), PES schemes are preferably output-based; this is however difficult to achieve in practice (Engel et al. 2008). How much is paid exactly can be fixed, determined by auctions or fixed within individual agreements; advantages of the latter option are that locally tailored measures can be implemented, payments can be aligned with the delivered services and participation is encouraged. Individual agreements may however also cause high program costs. Payments are preferably arranged by an organization that mediates between ES buyers and sellers. This spares ES sellers from undesirable paperwork and can aid trust-building, especially if the organization is known and trusted by prospective participants. Participation can therefore be promoted.

To ensure program continuation, the effects of the PES scheme on ES provision should be well monitored. This entails both keeping track of the adoption of the desired land use and management practices as well as scientifically supporting the link between input and ES provision.

Lastly, the measures implemented within PES schemes are generally economically unprofitable (Engel et al. 2008); programs are therefore preferably long-lasting so participation is encouraged and evident environmental effects can be achieved. In some cases, PES payments can induce a permanent shift to environmentally friendly practices by covering investment costs or gaining acceptance among potential ES providers; the program can then end as soon as this shift is realized.

References

Almaši, A. 2005. Some issues and examples of environmental services and financing for the protection and sustainable use of water-related ecosystems in the Netherlands. A contribution of the Ministry for Agriculture, Nature and Food Quality. Seminar on Environmental Services and Financing for the Protection and Sustainable Use of Ecosystems, Geneva.

Anderson, P., Ross, S. 2011. United Utilities Sustainable Catchment Programme. Volume 1 – Executive Report. Penny Anderson Associates Limited.

Aviron, S., Nitsch, H., Jeanneret, P., Buholzer, S., Luka, H., Pfiffner, L., Pozzi, S., Schupbach, B., Walter, T., Herzog, F. 2009. Ecological cross compliance promotes farmland biodiversity in Switzerland. Frontiers in Ecology and the Environment 7, 247–252.

Claassen, R., Cattaneo, R., Johansson, R., 2008. Cost-effective design of agri-environmental payment programs: U.S. experience in theory and practice. Ecological Economics 65, 738–753.

De Vos, J.A. , Hoving, I.E. 2005. Verkenning van bedrijfsvarianten en milieukundige gevolgen bij piekwaterberging op landbouwgrond in Salland. Wageningen, Alterra, Alterra-rapport 1224.

D'Haene, K., Laurijssens G., Gils B. van, Blust G. de, Turkelboom, F. 2010. Agrobiodiversiteit. Een steunpilaar voor de 3de generatie agromilieumaatregelen? Rapport van het Instituut voor Natuur- en Bosonderzoek (INBO) i.s.m. het Instituut voor Landbouw- en Visserijonderzoek (ILVO). I.o.v. het Departement Landbouw en Visserij, afdeling Monitoring en Studie. INBO.R.2010.38.

Dobbs, T.L., Pretty, J., 2008. Case study of agri-environmental payments: the United Kingdom. Ecological Economics 65, 766–776.

Engel, S., Pagiola, S., Wunder, S. 2008. Designing payments for environmental services in theory and in practice: An overview of the issues. Ecological Economics 65, 663-674.

Ferraro, P. J., Pattanayak, S. K. 2006. Money for nothing? A call for empirical evaluation of biodiversity conservation investments. PLoS biology, 4, e105.

Foley, J. A., DeFries, R., Asner, G. P., Barford, C., Bonan, G., Carpenter, S. R., Snyder, P. K. 2005. Global consequences of land use. Science, 309, 570-574.

Hoekstra, R., Boer, M., Smidt, R., Merkelbach, R., Kers, M., Beer, P. de, Corsten, R., Lentjes, P. 2002. Gebiedsconvenanten in de Bommelerwaard – Boeren en tuinders leveren zuiver water aan de Afgedamde Maas. Utrecht, CLM Onderzoek en Advies BV, CLM-rapport 541-2002.

Hoogheemraadschap Amstel, Gooi en Vecht. 2012. KRW innovatieproject – Boeren als waterbeheerders. Eindrapportage.

Jeanneret, P., Walter, T., Birrer, S., Herzog, F. 2010. Evaluating the performance of the Swiss agro-environmental measures for biodiversity: methods, results and questions. Aspects of Applied Biology 100, 35-42.

Joosten, L., Jansen, J., Berkhuizen, H. 2009. Evaluatie project “Schoon water voor Brabant” - Eindrapport. ClimateChanCe.

Klimek, S., Richter gen. Kemmermann, A., Steinmann, H-H., Freese, J., Isselstein, J. 2008. Rewarding farmers for delivering vascular plant diversity in managed grasslands: A transdisciplinary case-study approach. Biological Conservation.

Kleijn, D., Kohler, F., Báldi, A., Batáry, P., Concepcion, E. D., Clough, Y., Verhulst, J. 2009. On the relationship between farmland biodiversity and land-use intensity in Europe. Proceedings of the Royal Society B: Biological Sciences, 276, 903-909.

Kleijn, D., & Sutherland, W. J. 2003. How effective are European agri-environment schemes in conserving and promoting biodiversity? Journal of Applied Ecology, 40, 947-969.

Klein, A. M., Vaissiere, B. E., Cane, J. H., Steffan-Dewenter, I., Cunningham, S. A., Kremen, C. & Tscharntke, T. 2007. Importance of pollinators in changing landscapes for world crops. Proceedings of the Royal Society B: Biological Sciences, 274, 303–313.

Le Quesne, T. 2005. Cornwall Rivers Project – Independent Economic Evaluation.

MA (Millennium Ecosystem Assessment), 2005. Ecosystems and Human Well-being: Synthesis. Island Press, Washington.

Maertens, E. 2011. Agromilieumaatregelen: Hoe denken landbouwers erover? Departement Landbouw en Visserij, afdeling Monitoring en Studie, Brussel.

Mills, J., Short, C., Ingram, J., Griffiths, B., Dwyer, J., McEwen, L., Chambers, F. 2010. Review of the Exmoor Mires Restoration Project. Countryside and Community Research Institute.

Niedersächsisches Umweltministerium 2007. Prioritätenprogramm Trinkwasserschutz.

Oerlemans, N. 2003. Adoptie voor natuur en landschap - Handleiding voor het opzetten van een adoptieproject. Centrum voor Landbouw en Milieu.

Pagiola, S., Arcenas, A., Platais, G. 2005. Can payments for environmental services help reduce poverty? An exploration of the issues and the evidence to date from Latin America. World Development, 33, 237-253.

Pattanayak, S. K., Wunder, S., Ferraro, P. J. 2010. Show me the money: do payments supply environmental services in developing countries?. Review of Environmental Economics and Policy, 4, 254-274.Perrot-Maître, D. 2006. The Vittel payments for ecosystem services: a “perfect” PES case? International Institute for Environment and Development, London, UK.

Quirin, M., Hartung, T., Hoetmer, M., Kühling, G., Löloff, H., Nickel, G., Ohlebusch, H., Schültken, H., Sievers, H., Korn, H-C. von. 2011. Trinkwasserschutzkooperationen in Niedersachsen. Niedersächsischer Landesbetrieb für Wasserwirtschaft, Küsten- und Naturschutz.

Scheele, H., Gurp, H. van, Alebeek, F. van, Belder, E. den, Broek, R. van den, Buurma, J., Elderson, J., Rijn, P. van, Vlaswinkel, M., Willemse, J. 2007. Eindrapportage FAB 2005-2007. LTO Projecten.

Shelton, D., Whitten, S., 2005. Markets for Ecosystem Services in Australia: Practical Design and Case Studies. Bogor, CIFOR.

Ulber, L., Klimek, S., Steinmann, H-H., Isselstein, J., Groth, M. 2011. Implementing and evaluating the effectiveness of a payment scheme for environmental services from agricultural land. Environmental Conservation 38, 464-472.

Van Cooten, A. 2010. Overijssel boekt succes met groenblauwe diensten. Landwerk 8.

Van den Akker, P., Damsté, P.J., Kuit, G., Huiskes, R., Smolders, G., Stortelder, A., Verkaik, J.J. 2011. Boeren voor Natuur. Monitoring van drie natuurgerichte bedrijven op Twickel in 2009. Wageningen, Alterra, Alterra-rapport 2175.

www.groeneenblauwedienstenoverijssel.nl. Website visited 2-2013.

Wunder, S., 2005. Payments for environmental services: some nuts and bolts. Occasional Paper No. 42. Bogor, CIFOR.

Wunder, S., Engel, S., Pagiola, S., 2008. Taking stock: lessons learnt for the design of payments for environmental services programs. Ecological Economics 65, 834–852.

Appendix 1: Case study descriptions

Name	Adopt a field edge
Category	1
Area	Schouwen-Duivenland, The Netherlands
Status	Running 2002-
Reference	Oerlemans 2003, Landschapsbeheer Nederland
Type	Private
Buyers	Private persons
Sellers	Farmers
Other parties	Zonnestraal (intermediary organization), ecological advice company Sandvicensis (monitoring)
	Funding from national, provincial and municipal governments, as well as the local water board
Scale [ha]	36
Objective	Promote grassland and flowerland as agricultural field borders
Targeted ES	Partly selected by buyers: aesthetic value, habitat, pollination, recreation
Matter paid for	Land use, management, right to visit the area and pick flowers
Unit paid for	Square meters
Measured how?	n.a.
Payment mode	Cash
Amount paid	E3500/ha/yr
Indicator result	Monitoring of birds, insects and macrofauna
Effectiveness	Bird and insect abundances have increased
	Link between land use and ES is uncertain
Evaluation	Only a small part of the available land has been adopted, limiting program results
Conditionality	High: buyers can visit "their" field edge to see the results
Baseline	None
Additionality	Unknown
Leakage	Unknown
Permanence	Low: adoption is in principle for one year

Name	Exmoor Mires Restoration Project (ERMP)
Category	1
Area	Exmoor, U.K.
Status	Finished 2006-2010
Reference	Mills et al. 2010, CCRI
Type	Public-private
Buyers	South West Water (water company), Exmoor National Park Authority, Natural England (NGO), national government
Sellers	Farmers
Other parties	CCRI (research); Steering group (with representatives of stakeholders)
Scale [ha]	300
Objective	Restore the natural hydrology of degraded blanket bogs
Targeted ES	Water regulation, habitat, carbon sequestration, scientific value
Matter paid for	Management: rewetting land by ditch blocking
Unit paid for	Hectare
Measured how?	n.a.
Payment mode	Cash
Amount paid	10 UK pounds/ha/yr
Indicator result	Vegetation monitoring; dip-well monitoring of water height; hydrological flow modeling
Effectiveness	Hydrological data were unreliable
	Analysis of the vegetation data gave mixed results
	Targets of ditches blocked and area rewetted are exceeded
Evaluation	Stakeholders sometimes felt excluded from decision-making; communication was not optimal
Conditionality	Cross-compliance with ESA / CSS
Baseline	No true baseline; vegetation surveys and measurements done on each site before project start
Additionality	Low: overlap with ESA / CSS
Leakage	Unknown
Permanence	High: agricultural value of land is sometimes perceived to be permanently altered

Name	Vittel
Category	1
Area	Grand Sources, France
Status	Running 1993-
Reference	Perrot-Maître 2006
Type	Private
Buyers	Vittel (bottled water company)
Sellers	Farmers
Other parties	Agrivair (intermediary agricultural agency founded by Vittel)
Scale [ha]	5100
Objective	Adress nitrate contamination caused by intensive agriculture
Targeted ES	Drinking water provision
Matter paid for	Management (e.g. stop agrochemical use), land use (e.g. stop maize cultivation)
Unit paid for	Coverage of costs, land acquisition, abolition of debt
Measured how?	Individual farm plans
Payment mode	Cash, technical assistance, advice
Amount paid	Individual agreements
Indicator result	Nitrate concentration
	Link between management and nitrate concentration was modeled at multiple spatial levels
Effectiveness	92% of the subbasin protected; improvements in water quality
	Scheme is economically profitable
Evaluation	It took 10 years to reach an agreement; trust-building through Agrivair was crucial
	Costs increased because of competition with EU agricultural subsidies
	and because all farmers had a monopoly position and could thus act opportunistically
Conditionality	Unknown
Baseline	Declining baseline established by 4 years of research
Additionality	High
Leakage	Unknown
Permanence	High; contract length 18-30 years

Name	**Pure water in the Bommelerwaard**
Category	1
Area	Bommelerwaard, The Netherlands
Status	Pilot 2001-2002
Reference	Hoekstra et al. 2002, CLM
Type	Public-private
Buyers	Dune water company DZH, local and national water boards
Sellers	Farmers
Other parties	Alterra, CLM, DLV (research and advice)
Scale [ha]	15.700
Objective	Promote water quality to meet drinking water standards
Targeted ES	Drinking water provision
Matter paid for	Management (e.g. reduce agrochemical use, recirculate drainage water to limit chemical runoff)
Unit paid for	Hectare
Measured how?	Coverage of costs
Payment mode	Cash, advice
Amount paid	Individual agreements
Indicator result	Percent reduction emission of various substances; groundwater monitoring 13 times yearly;
	modeled results of management practices (relative to a "business as usual" baseline)
Effectiveness	Emission reductions due to new management vary from 0 to 100%
Evaluation	Management solutions were found in dialogue with the farmers;
	these were therefore targeted and locally optimized
Conditionality	Agreements are printed in convenants. Farmers must provide data on agrochemical use
Baseline	No true baseline; water quality was investigated in 1999
Additionality	High
Leakage	Unknown
Permanence	Unknown

Name	**Sustainable Catchment Management Programme (SCaMP)**
Category	1
Area	Lancashire / Peak District, U.K.
Status	Finished 2005-2010
Reference	Anderson & Ross 2011, Penny Anderson Associates
Type	Public-private
Buyers	United Utilities (water company), English Nature (NGO; specific measures), national government (via ESA/CSS)
Sellers	Land owners
Other parties	Penny Anderson Associates (monitoring), Royal Society for the Protection of Birds (bird monitoring)
Scale [ha]	20.000
Objective	Improve catchment quality to meet water standards; ensure a sustainable future for tenants
Targeted ES	Drinking water provision, water regulation, habitat, erosion regulation, carbon sequestration
Matter paid for	Land use, management (e.g. reducing grazing pressure, woodland enhancement, restoring degraded moorland)
Unit paid for	Hectare
Measured how?	n.a.
Payment mode	Cash
Amount paid	Individual agreements
Indicator result	Hydrological monitoring 2005-2014 (40 installations across 4 sites): discharge, dissolved organic carbon, coliform content
	Vegetation monitoring 2005-2014 (across 6 habitat types): diversity, richness, height and cover
	Bird monitoring; calculating carbon losses from particulate organic matter and turbidity
	Number of hectares that meets the High Level Stewardship (highest level CSS) indicators of success (SSSI)
Effectiveness	Dissolved organic carbon decreased with 45%; positive trend in most other indicators
	SSSI hectares in (recovering) favourable condition increased from 35 to 95%
	Runoff and flooding rates are not (yet) altered
Evaluation	Economical cost-effectiveness is unclear from report
Conditionality	Unknown
Baseline	No true baseline; monitoring since project start
Additionality	Unknown
Leakage	Unknown
Permanence	Unknown

Name	Cornwall Rivers Project (CRP)
Category	1
Area	Cornwall, U.K.
Status	Finished 2001-2005
Reference	Le Quesne, 2005
Type	Public-private
Buyers	40% EU, 40% national government, 20% beneficiaries
Sellers	Farmers
Other parties	n.a.
Scale [ha]	245.500
Objective	Empower local communities to manage land use in a sustainable way
Targeted ES	Habitat, water regulation, aquaculture, aesthetic value, recreation
Matter paid for	Management (e.g. managing bankside vegetation, timing and targeting of pesticide use, contour ploughing)
Unit paid for	Coverage of costs
Measured how?	Individual Farm Plans
Payment mode	Cash, advice
Amount paid	Based on individual agreements
Indicator result	Modeling of soil loss; Surveys on fertilizer use and tourism income
	Physical monitoring of the environmental effects could not be implemented
Effectiveness	Soil loss reduced with 9698 tonnes; Reduced fertilizer use savings 337.000 UK pounds
	7.000 extra tourist nights; improved farm profits
	Reduced N and P pollution; reduced dredging and water treatment costs
Evaluation	Program is both environmentally and economically successful
Conditionality	No formal checks; compliance is probably high because farmers benefit economically
Baseline	No true baseline, only monitoring during program
Additionality	Some measures would have been implemented anyway, but faster and better because of the program
Leakage	Unknown
Permanence	High: win-win solutions

Name	**Farmers as Water Managers**
Category	2
Area	Amstel, Gooi en Vechtstreek, The Netherlands
Status	Finished 2009-2011
Reference	Hoogheemraadschap Amstel, Gooi en Vecht 2012
Type	Public
Buyers	Local water board, Vechtvallei (organization for agricultural nature and landscape management), national government
Sellers	Farmers
Other parties	Watermaatwerk, Alterra (research and advice)
Scale [ha]	2
Objective	Achieve environmentally friendly ditch management by farmers
Targeted ES	Water regulation, habitat, nutrient regulation, water purification
Matter paid for	Ditch management
Unit paid for	Hectare
Measured how?	n.a.
Payment mode	Cash
Amount paid	EUR 1560/ha/yr
Indicator result	Monitoring of fish, macrofauna and macrophytes; calculating Ecological Quality Ratios (EKR) from these data
Effectiveness	EKRs mostly slightly increase, but hardly significantly relative to the baseline
	Effectiveness differs among sites, in relation to soil type, seepage, etc.
	Effects are hard to assess because of the short timespan of the project
Evaluation	Farmers' participation promoted because of the water board taking care of the paperwork,
	customized plans for each farm (from practice to policy, not vice versa) and long term (12 yr) contracts
Conditionality	No formal checks; compliance probably ensured by small spatial scale
Baseline	No true baseline; monitoring after 0, 1 and 2 years
Additionality	Unclear from report
Leakage	Unknown
Permanence	High: long-term contracts

Name	**Salland Waterproof**
Category	2
Area	Salland, The Netherlands
Status	Pilot 2010-2012
Reference	De Vos & Hoving 2005, Alterra
Type	Public
Buyers	Provincial and national government, EU
Sellers	Farmer
Other parties	Alterra (research and advice), local water board (construction works and monitoring)
Scale [ha]	4
Objective	Explore environmental and economical effects of peak discharge storage on agricultural lands
Targeted ES	Water regulation, water quality
Matter paid for	Land use: water storage
Unit paid for	Hectare
Measured how?	n.a.
Payment mode	Cash
Amount paid	Coverage of costs
Indicator result	Amount of water stored measured by the inlet; soil and water sampling
Effectiveness	If land is not taken out of production completely, N and P contamination of the surface water increase
	P concentration in the groundwater also increases due to eluvation; N may decrease due to denitrification
Evaluation	No win-win solution: decreasing water quality and economical losses
Conditionality	n.a.
Baseline	Clear baseline for water retention
Additionality	High
Leakage	n.a.
Permanence	n.a.: pilot study

Name	**Farmers for Nature**
Category	2
Area	Twickel Estate, The Netherlands
Status	Running 2007-
Reference	Van den Akker et al. 2011, Alterra
Type	Public
Buyers	National government, municipality, EU
Sellers	3 farmers
Other parties	Alterra (research), local water board (water monitoring), Vogelwerkgroep Twente (bird monitoring)
Scale [ha]	119
Objective	Explore a transition to extensive agriculture with closed cycles, high groundwater levels and protected landscape elements
Targeted ES	Nutrient cycle, water cycle, recreation, education, aesthetic value
Matter paid for	Management, land use
Unit paid for	Coverage of costs
Measured how?	n.a.
Payment mode	Cash
Amount paid	Individual agreements
Indicator result	Vegetation mapping, groundwater monitoring, bird monitoring
Effectiveness	Monitoring is too short-term to fully assess effectivity
	Plant richness is increasing, bird abundance has decreased - perhaps due to construction works
	Closing the cycles is not yet fully achieved
Evaluation	Problems are: long transition time, high costs and financing investments
Conditionality	No formal checks, spatial scale probably ensures compliance
Baseline	Unclear; groundwater monitoring started in 2008
Additionality	High
Leakage	n.a.
Permanence	Low; uncertainty about the future of the contracts

Name	**The Northeim-Model**
Category	2
Area	Northeim, Germany
Status	Finished 2004-2009
Reference	Klimek et al. 2008, Ulber et al. 2011
Type	Public
Buyers	Board with representatives of societal stakeholder groups; third party funding
Sellers	Farmers
Other parties	University of Göttingen (research, advice)
Scale [ha]	774
Objective	Promote biodiversity in grassland and arable land and preserve landscape features
Targeted ES	Water purification, water regulation, pollination, aesthetic value, pest regulation
Matter paid for	Output: hectares of farmland that meet biodiversity criteria
Unit paid for	Specific floristic criteria: e.g. number of species, presence of indicator species
Measured how?	Yearly monitoring on most farmlands by means of multiple inspection plots per site
Payment mode	Cash
Amount paid	Determined by bids
Indicator result	Number of sites fulfilling the biodiversity criteria
Effectiveness	Success rate 61-91%. Success rates are higher for grassland than for arable land.
	Plant species richness was almost three times higher on PES fields than control plots ($p < 0.0001$)
	Bid prices exceeded the individual farmers' opportunity costs substantially
Evaluation	A maximum bid price must be set to overcome the problem of too high bids
	The amount of competition and the size of the budget have a great impact on bid prices
Conditionality	Non-payment if criteria are not fulfilled
Baseline	In general, grasslands have declined by 20% from 1987-2007
Additionality	High in arable sites: assessed by comparing PES fields to control fields
	Presumably low in grassland sites: participating farmers probably met the floristic criteria already
Leakage	Unknown
Permanence	Uncertain: contract length only 1 year, but plant species can reproduce and are therefore sustained in the seed bank

Name	Functional Agro-Biodiversity (FAB)
Category	2
Area	Hoeksche Waard, The Netherlands
Status	Pilot 2004-2007
Reference	Scheele et al. 2007, LTO
Type	Public
Buyers	National government, Productschappen Akkerbouw en Tuinbouw (marketing boards of agriculture and horticulture), Rabobank
Sellers	Farmers
Other parties	LTO Nederland (farmers' employers' organization), NIOO, Wageningen University and DLV Plant (research institutes)
Scale [ha]	440
Objective	Promote biodiversity and minimize pesticide use in an agricultural area
Targeted ES	Disease and pest regulation, habitat
Matter paid for	Land use: converting agricultural field edges to flower/grassland
Unit paid for	Meter of field edge
Measured how?	n.a.
Payment mode	Cash
Amount paid	€0.50/m of field edge; crop-dependent payment for strips crossing agricultural fields
Indicator ES	Disease presence in crops; natural enemies presence in field edges
Effectiveness	Pesticides were no longer needed for potatoes
	Increase in natural enemy presence differed per year
	Effects could not be assessed on sprout fields, because pesticide use remained necessary there
Evaluation	Slug abundances increased in grassland edges, raising the need for other management practices
	The decrease in expenses on pesticides does not cover opportunity and implementation costs
Conditionality	No formal checks; compliance probably ensured by small spatial scale
Baseline	No true baseline; monitoring both in areas with and without grassland edges
Additionality	Unclear from report; probably high because measures are not profitable to farmers
Leakage	None
Permanence	Low; external funding is necessary for program continuation

Name	**Clean Water for Brabant**
Category	2
Area	Brabant, The Netherlands
Status	Running 2001-
Reference	Joosten et al. 2009, ClimateChanCe
Type	Public
Buyers	Provincial government, farmers' organization, local water board, NGOs
Sellers	Farmers, municipalities, companies and inhabitants
Other parties	DLV, CLM (research, advice)
Scale [ha]	7000 ha of farmland; 11 municipalities
Objective	Limit concentrations of (agro)chemicals in the groundwater
Targeted ES	Drinking water provision
Matter paid for	Management (e.g. limit agrochemical use, choose less damaging substances, switch to mechanical weed control)
Unit paid for	Hectare
Measured how?	n.a.
Payment mode	Advice, education, promotion
Amount paid	n.a.
Indicator result	Chemical use by all sellers; Environmental Load Points calculated from type and amount of substances
	For inhabitants: knowledge about the effects of and alternatives for using chemicals
Effectiveness	New practices implemented in 85% of agricultural area; modeled environmental damage decreases with 70%
	This decrease exceeds that in groundwater protection areas which receive financial support
	Among the municipalities only 1 achieved the goal (i.e. no more chemical use)
	Companies could not be motivated to participate. Link between knowledge and behavior of inhabitants is unclear
Evaluation	More success in agricultural than in urban track: related to personal motivation to participate
Conditionality	Farmers felt it was not-done not to participate
Baseline	Changes in the 15% remaining agricultural area not assessed. Comparisons are made with groundwater protection areas
Additionality	Unclear; probably different for farmers, inhabitants and municipalities
Leakage	Unknown
Permanence	Low: 3 yr agreements which are not "institutionalized"

Name	**Wimmera salinity auctions**
Category	2
Area	Wimmera, Australia
Status	Running 2005-
Reference	Shelton & Witten 2005
Type	Public
Buyers	National government
Sellers	Land owners
Other parties	Wimmera Catchment Management Authority (intermediary organization)
Scale [ha]	28.000
Objective	Reduce recharge of saline groundwater aquifers
Targeted ES	Drinking water provision
Matter paid for	Output: modeled salinity at a designated downstream point
Unit paid for	Reduction in tonnes of salt
Measured how?	Modeled links between land use and water salinity
Payment mode	Cash
Amount paid	Determined by bids
Indicator result	Modeled salinity at a designated downstream point
Effectiveness	Unclear: long-term effect
Evaluation	Models linking land use offered by farmers to groundwater salinity are imperfect
	Auction mechanism is expected to promote cost-effectiveness
Conditionality	High upfront payments and limited checks may decrease compliance;
	cross-compliance and social pressure have the opposite effect
Baseline	Explicit, static baseline established
Additionality	Supposed to be high because of output-targeted payments
Leakage	Unknown
Permanence	Low: contract period 1 yr

Name	Groundwater Protection Cooperations
Category	2
Area	Lower Saxony, Germany
Status	Running 1992-
Reference	Niedersächsisches Umweltministerium 2007, Quirin et al. 2011
Type	Public
Buyers	Province of Niedersachsen
Sellers	Farmers
Other parties	Water providing companies (intermediary role)
Scale [ha]	314.000
Objective	Improve drinking water quality by reducing nitrogen contamination
Targeted ES	Drinking water provision
Matter paid for	Land use, management (e.g. converting cropland to grassland, limiting manure use)
Unit paid for	Hectare
Measured how?	n.a.
Payment mode	Cash, education, advice
Amount paid	EUR 15-450/ha/yr; in some cases reimbursement of actual costs
Indicator result	Groundwater nitrogen and pesticide concentrations; modeled nitrogen balance,
	mineral nitrogen content in the soil root zone
Effectiveness	Decrease in N surplus from 94 to 66 kg/ha; N fertilizer purchases decreased from 139 to 110 kg/ha;
	average N in root zone declines by 12 kg/ha, N concentrations decreased in 64% of test wells
Evaluation	Comparison with national trend supports program success
Conditionality	Unknown
Baseline	No true baseline; increasing national trend in N purchases
Additionality	Unknown
Leakage	Unknown
Permanence	High: long-term program and monitoring

Name	Agro-environmental measures Flanders (PDPO)
Category	2
Area	Flanders, Belgium
Status	Running 2000-
Reference	D'Haene et al. 2010 and Maertens 2011, Department of Agriculture and Aquaculture, Government Flanders
Type	Public
Buyers	Government of Flanders, EU
Sellers	Farmers
Other parties	Vlaamse Landmaatschappij VLM (intermediary land agency)
Scale [ha]	67.873
Objective	Reconcile agriculture with environmental goals
Targeted ES	Genetic diversity, water purification, pollination, erosion regulation, air quality, connectivity
Matter paid for	Management, land use (e.g. limit agrochemical use, prevent erosion, etc.)
Unit paid for	Hectare
Measured how?	n.a.
Payment mode	Cash
Amount paid	Depending on measure EUR 75-6000/ha/yr. Some individual agreements
Indicator result	Little monitoring except for bird counts
Effectiveness	>60% of participants signals positive effects on the landscape
	Locally targeted projects are more effective
Evaluation	Relation between management and ES is unclear
	Flexibility is limited: now some measures are profitable to some farmers but not all; allowances don't vary with crop prices
	Participants fear that the destination of their land may change as a result of implementing environmental measures
Conditionality	Compliance monitoring takes place
Baseline	None
Additionality	Low: measures would have been implemented without financial support in 44% of cases
	1/3rd of farmers has one or more measures without participating in the program
	Most popular measures require little effort or are already (partly) obligatory
Leakage	Unknown
Permanence	Medium: When contracts for a measure declined with 80%, implementation of that measure declined with 29%

Name	**Ecological Compensation Areas (ECA)**
Category	3
Area	Switzerland
Status	Running 1993-
Reference	Aviron et al. 2009, Jeanneret et al. 2010
Type	Public
Buyers	National government
Sellers	Farmers
Other parties	n.a.
Scale [ha]	120.000
Objective	Enhance and preserve agrobiodiversity and threatened species
Targeted ES	Habitat
Matter paid for	Land use, management (e.g. maintain diversity in cultivated crops, integrated pesticide use)
Unit paid for	Hectare
Measured how?	n.a.
Payment mode	Cash
Amount paid	Variable; linked to agricultural subsidies
Indicator result	Monitoring of vegetation, birds, hare and invertebrates: three regions, >1000 plots
Effectiveness	ECA management promotes species richness and diversity
	Only common species benefit; threatened species are not promoted
	Link between management and ES varies between sites and through time
Evaluation	Connectivity is not addressed; future success depends on height of subsidies and crop prices
Conditionality	Agricultural subsidies (approx. 20% of farmers' income) are linked to compliance
Baseline	None
Additionality	Low: ECA are mostly located in areas with little potential (e.g. steep hills) or are already extensively managed
Leakage	Unknown
Permanence	Unknown

Name	**Green-blue services in Overijssel**
Category	3
Area	Overijssel, The Netherlands
Status	Running 2004-
Reference	www.groeneenblauwedienstenoverijssel.nl 2013, Van Cooten 2010 (Landwerk)
Type	Public
Buyers	Landschap Overijssel (provincial organization), municipalities, Postcodeloterij (charity lottery)
Sellers	Land owners or tenants
Other parties	Municipalities (drafting landscape development plans), Nationaal Groenfonds (landscape fund carrying out payments)
Scale [ha]	Unclear
Objective	Promote sustenance of green-blue landscape elements
Targeted ES	Aesthetic value, recreation, connectivity, water regulation, water purification, habitat
Matter paid for	Land use, management (e.g. manage small landscape elements, culture ecological field borders, promote accessibility)
Unit paid for	Hectare
Measured how?	n.a.
Payment mode	Cash
Amount paid	Differs per measure and municipality
Indicator result	n.a.
Effectiveness	Unclear
Evaluation	n.a.
Conditionality	Compliance checks take place
Baseline	None
Additionality	Unknown
Leakage	Unknown
Permanence	High: contract length 20-30 yr

Name	Environmentally Sensitive Areas (ESA) / Countryside Stewardship Scheme (CSS)
Category	3
Area	U.K.
Status	Running 1986-
Reference	Dobbs & Pretty 2008
Type	Public
Buyers	National government, European Union
Sellers	Farmers
Other parties	n.a.
Scale [ha]	640.000 (ESA); 530.620 (CSS)
Objective	Preservation of both ecological and historical landscape qualities
Targeted ES	Habitat, education, aesthetic value
Matter paid for	Land use (e.g. converting cropland to grassland), management practices (e.g. maintenance of hedges), accessibility
Unit paid for	Hectare
Measured how?	n.a.
Payment mode	Cash
Amount paid	USD 20/ha/yr (ESA); USD 16/ha/yr (CSS); some individual agreements
Indicator result	Site visits
Effectiveness	Link between land use and ES unclear
Evaluation	Participation within individual watersheds is too low to effectively address watershed management
Conditionality	5-10% compliance inspections; exclusion and repayment can follow from non-compliance
Baseline	None
Additionality	Low: only in 36% of cases would none of the work have been undertaken without payment
	Enrolment is low in intensive agricultural areas whereas participation of extensive farmers is high;
	this indicates that the program may halt further intensification, but is not profitable enough to reverse it
Leakage	Unknown
Permanence	More than 50% of farmers expected to continue in the same way if payments were to stop
	For 25% there would likely be a decrease in their level of environmental management

Name	Conservation Reserve Program (CRP) / Environmental Quality Incentives Program (EQIP)
Category	3
Area	U.S.A.
Status	Running 1985-
Reference	Claassen et al. 2008
Type	Public
Buyers	National government
Sellers	Land owners
Other parties	n.a.
Scale [ha]	15.900.000
Objective	CRP: Promote land retirement in order to prevent erosion, restore wetlands and increase wildlife habitat
	EQIP: Promote adoption of environmentally friendly practices on agricultural lands
Targeted ES	Erosion regulation, water regulation, habitat
Matter paid for	Land use, management practices
Unit paid for	Hectare
Measured how?	n.a.
Payment mode	Cash
Amount paid	Determined by bids
Indicator result	A benefits-costs is calculated using soil and land condition databases
Effectiveness	Relation between land use and ES is unclear
	Use of the benefits-costs index is stated to increase environmental benefits from USD 464 to 834 million
Evaluation	Auction mechanism is expected to improve cost-effectiveness
Conditionality	Compliance checks in approx. 5% of sites; compliance rate 98%. Cross-compliance with other government payments
Baseline	None
Additionality	15% of CRP land would also have shifted to retirement without payments
	51% of CRP land would be shifted to crop production in absence of payments
	Determining whether a land use is firstly adopted because of the program is problematic
Leakage	Maximum 21% for CRP
Permanence	Land retirement permanence is estimated at 49%