Water-Based Payment for Ecosystem Services (PES) Schemes in Scotland

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Abstract

Payment for ecosystem services (PES) schemes in general, and those for freshwater systems (catchments) in particular, have been receiving increased attention as one potential approach to natural resource management. This paper describes the case of the Sustainable Land Management Incentive Scheme (SLMIS) developed by Scottish Water since 2010-11 in six areas of the country, informed by the academic literature of key attributes and issues associated with PES.

SLMIS is an input-based (i.e. payment for actions, not environmental outcomes) payment scheme, administered by Scottish Water. The aim of SLIMS is to improve the quality of water before it reaches their water treatment works. It is too early to evaluate SLMIS, as it only recently began. However, early information about SLMIS allows us to explore how well PES theory matches practice, and may also allow us to infer implications for the outcomes of this and other PES schemes in future.

Several attributes of the SLMIS design, and early interest in the scheme from land managers, bode very well for the future success of this and any similar schemes.

At this time, SLMIS does not match with all theoretical ideals for PES. Therefore it is possible that there may be some problems with inefficiency, e.g. paying too much for some services, or not addressing a full range of possible ecosystem services with existing payments. If this does occur, options exist for revising programme design that may help: for example, "piggybacking" requirements for ecosystem services onto payments for leading services such as drinking water.

Future research to track progress with SLMIS will be valuable. At this time, given the lack of examples in Scotland and Europe, it is hard to predict how or which PES schemes can best be tailored to Scotland. Therefore, any future research to track progress with SLMIS, will provide valuable insights that can inform the choice and design of PES schemes elsewhere in Scotland.

1. Introduction

Within Scotland, there is currently great interest in Payments for Ecosystem Services (PES) schemes, especially those related to water services (for example, see Martin-Ortega *et al*. 2013a. There are multiple reasons to focus on such schemes, and in fact most existing PES schemes across the world include water services (Locatelli and Vignola, 2009). It is thought that the water cycle provides *"a good fit for the ecosystem service approach",* as it clearly demonstrates how changes of ecosystem functioning affect the provision of ecosystem services and therefore human well-being (Martin-Ortega et al., 2013a).

However, if and how PES theory translates into practice is unclear. What evidence there is often comes from developing country contexts (e.g. Martin-Ortega, 2013b), which have many social and environmental differences to Scotland. It is therefore unclear how PES schemes may be used to support environmental management in Scotland. Understanding existing examples of PES in Scotland is therefore critical to help inform when and how future PES schemes should be implemented in the country.

This report begins by explaining the theoretical background to PES, as well as the background to freshwater management in Scotland. Using the resulting understanding of PES in this context, we then search for existing PES and PES-like schemes for water management in Scotland – finding only one example matching the criteria of our search, the ongoing Sustainable Land Management Incentive Scheme. The six catchments or sites within this programme are described according to criteria derived from the literature on PES, and the wider literature on natural resource management. Finally, the discussion section contains some reflections on this scheme, and more general implications for other schemes (water and non-water).

2. The development of Payment for Ecosystem Services concepts for water

This section first provides a brief introduction to ecosystem-based approaches and the concepts of ecosystem services that have helped to give rise to the concept of PES schemes. As contributions to the academic literature, PES schemes are then considered

generally in two subsequent sub-sections, one dealing with the nature of such schemes, and the other with "willingness to enter".

2.1. Origins of PES: Ecosystem-Based Management approaches

Ecosystems services are "*the direct and indirect benefits [which] people obtain from ecosystems*" (MEA, 2005; TEEB, 2010). Such services are usually[1] divided into four broad categories of services: provisioning (e.g. food, drinking water), regulating (e.g. climate regulation, flood regulation), supporting (e.g. photosynthesis, water cycling) and cultural (e.g. recreation, art). In the case of freshwater ecosystem services, this four-fold classification suggests:

- Provisioning: water supply (for drinking, crop uptake and livestock nutrition, food and drink processing, and commercial and other residential uses), hydroelectric power, food provision (e.g. fish)
- Regulating: water flow, soil erosion, sedimentation, water purification
- Supporting: habitat for biodiversity, direct or indirect (e.g. food for wildlife)
- Cultural: water-based recreation (marketed and non-marketed) such as leisure fishing, canoeing, etc.; landscape beauty, art inspiration, heritage.

The services provided by freshwater ecosystems are many, since they include the habitat of fishes, molluscs, reptiles, insects, plants, and mammals. Globally, about one million species may be found in freshwater systems (http://www.iucnredlist.org/initiatives/freshwater). In Scotland, there are 42 species of fish (SNH, 2001) and many other forms of aquatic and nonaquatic wildlife also depends on freshwater for food and nutrition. This variety of life underpins the many ecosystem services enjoyed by humans. In addition, freshwater is essential to humans for drinking water, and is useful for irrigation and aquaculture, transport, energy generation, waste removal, recreation and sport (UK NEA, 2011). Culturally, inland waters in Scotland provide both a historical context (crannogs, ferries, etc.) and an important aesthetic pleasure for tourists and other visitors (represented via viewpoints,

[1] The classification of ecosystem services originally popularised by the Millennium Ecosystem Assessment has since been critiqued, and various updates and refinements offered (see Ojea, J. Martin-Ortega and A. Chiabai, (2012) for a review).

postcards, calendars, etc.) Under recent legislation (the Land Reform (Scotland) Act 2003), anyone has the right to non-motorised access to most inland water in Scotland, e.g. for sailing, canoeing or swimming. Fishing rights (part of riparian rights primarily belonging to the owners of adjacent land) remain private, and are widely commercialised via estates, hotels, and clubs, although unauthorised fishing certainly takes place in more remote areas. Water-related ecosystems may range in spatial scale from biomes (such as freshwater), through lakes ('lochs' in Scotland), river catchments, streams ('burns' in Scotland) and small ponds.

Water ecosystem services are threatened globally by climate change, drainage, burning, water extraction, pollution, over-harvesting, and invasion by exotic species, land conversion for agriculture and intensification of agricultural production (Maltby and Ormerod, 2011). According to the Millennium Ecosystem Assessment (2005), "*globally, freshwater ecosystems are amongst those most significantly altered by human activity*". This is also true in Scotland, where there has been a considerable change in ecosystems and the services they provide over the past years (UK NEA, 2011). The delivery of some services has increased considerably, such as the provision of food and energy. However, most of the habitats and 'natural' ecosystems have declined in area and condition in the last 70 years (UK NEA, 2011). Within Scotland, some of the main pressures include pollution and sedimentation arising from deforestation or afforestation, agriculture, other industry, and domestic properties (SEPA, 2009). All these pressures may thus threaten human well-being. Although calls to conserve and manage the water environment are not new, there is a strong impetus to try and find ways to tackle these problems.

Therefore, new attempts to management are needed. The drive for "sustainable development" has focused attention on ecosystem-based management approaches (Laffoley *et al*., 2004). Instead of focusing on single species or habitats, these approaches attempt to consider ecosystem functioning as a whole, i.e. "*a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit*" (as per the CBD, 2010). It is thought that focusing on ecosystem services may help those planning resource management to balance various goals, over the short and long term (Daily, 1997). One scheme which may promote action along these lines is "payment for ecosystem services".

2.2. Payment for Ecosystem Services (PES)

PES schemes are designed so that buyers purchase - more or less explicitly - services from providers (e.g. Rowcroft *et al*., 2011). A PES scheme may be a complement or an alternative to either - or both - regulation under which land and water operators must observe certain levels of ecosystem provision, and "voluntary" provision, e.g. by land managers (DEFRA, 2011). The payments represent an explicit economic encouragement to land managers to provide such services through market-like incentives.

The rationale for this is that land managers have a direct influence on the provision of many ecosystem services of which they are often not aware, e.g. water quality affected by fertilizers and/or pesticides applied to fields. Moreover, they are often unaware of impacts of their practices on third parties, e.g. on downstream water users. These impacts are called 'externalities' and can be either positive or negative. Usually, such environmental externalities are not incorporated into market prices. Even if land managers are aware of the impacts of their decisions on ecosystem services, it is not in their financial interest to take these services into account in their management strategies as this offers no additional benefit for them.

The different stakeholders who may be involved in a PES scheme for a river, loch or watershed are: landowners (upstream and downstream), farmers (as landowners, but also as potential polluters), local and distant domestic consumers, enterprises (distilleries, food, water) who need good-quality water, and fishers, as well as local and national governments and their agencies.

One way to address land managers' externalities is via mechanisms which incorporate externalities into markets. This is the aim of PES schemes, where land owners get compensated (usually through cash payments) by resource users for providing ecosystem services (ESs), thereby internalising the externalities (Engel *et al*, 2008). The core idea is that service providers, such as land owners and farmers, can be compensated by resource users for providing these services, and will therefore adapt their management strategies in a sustainable way, to the benefit of buyers, sellers and nature itself. This approach is expected to offer multiple advantages as it values many nature services commonly taken for granted, while at the same time raising awareness of service existence and human impacts, and highlighting the social interdependence of

providers and buyers. It can also be seen as a mechanism for pricing services provided by nature that have been formerly undervalued or unvalued, hence creating economic markets for them.

Wunder (2005) famously defined a PES as: a voluntary transaction where a well-defined environmental service (or a land use likely to secure that service) is being "bought" by at least one buyer from a (minimum of one) environmental service provider; if, and only if, the environmental service provider secures environmental service provision (conditionality).

This definition highlights several issues or questions that need to be considered before a PES scheme can be implemented in Scotland.

i) It refers to a single transaction or (if taken to include a set of simultaneous payments) a PES "project". In many cases, such projects fall within the remit of a PES "scheme" or "programme" (i.e. a timetabled scheme), with or without an overall budget or other resource, such as an advisory agency or *animateur*.

ii) The "voluntary" nature of a PES transaction means that it is not part of a compulsory arrangement imposed by regulation, i.e. it is "additional" to the ecosystem services to be provided under basic legislation, e.g. on pollution, water abstraction or birdlife management (OECD, 2010) or within standard contracts. However, there are degrees of voluntariness (or of compulsion), e.g. many Scottish farmers depend heavily on receipt of their Single Farm Payment (SFP), which is dependent on environmental (and other) cross-compliance. A parallel but private case might be a reduction in agricultural rent (a reverse and partial 'transaction') granted or insisted upon by a landlord in exchange for restricting farm operations for sporting or landscape reasons.

iii) The degree of ecosystem service "definition" may be high or low, i.e. may cover a broad range of services (general preservation of landscape), or a specific one (X litres of clean water per day). In many cases, what is defined for a PES refers to land management activities rather than the consequent ecosystem services affected. Moreover, the amount of "service" delivered depends on its utilisation, or on some measure of potential availability. Such measurement might be conceived in biophysical terms (litres of clean water, reduced risk of flooding, numbers of water birds) or in monetary terms (the value placed upon these).

iv) The "buyer(s)" may be governmental – as in the agri-environmental / Scotland Rural Development Programme (AES/SRDP) schemes, which are thus inherently monopsonistic (single-purchaser) in nature. Alternatively the buyers may be private (commercial or voluntary). In the latter case, several or many actual or potential buyers may exist, at least across the country. However, buyers of one type of ecosystem service in one place may often be monopsonists, as in the case of water supply companies within a river basin.

v) Similarly, at any one site, the service provider (land or water manager or rights owner) is likely to be a monopolist (a single seller). However, the often-complex nature of property rights may mean that several parties are involved even for a single site, e.g. landlord, tenant, holder of sporting rights, utility providers, local planning authority. On a wider scale, the availability of alternative providers – and thus the possibility of competition between them, as in an auction-type scheme – depends upon the rarity of the species or other natural resource, e.g. pure water.

vi) Conditionality is inherent to any contractual arrangement; i.e., payment depends on delivery of the product or service promised. However, given the inherent variability of many biophysical conditions (rainfall, wildlife populations, etc.), and the cost of measurement of quantity and/or quality over time, it may be difficult to establish what was actually "delivered". Moreover, as noted above, a PES should be "additional" in nature, i.e. a reward for supplying more than is laid down in basic legislation; but such standards, or responsibility for meeting them, may be ill-defined in law, leaving "value added" unclear.

In the light of these and other criticisms, new definitions/interpretations of PES schemes have been debated in the academic literature (Schomers & Matzdorf, 2013). For example, Vatn (2010) argues that the definition provided by Wunder excludes many payment schemes which do not meet all of his criteria, especially the voluntary aspect, since many PES schemes involve governmental interventions which cannot be seen as voluntary transactions. Muradian *et al*. (2010) defined PES as *"transfer of resources between social actors, which aims to create incentives to align individual and/or collective land use decisions with the social interest in the management of natural resources*", and pointed out that many PES cases do not meet the conditionality criterion due to, for

example, lack of monitoring or of continuous payments. It has also been argued that PESs in practice should primarily be seen as a tool both to increase natural resource management efficiency and to alleviate poverty (Pagiola, 2005). Vatn (2010) states that it may be important to differentiate between *"the wider concept of PES and the narrower concept of markets for environmental services".* Overall, *"PES remains a multi-faceted term with many diverse definitions coexisting"* (Schomers & Matzdorf, 2013).

In order to differentiate between various PES schemes, we use the following classification (adapted from Porras *et al.*, 2012)

- *Government-financed schemes*: In these schemes, the buyer (e.g. the European Commission, UK government, Scottish Government, or local authority) is a third party (often in hierarchy) acting on behalf of service users, which "*acquire[s] funding to compensate service providers through allocating revenues derived from earmarked tax revenues or general budget*" (Porras et al. 2012). These kind of schemes are of a Pigouvian nature (Schomers and Matzdorf, 2013). The participation of the end-users may not always be voluntary, as when all citizens are taxed regardless of their individual use of the service(s) provided. Such schemes are generally large in scope, provide legitimacy, and offer scale economies in transactions. On the other hand, government-financed schemes cannot always observe directly whether ESs are provided, they do not have a direct incentive to ensure that the scheme is working efficiently, and they are likely to be subject to side-objectives such as meeting political pressures or alleviating poverty.
- *Private-user-financed schemes:* In these schemes, the buyers are the end-users of the services. These schemes can be seen as "private deals" and reflect true consumer service demand. They usually operate at a small scale, and target only one or a few services. They tend to have better monitoring, and are less likely to be subject to side-objectives. However, they may struggle to achieve legitimacy, and may involve high transaction costs.
- *Utility-financed schemes*: These **"***acquire funding to compensate providers through allocating revenues derived from user fees or tariffs from a public utility or a regulated private utility. These utilities are for example water supply utilities (e.g. Scottish Water) with plants and facilities located downstream of land-use*

> *operations influencing watershed function and may also include large irrigation service districts or hydropower facilities"* (Porras *et al*. 2012).

Many of the above considerations enter into the assessment of the economic efficiency of a PES scheme. Basic theory suggests that such efficiency is only maximised "automatically" under conditions of "perfect" competition, including a well-defined homogeneous good or service, many buyers and sellers, and perfect information. In the absence of such conditions, there is likely to be under-supply of desired ecosystem services, since few of these can be "commoditised" and thus priced on a market.

However, as in other cases, the likely absence of all criteria for a well-functioning market turns attention to "second best" cases and their features, such as imperfect knowledge, transaction costs and biased valuations. Such features are obvious in many PES situations; in particular, and respectively, limited knowledge of natural systems, high search, negotiation, monitoring and control costs, and "non-economic" perceptions of lifestyle (e.g. farming, sport) and ESs themselves (e.g. climate change drivers).

PES schemes related to freshwater may therefore cover only one or a few of these services, or many of them, thus involving the various forms of PES "packaging", e.g.

- by a single buyer ('bundling')
- by multiple buyers ('layering') or
- one service is sold as an 'umbrella' service while other services 'free ride' ('piggy-backing').

In the UK, some PES-type schemes are already in place, e.g. the agri-environmental schemes (AESs) of the European Union's Common Agricultural Policy (CAP), under which both EU and national governments offer farmers payments for specified management practices. There are also a number of "club good" examples. These are quasi-private goods, for which there is rivalry in consumption but not excludability (Hanemann, 2006). These can include purchase or leasing of land and/or water by nature conservation organisations such as the Royal Society for the Protection of Birds.

Other types of PES schemes are uncommon, e.g. the involvement of private commercial or voluntary Non-Government Organisation (NGO) purchasers and intermediaries for landscape, biodiversity or public-access services. However, there is interest in involving

these sectors and official or officially sponsored reports have emerged that would support this, e.g. on developing place-based PES approaches with a case study on carbon storage in upland England peatland (Quick *et al.*, 2013), and a PES best practice guide has been published (Smith *et al.*, 2013).

Compared to other resource management approaches, such as command-and-control measures, PES schemes are often recommended as being more flexible, more easily applied and more cost-effective (Ferraro & Simpson, 2002). PES schemes may also offer distributional benefits, if poor communities can improve their livelihoods by offering and selling their ESs (Wunder, 2005). Besides providing cash to land users, PES schemes may also provide non-monetary benefits such as training, specialist advisors, infrastructure improvements or technical support. Furthermore, PES schemes bridge the interests of landowners, resource users and nature itself, and can therefore be seen as an efficient tool to address a set of problems. However, it is not well understood whether or not these potential benefits are realised in practice, or how they depend on scheme design.

The next two subsections highlight two key issues in the design of PES projects that are likely to affect their uptake and influence.

2.2.1. "Willingness to Enter" into PES

A PES project often needs the involvement of different "stakeholders", a term used here to cover all those with an economic or socio-cultural interest (whether expressed or not) in the proposed project. The term encompasses anyone with a 'stake' in an issue, both those actors with influence (i.e. those controlling a resource), and those influenced (i.e. those affected by a change in the resource).

Active involvement of stakeholders is here termed "participation", which may range from "consultation" (effective or not) through to more or less complete control of project decision-making. The ''Arnstein ladder'' (Arnstein, 1969) defines 8 levels of participation in a project, from degrees of 'non-participation' (e.g. simple 'manipulation') through forms of 'tokenism' (e.g. 'consultation') to degrees of 'power' (e.g. partnership, or full control) at the top. This framework may suggest one way to analyse the degree of involvement of potential entrants to a PES scheme.

In general, after (or if) a scheme or programme is set up by the government or one of its agencies, an initiator proposes a local project to a number of stakeholders, and takes forward the terms (scope, payment levels, etc.) of the potential contract(s) with one or more buyers and sellers. Third parties may be approached for finance on a grant or loan basis, while residential and interest communities are consulted, both informally and (for state-backed schemes) formally. This process may last for some time (e.g. several years) while concerns are addressed, reluctant participants are persuaded, additional interests or developments become involved, etc. After agreement, a contract manager takes on the administration of the project, e.g. monitoring and payment. In the longer term, others may become involved (or re-involved) as disputes or extension (of scope or time) possibilities arise.

For the smooth long-term functioning of a PES project, the most concerned protagonists are the buyers and the sellers, who are directly affected participants. For an investment PES project, the buyer has to provide the necessary funds (and perhaps other resources, such as contributions in kind, or voluntary labour), and will expect a result from the investment over at least an agreed period. Other PES projects involve annual payments, with similar expectations. The seller has to work, or make concessions, to provide the service, in exchange for payment(s).

As a PES scheme is supposed to be, by definition, a voluntary scheme (Wunder, 2005), we need to consider the elements which affect the willingness(es) of these participants to enter or not enter such a scheme. Such "entry" involves at least some of the following components:

- Awareness of the PES proposal, whether derived from formal announcement/invitation, media coverage, or "word of mouth". With the growing use of alternative public and private media, such as social networks and interest-group websites, dissemination of information is becoming increasingly diversified.
- Sufficient trust or interest in the invitation source to respond "in principle", e.g. to gain more information, explore eligibility, establish further credentials, etc. The medium used for the initial approach may affect this trust, as does previous

experience or contact over similar exercises (or in other ways, such as water billing)

- Acceptance of the information received, based on level of detail and certainty, the involvement (or non-involvement) of others, etc.
- Agreement to enter the PES contract, i.e. its legal, financial and administrative (e.g. reporting) aspects
- Compliance (in whole or part) with the contract, e.g. regular payment, reporting
- Compliance with follow-up procedures, whether mandatory or compulsory, e.g. disputes, alterations (e.g. increased payment levels, additional requirements, contract prolongation) and publicity (e.g. study tours by visitors).

There are also the ultimate *beneficiaries*, such as countryside visitors, water consumers or global citizens (in the case of climate change), who may or not pay directly or indirectly even if a PES scheme is in operation.

Given well-known features of governance and social behaviour, it can be expected that "willingness to enter" many of these aspects of a PES project will often depend on a potential participant's perception of the actions or perceptions of others in a similar position (e.g. fellow land managers, family members), on organisational advice (e.g. from farmer unions, council or NGO officials), and on treatment by public media (newspapers, magazines). Once underway, the more or less routine contacts involved in the project become more crucial, e.g. how payment is requested or received, and how uncertainties and disputes are handled.

2.2.2. Structuring financial incentives

From a financial point of view, how the payment offered to sellers of the ecosystem service concerned compares with alternatives ("opportunity cost") is of core importance, but other aspects, such as the length of contract, the risks involved (e.g. of non-compliance, or forgone future possibilities), the payment mechanism (additional to existing systems, or novel and complex) and "non-economic" considerations (e.g. privacy) may loom equally importantly. For buyers (or those they represent, such as water customers), some of the same factors also apply, although alternative uses of the same funds are likely to be much wider in scale (returns to shareholders, other household expenditures, other PES possibilities, savings).

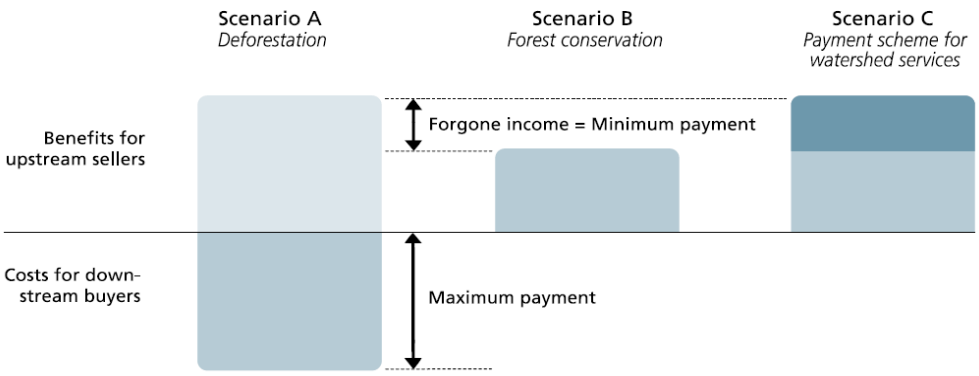

Figure 1 Payments for watershed services should be based on assessments of the costs and benefits of land and water management for upstream and downstream stakeholders. Taken from Smith *et al* (2006).

In deciding whether to pay, the **service buyer** has to evaluate if it is worth investing or if some other alternatives could be economically better for him. A payment scheme will, in principle, only be attractive to a buyer if the costs of the scheme are lower than the costs of alternative solutions (Smith *et al*., 2006).

The **service seller** provides the effort, change his habits, ways of working or make the concessions. He has to evaluate if it is economically worthwhile for him to make this change, if it will decrease profits. He should not accept less than the opportunity cost of the scheme (figure 1). This is the profit he would lose as a consequence of the changes in land use and management or restrictions on land use needed to comply with the scheme payment must be at least equal to the foregone net profit of upstream service sellers (Smith *et al*., 2006).

It is also worth noting that non-financial incentives or motivations may influence participation in a PES scheme. For example, in a study of three cases in Central America, Kosoy *et al*. (2007) found that the degree of compensation was setting payment amounts below opportunity costs. This suggests that motivations or benefits other than the compensation payments influence decisions to get involved in a PES scheme. This of course is backed up by decades of management approaches that do not involve financial transactions as PES does, yet still manage to achieve influence. However the relative influence and effect of different motivations and incentives are unknown, and a matter for future research.

2.3. Existing water-based PES Schemes in Europe, the UK and Scotland

PES is often implemented outside of Europe (e.g. Martin-Ortega *et al*., 2013b; Brouwer et al. 2011) but less often within it. It is thought to have been an approach "*largely overlooked in Europe so far*" (Coull & Valatin, 2008).

This section focuses on key examples from elsewhere in Europe, and notes some related schemes within the UK.

The PES programme developed since 1988 by the Vittel (Nestlé Waters) company in north-eastern France has attracted much attention. In order to combat the risk of nitrate contamination to its water-bottling and thermal tourism, Nestlé Waters, an important employer in the region, offered a set of incentives to encourage farmers to permanently change their intensive dairy farming practices into extensive, hay-based ones using no pesticides and chemicals. The problem was investigated in partnership with the French National Institute for Agronomic Research (INRA), and an intermediary (Agrivair) was set up in 1992 to negotiate and implement the programme, which took over 10 years, from 1992 to 2004 (FAO, 2013).

In her study of the Vittel case, Perrot-Maître (2006) concluded that "*The ability to maintain farmers' income level at all times and finance all technological changes was an important element of success, but primary reasons for the programme's success were not financial*." Rather, "*fundamental conditions of success*" included trust-building through a local intermediary; a long-term participatory process; and linking incentives to land tenure and debt cycle issues. Perrot-Maître (2006) considered that the Vittel experience (and others pursued by Nestlé with Perrier and Contrex in France) is most likely to be replicable where: land cannot be purchased and set aside for conservation; the risk to business is high; the link between ecosystem health and farming practices is well understood; and expected benefits are sufficiently high to justify the investment. These conditions are more likely in industrialised countries than developing ones.

In England, "*Local schemes have also been established at the scale of individual catchments with a single or multiple buyers paying multiple sellers (usually landowners and managers) to provide specific ecosystem services e.g. the West Country Rivers Trust Anglers' Passport scheme where anglers pay for improvements to river water quality to*

boost fish stocks, and schemes run by South West Water and Wessex Water paying landowners to change their land management practices to deliver water quality and quantity benefits" (Reed, 2013).

In 2004, HSBC (a British multinational banking and financial services company) funded, via World Wildlife Fund-UK, sustainable flood management measures such as tree planting, erosion control and wetland restoration in the River Devon catchment in south-west England. This was a three-year project and actions were undertaken voluntarily by employees of HSBC.

These rather variable examples mainly serve to illustrate that there is little evidence as to how best to design PES schemes within a European context, let alone within the UK or Scotland.

3. The context of water management in Scotland

This section first provides an overview of water management in Scotland, focusing on the key problems and existing organisations and approaches involved in tackling these.

3.1. The status of Scotland's waters

Warren (2002) provides a useful overview of the historical and current problems affecting water quality in Scotland.

Scotland has a total area of about 78,800 km^2, of which about 2% is covered in freshwater (in lochs and rivers). The country has long had a widespread reputation for high-quality water, as evidenced by its reputation for fishing (mainly trout and salmon) and whisky, and by the prominence of its lochs (e.g. Ness, Lomond) and rivers (e.g. Clyde, Tay, Dee) in its iconic landscapes. Given its annual rainfall (between 1 and 3 metres from east to west), water quantity is not normally considered a major issue, although flooding has been occasionally disastrous.

Since the 1980s, controls on point sources and atmospheric pollution have improved water quality particularly in the lowlands, although diffuse pollution remains high and a greater incidence of low flows in future could reduce the pollutant dilution. Upland

waters are recovering from acidification, but concurrent increases in dissolved organic carbon concentrations have affected water treatment.

In the 2009 River Basin Management Plan for Scotland, about 35% of waters were assessed as needing an improvement in their ecological status (SEPA, 2009). Many of the water bodies suffer less disturbance from human activity when compared to the majority of rivers elsewhere in the UK and Europe.

The drivers of these problems often relate to the predominant land uses in Scotland. With a population of about 5.1 million, Scotland has a low population density and is predominantly rural: over 63% of the land area is farmed, but of this about two-thirds is "rough grazing", with arable land occupying only about 11% land area. Forestry (mostly coniferous plantations, planted during the last 50 years) accounts for another 17% of the total land area (Warren, 2002). Crop irrigation is uncommon, but available water and equipment cover some 350,000 ha, mostly along the east coast and on the south side of the Moray Firth (Scottish Government, 2013). Quite often agricultural activity is thought to cause diffuse pollution, although forestry, industry and septic tanks can also contribute (SEPA, 2007; 2009).

In summary, key issues pose an ongoing challenge for water management: the need to respond the 2000 EU Water Framework Directive (WFD) and to achieve its new ecological standards; which includes tackling diffuse source pollution; and the need to maintain and improve the status of conservation sites associated with water bodies and catchments under both EU (e.g. SACs and SPAs) and national designations (e.g. SSSIs). Another key influence is the Scottish Government Flood Risk Management (Scotland) Act, 2009, which is refocusing attempts to control the impacts of flooding. Looking into the future, all these challenges may be exacerbated by a changing climate, and by other drivers such as increasing water demand in urban areas.

3.2. Existing approaches to managing Scotland's waters

With only small proportions of wetlands, and less than 1% of the UK river length in formal protection networks, sustainable freshwater management will depend upon better use of existing legislation, but also from other instruments and approaches (such as incentive schemes, or encouraging voluntary changes in behaviour).

The historical approach to managing Scotland's water has been focused on regulating and licensing activities (many applying to land managers) in order to regulate impacts (Warren, 2002). The Scottish Environment Protection Agency (SEPA) is responsible for enforcing these rules, and is thus a key organisation.

In recent years, the management of Scotland's waters has been strongly influenced by the EU Water Framework Directive (WFD), which is driving efforts to achieve 'Good Ecological Status' for nearly all of Scotland's water bodies. The WFD is being implemented via a River Basin Management Planning (RBMP) process, for which the SEPA is also responsible. The first RBMPs were published in 2009 (SEPA, 2009) and a second set of plans will be published in 2015. The RBMP process is widening SEPA's scope and driving a new focus on voluntary collaboration and participation for water management (Blackstock & Richards, 2007).

The EU-funded Common Agricultural Policy has several features of relevance to land managers and water management. Firstly, all land managers must ensure "cross-compliance" with a set of Statutory Management Requirements (SMRs) and they must keep their land in Good Agricultural and Environmental Condition (GAEC) in order to qualify for the full Single Farm Payment and other direct payments. These rules include, example, instructions on how livestock should be managed alongside watercourses. Secondly, the Scotland Rural Development Programme (SRDP) has offered grants to landholders for improvements to wetland and river management. Thus, the addition (or withdrawal) of incentives is used alongside regulation to influence management.

The management of freshwater, particularly with respect to drinking water, is also strongly influenced by Scottish Water. Since Scottish Water are the only organisation known at present to be participating in water-based PES in Scotland (see Section 4.1), it is discussed in more detail below.

3.2.1. Scottish Water

Scottish Water is a "*public sector body classified as a public corporation of a trading nature, and is answerable to the Scottish Parliament through Scottish Ministers", and "responsible for providing water and waste water services to household customers and wholesale Licensed Providers*", i.e. businesses (for more information see http://www.scottishwater.co.uk/). Drinking water supplies are drawn largely from

reservoirs in the uplands and along the major rivers, i.e. the Clyde, the Forth and the Dee.

Scottish Water operates within a framework set down by Scottish Ministers under the Water Services etc. (Scotland) Act 2005. The Water Industry Commission for Scotland regulates water charges, costs and Scottish Water performance, and the Drinking Water Quality Regulator ensures compliance with drinking water quality regulations, respectively. Scottish Water supplies 1.3 billion litres of water daily to 2.4 million households and 159,000 business premises across Scotland, and takes away 840 million litres of waste water for treatment. Consumer/customer concerns are handled by Consumer Focus Scotland, a representation body with statutory status, and the Scottish Public Services Ombudsman, a complaints investigator. Scottish Water has an active corporate responsibility policy focused on "a cleaner environment" and "a healthier Scotland" (Scottish Water, 2009). A review of water resources and management in Scotland, and of public participation in these processes, is given by Walker (2003). Since then, considerably more academic and political attention has been paid to water-related issues in Scotland, including "integrated catchment management" (ICM) (CREW, 2013), flooding (Marshall & Morris, 2012) and the launch of the "Hydro Nation" initiative (Scottish Government, 2012).

Scottish Water staff total about 3500, and for the year ended 31 March 2013 its revenue was £1146 million, with cost of sales at £722 million, giving a gross surplus of £424 million, on assets of nearly £6 billion. Net finance costs (largely interest on government loans) reduced this to a surplus before taxation of £95 million, and an annual post-tax surplus of £89 million (Scottish Water, 2013a). In 2012/13, Scottish Water investment totalled £487 million. The average annual household charge for water (and water treatment) in Scotland was £334 (about £50 lower than in England), or about £1 per day. According to Scottish Water's website, surveys of customer perceptions suggest that it is a well-known and largely trusted operator. However, these figures do not prove how it might be regarded by actors involved in PES.

4. Methodology to identify and describe water-based PES schemes in Scotland

This section describes how water-based PES schemes were identified, and the analytical framework used to shape data collection.

4.1. Search for water-based PES projects in Scotland

In 2012–2013, a search for water-based PES or PES-like projects in Scotland was carried out, using the internet search engine 'Google' and specific academic databases (e.g. Web of Science, SCOPUS) to search academic literature, 'grey literature' and organisation websites. This search was supplemented by enquiries with contacts in public agencies and in Scottish Water. Mindful of the variable definitions discussed in the previous sections, the search used a fairly broad definition of what kind of scheme would be counted as PES or PES-like.

The search uncovered only one scheme matching our searching criteria (private-user financed schemes or utility-financed schemes) that was already ongoing, This is Scottish Water's Sustainable Land Management Incentive Scheme (SLMIS), which is described in more detail in the next main section of this report.

4.2. Projects in Scotland uncovered but not included in this review

The Royal Society for the Protection of Birds (RSPB) purchased in 2004 some land behind Nigg Bay in the Cromarty Firth in north-east Scotland to allow coastal water to flood the fields in order to create and preserve wildlife habitats, especially for birds. This was a one-off payment, and the project is no longer running.

In the White Cart Water Flood Prevention Scheme, Glasgow City Council has bought or leased land from farmers to use for management purposes. However, this resembles a change in ownership more than paying land managers for specific actions or outcomes.

The Tweed Forum is a catchment-wide body which provides a platform for stakeholders within the Tweed Catchment to connect and communicate. The Forum has secured funding from private and public sources for flood management measures but currently there are no running projects.

The Scotland Rural Development Programme (SRDP), financed by Scottish Government and EU funds, runs many projects financially supporting land managers. For example, farmers are paid to establish water margins around water courses in order to improve drinking water quality. According to the definitions of PES (see previous section), it is questionable whether governmental schemes such as those in the SRDP qualify as examples of PES. Furthermore, the SRDP has been extensively studied in a separate literature.

4.3.Analytical framework used to describe PES schemes

The literature reviewed in the above sections offers many insights as to the features or criteria that may affect the operation and outcomes of a PES scheme (e.g. Pagiola, 2005). Figure 2 shows a conceptual model illustrating key features of a PES scheme. Any description of a PES scheme must therefore include these features, in order to allow reflection on the likely operation and outcomes of the scheme.

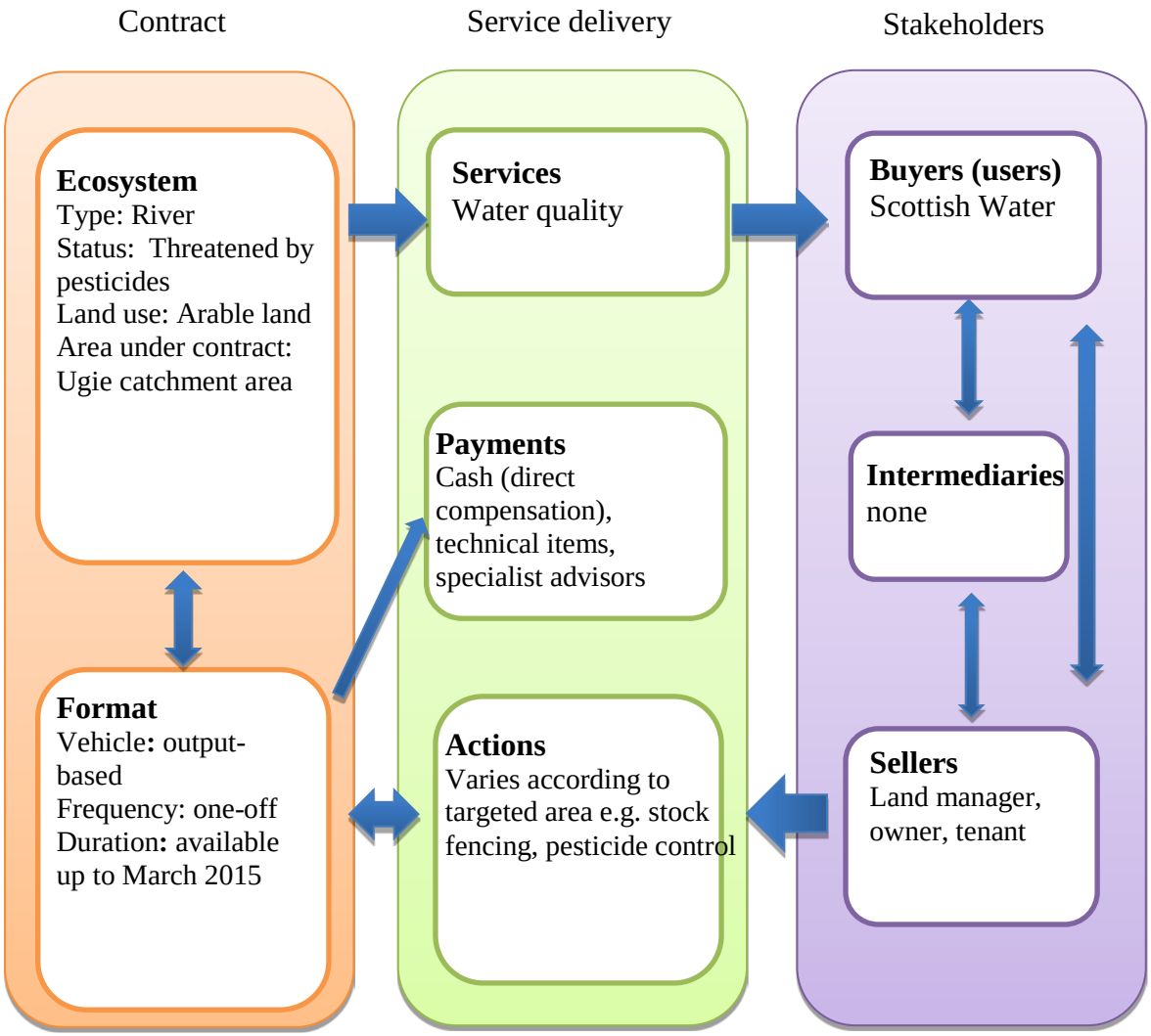

Figure 2 Key features of a PES scheme (adapted from Martin-Ortega et al. 2013b)

In addition, the wider literature on Natural Resource Management suggests a number of attributes of a project's context, and of project design that will also likely affect its achievements and outcomes. These attributes are discussed at more length in a contemporaneous 2013 report which has reviewed examples of the Ecosystem Approach[2]. Ecosystem Approach projects aim for holistic and participatory ecosystem-based management. They should not necessarily be equated with PES projects (if and how PES projects and the Ecosystem Approach link is an unresolved question, not tackled by this report). However, many of the criteria likely to affect their progress and outcomes may be shared with PES projects.

[2] This report is available from http://www.hutton.ac.uk/research/projects/ecosystemapproachreview

The final list of criteria used to describe PES projects are listed below. Some of these criteria (particularly those towards the end of the list) cannot be applied to ongoing or recently initiated projects, but are necessary to finally evaluate and understand a PES project's outcomes.

This framework was used to collect data about SLIMIS, via an internet research, published documents, and an interview in spring 2013 with Ms Zoe Frogbrook (Scheme leader).

Criteria used by this report to describe PES projects – the analytical framework

Project context and environmental settings

- Scale of area under contract
- Type of ecosystem /habitats and land-use classes
- Status of Ecosystem (River threatened by pesticides, WFD classification?)
- Ecosystem Service(s) delivered and discussed

Project design and management

- Impetus for project, policy drivers
- Project management and timescale
- Stakeholders: Buyers (Financing), Sellers (who owns and manages the resources), who else has been involved in the overall planning of the project?
- Design of payments (type/frequency), input-based, output-based
- Detail of actions or outcomes financed
- Any other actions by project (distinguishing between actions using different 'levers': voluntary, sanctions, incentives, education/awareness-raising)
- Monitoring and Evaluation (what, how and by whom)

Experiences of project operation

- Evidence of transaction costs noted (e.g. in time taken to set up the project)
- Existence of resource use conflicts
- Other challenges faced to date
- Social side effects (are there any additional beneficiaries, distributional effects: who/what type of people get how much money?)
- Does the project expect to meet its own expectations/aims. Are there any indicators of success yet (environmental, social)?
- Additionality (net benefits created by PES),
- Effectiveness (degree on which policy (i.e. PES) achieves specific environmental goals better than alternative policies (i.e. national park)
- Compliance (degree to which PES recipients comply with their contracts, which in turn requires appropriate monitoring).
- Evidence of leakage (where environmentally-damaging land uses that the PES program is replacing are displaced elsewhere (Wunder, Engel, Pagiola 2008)
- Permanence (whether the desired change is provided on a long-term basis)

5. Scottish Water's Sustainable Land Management Incentive Scheme (SLMIS)

This section describes key features of the Sustainable land Management Incentive Scheme (SLMIS) operated by Scottish Water. We describe SLMIS following the first two subheadings of the analytical framework that directed data collection: firstly we describe project context and environmental setting, and then project design and management. We offer only brief reflections related to the last sub-heading of the analytical framework (experiences of project operation) because SLMIS began only in 2012, so there was little project experience to report on at the time of data collection.

5.1. Project context and environmental settings

SLMIS is operated in the following six catchments (see Figure 3):

- River Ugie Catchment
- River Deveron Catchment
- Loch of Lintrathen Catchment
- Loch Ascog Catchment
- Lochgoin/Craigendunton Reservoir Catchment
- Dumfries Basin Aquifer

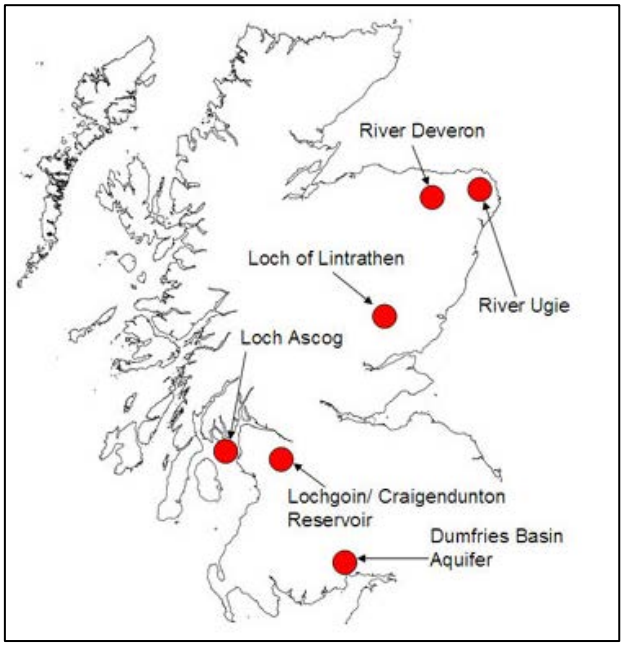

Figure 3 Areas where SLMIS operates. www.scottishwater.co.uk/protectdwsources

All six catchments were selected because they were perceived to share problems of diffuse water pollution, which occurs when potential pollutants such as sediments, nutrients, faeces and pesticides from farmland, houses, commercial areas and seepage get released from land into waterways. Sources of pollution are therefore often driven by rainfall and land-use activities.

Although all 6 target catchments or sites share these problems, there are of course differences between the six areas. These differences may or may not affect the progress and outcome of any intervention, such as SLMIS. Therefore this section separately describes each catchment. Each of the following subsections describes issues noted as key from the analytical framework: scale; type of ecosystem /habitats and land-use classes; environmental issues and status of ecosystem. The ecosystem services delivered by these sites are summarised in the following section.

5.1.1. River Ugie Catchment

This area is located in Aberdeenshire in the north-east of Scotland, and comprises two distinct branches, the North and the South Ugie Waters, together with several tributaries. The catchment covers an area of about 335 km^2 with around 13,000 people living in it (SEPA, 2011). The Ugie Waters meander through intensively farmed rural areas, mainly used for intensive arable, mixed and livestock farming. Land-use classes within the catchment (after Land Cover Map (LCM) 2000) comprise 48% arable and horticulture, 27% improved grassland, 25% broad-leaved woodland, coniferous woodland, dwarf shrub, bog and other shrub, and 1% suburban and rural development (SEPA, 2011; pg19).

River monitoring showed that 12 of the 13 catchment rivers did not achieve the "good ecological status" required by the EU Water Framework Directive (WFD), mainly due to diffuse pollution of pesticides from application and storage. Additional issues identified from SEPA catchment walks in 2010 were groundwater pollution through elevated nitrogen and phosphorus levels, soil erosion due to cultivation within two metres of watercourses and livestock poaching the land within five metres. Chemical analyses of water revealed that the pesticides found are mostly used in agriculture, to control insects, weeds, and molluscs. These pesticides can enter the water ways via aerosol drift, leaching and surface run-off, or by being sprayed over water courses. Because the

River Ugie is relatively slow-moving, it is more likely that deposited sediments and nutrients are retained. In total, 223 rural diffuse pollution problems were reported by SEPA (2011).

In light of these problems, SEPA classified the River Ugie as a "diffuse pollution priority catchment", and considered that it needed a focused management approach. The catchment has also been designated, at various times, as a Drinking Water Protected Area, an Urban Waste Water Treatment Directive (UWWTD) Sensitive Area, a Freshwater for Fish (FWF) Directive Salmonid Water, and a Nitrate Vulnerable Zone.

Between 1997 and 1999, Scottish Natural Heritage (SNH) undertook the Ugie Wetland Project, with the main aim of improving river and wetland management by farmers, i.e. helping farmers to minimise fertiliser and manure losses to watercourses and giving advice in nutrient budgeting. In 2000, the 'River Ugie Voluntary Initiative' was proposed with the main aim of reducing pesticide application and hence improving water quality, as an alternative to the introduction of pesticide taxes. Within this Initiative, farmers were given advice on pesticide spray operations and on mixing, filling and cleaning operations.

5.1.2. River Deveron Catchment

The River Deveron catchment is also located in Aberdeenshire in north-east Scotland, and is well known for its angling opportunities. It has an overall area of 1232 km^2 and has three major tributaries: the River Bogie, River Isla and Turriff Water. Around 48,000 people live within the catchment. The main land-use classes within the catchment are farmland, moorland and some forestry, and the catchment includes a number of whisky distilleries.

Scottish Water has targeted pesticides as the main pollutants of concern, and issues of soil erosion and morphological alterations have also been reported. The main pressures on the catchment are coming from agricultural pollution (e.g. cattle with direct water access), septic tanks, water abstraction, and morphological alterations of river beds and banks (SEPA, 2011).

The River Deveron Catchment has also been designated as a priority catchment by SEPA. Furthermore, it is designated as a FWF Area, a Drinking Water Protected Area, a

Special Area of Conservation /Special Protected Area, a Nitrate Vulnerable Zone and a UWWTD Sensitive Area.

5.1.3. Loch of Lintrathen Catchment

The Loch of Lintrathen is located north of Alyth in western Angus in east Scotland, and covers an area of around 186.4 ha (JNCC, 2001). It is an important reserve for many birds, and is surrounded by fertile farmland.

The Loch is at risk of deterioration caused by nutrients, with the main pollutant of concern being phosphorus, mainly from agricultural activities and septic tanks. Phosphorus is used in fertilisers, and as an ingredient of detergents.

The Loch of Lintrathen is a Special Protected Area, a Site of Specific Scientific Interest (SSSI), a Ramsar Site and a Scottish Wildlife Trust (SWT) Reserve.

5.1.4. Loch Ascog Catchment

Loch Ascog is located on the east coast of the island of Bute and covers an area of around 45 ha. It is surrounded by mainly arable fields and improved grassland but also some areas of woodland.

The loch has faced problems with algal blooms, especially in warm summers, due to nutrients, with the main pollutant of concern again being phosphorus. Possible sources of pollution are agricultural activities, and septic tanks. As the loch is situated on the island of Bute, it is difficult for Scottish Water to find alternative sources should drinking water of the required quality not be provided by the loch.

Prior to the SLMIS, the loch was not subject to any specific designations or policies.

5.1.5. Lochgoin/Craigendunton Reservoir Catchment

The Lochgoin/Craigendunton Reservoirs are situated in the southwest of Scotland, between Eaglesham and Galston. The Lochgoin Reservoir extends to 69.7 ha and the Craigendunton Reservoir to 10.1 ha.

The pollutant of concern targeted by Scottish Water in these reservoirs is colour, mainly caused by dissolved organic carbon running off the surrounding catchment, which is mainly peatland. During the disinfection stage of water treatment, the presence of

organic compounds leads to the production of disinfection by-products known as Trihalomethanes (THMs). THMs have drinking water quality standards that set levels of THM that must not be exceeded.

Both reservoirs are operated by Scottish Water for the supply of drinking water, and they own a small part of the catchment. There have been concerns about the installation of a large wind turbine development within the catchment in 2009, by the Scottish Power generating company. However, it is unclear whether the farm has caused issues with colour in the Reservoirs.

5.1.6. Dumfries Basin Aquifer

The Dumfries Basin Aquifer is situated in the southwest of Scotland in the lower part of the River Nith catchment. The Basin is about 10 km wide and 20 km long. The river catchment consists mainly of grassland used as pasture for cattle and horses. There is also some forestry and moorland, with some industrial or urban land, including a sandstone quarry (Robins and Ball, 2006).

The Aquifer faces pressure in terms of water quality and quantity. The main pollutants of concern are nitrates, coming from agriculture (e.g. fertilizers) and from septic tank discharges.

"The Dumfries Basin has been designated as a single groundwater body and is likely to be designated as a Drinking Water Protected Area. … The primary mechanism for the implementation of any measures that are required for the protection and restoration of the water resources of the Dumfries aquifer will be the new abstraction and control system being created under the Water Environment and Water Services (Scotland) Act 2003" (Robins & Ball, 2006). Currently, the Dumfries Basin Aquifer is not listed as a Special Protected Area.

5.1.7. Ecosystem Services in the SLMIS areas

In order to set up a PES scheme, the ecosystem services that will be the subject of that scheme must be understood.

Table 1 shows various ecosystem services which are delivered by each SLMIS catchment. This table is adapted from a generic categorisation of the ecosystem services

provided by freshwater ecosystems (Chopra, 2005). At this time we are not aware of any more specific or detailed information about the ecosystem services provided by these sites. For example, it can be seen that the Ugie River catchment provides water (quality and quantity), aquatic organisms as food, natural filtration and water treatment, buffer functions, recreation, landscape beauty, existence value as well as nutrient cycling, primary production and predatory/prey relationship and ecosystem resilience.

Table 1: Freshwater Ecosystem Services delivered by each catchment within SLMIS

	River Ugie	**River Deveron**	**Loch of Lintrathen**	**Loch Ascog**	**Lochgoin/ Craigen-dunton Reservoir**	**Dumfries Basin Aquifer**
Provisioning Services						
Water (quantity and quality) for consumptive use (drinking, domestic, agricultural & industrial use)	✓	✓	✓	✓	✓	✓
Water for non-consumptive use (power generation, for transport and navigation)	?	?	?	?	?	
Aquatic organisms for food and medicines	✓ (esp. salmon)	✓ (esp. salmon, sea trout, brown trout)	✓	✓ (esp. rainbow trout, brown trout)	✓ (esp. rainbow trout, brown trout)	
Regulatory Services						
Maintenance of water quality (natural filtration and water treatment)	✓	✓	✓	✓	✓	✓
Buffering of flood flows, erosion and flood control	✓	✓				
Cultural Services						
Recreation	✓	✓	✓	✓	✓	
Tourism (landscape beauty)	✓	✓	✓	✓	✓	
Existence value (personal satisfaction from free-flowing rivers)	✓	✓	✓	✓	?	
Supporting Services						
Role in nutrient cycling, primary production	✓	✓	✓	✓	✓	✓
Predatory/prey relationships and ecosystem resilience	✓	✓	✓	✓	✓	✓

Source: adapted from UNEP Freshwater Ecosystem Services (Chopra, 2005).

5.2. Scheme design and management

5.2.1. Impetus for project

Scottish Water was provided in 2010/2011 with a budget from the Water Industry Commission of Scotland to look at taking a more sustainable approach to the treatment of drinking water. The main driver in initiating the scheme was the failure, on a number of occasions, of the River Ugie Catchment with respect to regulatory requirements. Scottish Water decided that using a PES approach might be the best approach to meet their objective of improved water quality, and carried out analysis to identify which other catchments faced problems with similar issues, and where the SLMIS approach might work best.

The Scheme is designed to provide farmers with financial assistance for measures to protect and improve drinking water sources. The overall approach of the project is to improve water quality through collaboration rather than command-and-control regulation. Additionally, peatland in the Lochgoin/Craigendunton Reservoir area will be restored with the aim of improving carbon sequestration and hence mitigating climate change. A good overview and the rationale of the scheme is given by Brown (2012).

5.2.2. Project management and timescale

The SLMIS was initiated in 2012 by the Water Quality Regulation Section of Scottish Water, led by Peter Brown. The Scheme itself is led by Zoe Frogbrook, with five catchment liaison officers and one data analyst. There are no volunteers involved. The catchment liaison officers underwent two years' training with SEPA before coming back to Scottish Water. At the time of this report, the scheme is ongoing.

5.2.3. Stakeholders involved in project

The stakeholders most directly involved with the Scheme are:

- *Buyer:* Scottish Water
- *Seller:* land managers. In some catchments these are mainly tenant farmers (Loch Ascog and Loch of Lintrathen), and in other landowners.
- *Intermediaries:* Scottish Water catchment liaison officers, data analyst

In addition, *water consumers* are affected indirectly as Scottish Water customers.

5.2.4. Design of payments

In each SLMIS area, any agricultural landowner and tenant within the relevant catchment is eligible to apply, individually or as a group. Each farmer can apply as many times as desired, within a maximum annual financial ceiling of £20,000 per business.

Once an application is made, and Scottish Water has approved the items and amounts to be financed, the farmer has to install the items applied for and submit a claim form. Scottish Water will then check that everything has being done as agreed, and if so will pay the farmer directly, as a one-off bank-transfer payment. Payments are input-based, i.e. calculated according to the adoption of particular land uses or management practices expected to deliver the targeted ecosystem service.

"The financing available from Scottish Water is intended to be compliant with provisions under the State Aid rules, as summarised by Commission Regulation (EC) No 1857/2006. Under these constraints, Scottish Water is able to finance 100% of the cost of: Water Environment Management Plan, Technical Support, peat land items, man-made ditch modifications, re-imbursement of costs. The remaining capital items are financed at either a 60% or 75% level depending where the farm is located. If the farm is within a Less Favoured Area (LFA) a 75% finance level applies. For farms outside the LFA the maximum finance is 60%." (Scottish Water, 2013b).

5.2.5. Actions financed

As noted in the previous subsection, SLMIS funds actions (rather than environmental outcomes). This is thus an input-based PES scheme, rather than output-based, as is the case for the majority of existing schemes in the world (Porras et al. 2012).

The project was launched in April 2012, and application for farmers will be open until 30th November 2014. Under current arrangements, activities must be carried out and claims submitted by 1st March 2015, and final payments by 31st March 2015 (Scottish Water, 2013b).

Scottish Water currently provides financial support (reimbursement of costs) for a number of activities (table 2) ranging from stick fencing to ditch-modifications and peatland restoration. A Water Environment Management Plan (WEMP) is a whole farm plan and one of the items available under SLMIS. Although other items (e.g. livestock

fencing) are available separately, the WEMP may recommend the farm installs some items which are also available under the SLMIS. The ecosystem service targeted by the SLMIS scheme is drinking water quality. Improvements in this quality must be traded off mainly with higher biomass productivity due to pesticide and/or nutrient application.

Each application is evaluated to ensure the items applied for will bring benefit to the water quality. For capital items this will involve a visit to the farm before a decision is made on whether to accept or reject the application.

Table 2: Management activities financed by Scottish Water within SLMIS catchments

Item	Management Activities	River Ugie	River Deveron	Loch of Lintrathen	Loch Ascog	Amlaird / Craigen-dunton Reservoir	Dumfries Basin Aquifer
	Main Pressure on Drinking Water Quality	Pesticides	Pesticides	Nutrients (partic. phos-phorus)	Nutrients (partic. phos-phorus)	Colour (disslvd. organic carbon)	Nitrates
1.1	Water Environment Management Plan	✓	✓	✓	✓	✓	✓
1.2	**Water Environment Management Plan** (including nutrient management)			✓	✓		✓
1.3	Technical Support	✓	✓	✓	✓	✓	✓
2	**Pesticide controls:** plant protection product substitution, pesticide sprayer loading area, biobed	✓	✓				
3	Stock fencing and Livestock watering	✓	✓	✓	✓		✓
4	**Field management:** Loosen compacted soil layers, cultivate/ drill across slope, manage over-winter tramlines	✓	✓	✓	✓		✓
5	**Reduced surface flow:** Re-locate gates, re-surface gateways, cross drains under farm tracks, swales and check dams	✓	✓	✓	✓		✓
6	**Man-made ditch modifications:** In-ditch seepage barriers and vegetated re-profiling	✓	✓	✓	✓		✓
7	**Peatlands:** grip blocking, peatland restoration	✓	✓			✓	
8	Re-imbursement of costs	✓	✓	✓	✓	✓	✓
Source: Scottish Water Information Booklet							

5.2.6. Other activities undertaken by the project

Scottish Water offers technical and advisory support: "*...a team of Catchment Liaison Officers is available to provide further information about the SLM scheme, discuss the wider SLM initiative, help with completion of application form and answer queries on eligibility*" (Scottish Water, 2012). Thus the incentives are complemented by awareness-raising and information.

5.2.7. Monitoring and evaluation

Some of the budget has been allocated to monitoring and information-gathering. All monitoring is undertaken by Scottish Water with the exception of the Dumfries Basin Aquifer which is monitored in partnership with SEPA.

5.3. Early experiences of project progress

The scheme was approved by the European Commission in April 2012, and was revised in April 2013.

The scheme has been successful in generating interest and applicants to participate (land managers to be compensated). There were eighty applications in the first year. These numbers may increase further as the scheme has so far only been promoted in 2 of the 6 catchments "*The scheme has mainly been promoted in the Ugie and the Deveron Catchment but this year we are going to look at all those catchments and trying to establish a way forward ...*" (interview with Zoe Frogbrook, SLMIS manager, 2013).

There have necessarily been costs associated with setting up the project, e.g. training to establish SLMIS management and catchment liaison staff. As a new approach for Scottish Water, *"getting the technical expertise into the business*" was recognised as challenging by Scottish Water, so they seconded some of their staff into SEPA for training (interview with Zoe Frogbrook, SLMIS manager, 2013). Another difficulty faced has the need to comply with European Union regulations, i.e. requirements as to what needs to be done in order to get the scheme authorized.

In terms of ongoing transaction costs, e.g. costs of information search, bargaining administration, policing and enforcement, there is not much information available yet. The cost committed to monitoring and evaluation could be classed as a transaction cost.

6. Discussion

At the time of the investigation reported in this paper, the Sustainable Land Management Incentive Scheme (SLMIS) was the only one found where payments were being made for water management actions not directly financed by the government (e.g. via the SRDP).

As SLMIS was launched only in 2012, it is difficult to judge whether the project has met expectations or will prove cost-effective. However, revisiting this scheme in future, structuring research with the same analytical criteria, should prove valuable in helping to track the outcomes of the project.

6.1. Early reflections on SLMIS

In the meantime, we may consider how the design of the SLMIS project may affect its outcomes. Although some PES schemes are complex, the SLMIS is clearly structured, and is easy to investigate for details and background information on scheme set-up and operation. It is good that Scottish Water has planned monitoring. In future, it wishes to link monitoring data more closely with where the applications are coming from, and to target more within catchments where they face the greatest problems.

The Scheme does not fully fit the strict (Wunder) definition of a Payment for Ecosystem Services (PES) scheme. Firstly, the SLMIS has been indirectly financed by government via the Water Industry Commission: however, from April 2015 it will be financed within Scottish Water itself. Secondly, State Aid rules mean that SLMIS payments may not fully compensate the providers (farmers and others) for the improvements in ecosystem service (water quality) made, so that further costs may be incurred. On the other hand, their SLMIS payments may enable farmers to improve their farm businesses, thus bringing about positive side-effects. For example, stock fencing may prevent animals from slipping down banks and/or standing in wet areas which can cause disease or injury, with possible treatment costs or even loss of animal. In any case, there is not an exact relationship between the SLMIS payments and (unestimated) value of water quality improvements. This may promote inefficiency, an important criterion for evaluating PES schemes, since they are especially premised on efficiency. Engel *et al*. (2008) identify various types of inefficiency which may be faced by a PES scheme.

These types of inefficiency, and how they may or may not affect SLMIS, are discussed in the following box.

4 types of inefficiency that may affect PES, and potential implications for SLMIS

Social inefficiency: "…either the failure to adopt practices whose social benefits exceed their costs, or in the adoption of practices whose benefits are smaller than their costs. In both cases, social welfare is reduced over what it might have been." As already mentioned, a farmer may not get fully compensated for changes in land use practice, although other benefits are possible, such as enhanced animal welfare or improved collaboration between farmers, thus creating better social networks.

Lack of additionality: This occurs when money is paid for changes in land use practices which would have been changed without the financial incentive anyway. It is hard to tell whether SLMIS farmers would have installed the scheme-suggested items, but if so this would probably have happened less quickly and not by as many farmers as required to improve and sustain drinking water quality in the long run.

Leakage: Leakage occurs where environmentally damaging land uses which PES schemes try to replace are displaced to occur in other locations. This is not thought likely to take place in any of the six SLMIS cases.

Lack of permanence: "the ability of PES to achieve long-run improvements in environmental service provision, including beyond the period of payments proper when payment horizons are finite." The SLMIS provides a one-off payment after agreed measures have been completed. As these measures include mostly one-off changes in land management such as the installations of items (e.g. stock fencing, electric water pumps), it is likely that the service is provided beyond the duration of the payment.

Lack of targeting: In case the number of applicants exceeds the available financing, service buyers are forced to select among applicants, using some form of rationing or targeting criteria. However, during the initial period of SLMIS adequate finance has been available for all applicants. (From interview with Zoe Frogbrook, SLMIS manager, May 2013).

Pagiolas's framework (2005) provides a simple way to think about how the private profitability of land users and the value of ecosystem services may be related to each. In a 'win-win' situation, both profits to land users and positive externalities are generated. In 'lose-lose' situations, the opposite occurs. In intermediate cases, land user profits are accompanied by negative externalities, or losses of profits are accompanied by positive externalities (Pagiola, 2005). In case of SLMIS, taking the possible improvement of the farm business into account, the scheme can be seen as supporting 'win-win' situations as it results in both increased profits to land users and the generation of positive

externalities. However, there may also be the chance that the offered payments are not sufficient, so that farmers are not financially motivated to apply for the incentive, resulting in the continuation of undesirable land use.

6.2. Implications for future water management

In the case of freshwater, the presence of large, highly organised corporations (private or public) responsible for regular and reliable supplies of clean water suggests that the 'piggy-backing' approach is well worth exploring. Such corporations generally have scientific, engineering, legal and administrative expertise (or can hire this, via outsourcing or consultancies), and "intermediaries" such as local and press offices who can negotiate and implement PES contracts. Their human and other infrastructure (e.g. access points) may aid them in negotiating PES contracts with a wide variety of ecosystem service sellers, while their broad customer base enables them to spread the costs over an extensive "buyer" base using existing payment mechanisms, thus minimising objections and protests. Moreover, they are generally amenable to arguments of "corporate social responsibility" (CSR) into going beyond the minimum necessary to secure water supplies, into activities designed to demonstrate concern over the wider community and environment.

In most countries, the crucial role of human water supplies and the monopolistic nature of the sector are recognised via government oversight, if not directly by the responsible Minister then by a Regulator, whose primary duty may be to control standards and pricing but whose remit can extend to equity and wider environmental issues. The additional costs incurred by land managers and water corporations themselves in securing ecosystem services can be added explicitly or implicitly to standard water billing systems, thus avoiding payment collection expenses. In Scotland this is especially relevant given the recent Water Resources (Scotland) Act, by which Scottish Ministers are given the duty to develop the value of Scotland's Water Resources (Martin-Ortega *et al*., 2013a). The Act provides for Scottish Water to 'do anything' that it considers will assist in this goal. Part 4-Section 28 of the Act enables Scottish Water to *'enter into voluntary agreements with the owners and occupiers of land, or with local authorities for the carrying out of activities that [it] considers will help protect or improve the quality of raw water'*. Although probably not originally intended with this specific

purpose, this can be interpreted as an entry point for the establishment of PES (Martin-Ortega et al. 2014).

There are of course actual or potential limitations to the "use" of water corporations or companies as a "vehicle" for water-related PES schemes. More challenging situations may include those where catchment areas provide ecosystem services but are *not* used for human water supply; and where drinking water is supplied from groundwaters (aquifers), as these provide a smaller range of other ecosystem services. The level of CSR practised by water corporations can vary – e.g. by their degree of privatisation – as can pressure to do so exercised by the sector's regulator. Some water suppliers may discourage certain ecosystem services, e.g. human use of reservoirs or rivers, or the colonisation of water bodies by unwanted biomass, and their physical infrastructure, such as dams, pumping stations, etc. may not only create visual impacts on the landscape but also distort natural variations in water flows.

Furthermore, whether or not large intermediaries are always best placed to facilitate PES is an open question. As yet, in Scotland there are no examples of more direct transactions between buyers and sellers (for example, between land managers, whose land provides flood storage, and between a downstream community at flood risk). In future, any such examples could offer an informative contrast as to how PES schemes may best be designed in Scotland.

6.3. Implications beyond water

In other countries, PES is often applied to water management, but is also seen as relevant to managing other types of resource, particularly forestry (especially focused on carbon). Coull and Valatin (2008) reviewed PES-type schemes in the United States from a forestry perspective, and concluded that: "*If designed and implemented well, PES offer great potential for protecting ecosystems*". This and other studies have also pointed to voluntary carbon markets as a means of addressing climate change. However, in Scotland questions of conflict might arise as to the role of government and government agencies (such as Forest Enterprise, and potentially Scottish Water) in such markets, as regulator, monitor or participant.

6.4. Implications for future research

The bulk of this paper has dealt with water-related PES schemes, in general and for a specific PES scheme in Scotland. This paper has already identified some clear needs for future research: tracking progress with the SLMIS scheme; exploring if and how intermediaries may affect PES. Further investigation into scheme set-up, practical application and subsequent monitoring and evaluation is needed in order to be able to compare effectiveness (economic and social) of PES schemes in general to other resource management approaches. Any such research accords with and should be informed by existing recommendations (e.g. see box below).

Related to this there may also be a need to further communicate the concept of ecosystem services and payments for environmental services in a language and approach amenable to those expected to participate in PES schemes. Finally, continuing research on the effects of land use management on the provision of various ecosystem services is needed in order to assess possible trade-offs and to establish which land use practices are most effective in which cases.

"Messages for researchers and funders" on PES, taken from Reed (2013)

"Inter-disciplinary research into PES is needed, involving social scientists as well as ecologists and economists, and key stakeholders such as businesses and landowners/managers.

Future research needs to pay greater attention to social and economic outcomes of PES approaches as well as environmental ones - for example exploring unintended socio-economic consequences of PES schemes and better understanding how PES might contribute towards the rural economy.

Continuing research is needed into how different land management practices influence the production of different ecosystem services in different places and the role of PES and other incentives in altering these practices.

Cause and effect mechanisms are not yet sufficiently clear for some habitats and/or ecosystem services – for example, how land management practices in the uplands can help mitigate flooding risk downstream.

Better understanding is required of the potentially damaging trade-offs between ecosystem services that may be caused by PES schemes, and the social justice implications of expanding the use of PES.

More research is needed into the behaviours of potential buyers and sellers of ecosystem services to assist with the development of markets and understand what people value and why.

Continuing research is needed into incentivising land managers' behaviour e.g. enabling collaboration across property boundaries for management of certain ecosystem services."

6.5. Conclusion

Freshwater is not only a major Scottish natural resource, with multiple human and biodiversity functions, but its catchment and storage link to a wide variety of other ecosystem services such as landscape, culture and the wider environment. The example of the SLMIS project offers a useful prompt to consider if "Payments for Ecosystem Services" schemes may be useful for managing water resources in Scotland.

Although PES is a popular concept, there are many debates about how they should be designed, and furthermore much existing PES experience comes from beyond Europe. Indeed, at the time of writing only one extant project for water management in Scotland – SLMIS – was identified as PES-like. This may offer a useful model to inform other projects but since this project has only recently started, it is too early to identify many lessons for other projects.

It remains important to explore different approaches to implementing PES, and to track multiple aspects of project progress and outcomes. Only then will we understand when and how to implement PES schemes suitable for the Scottish context.

7. Acknowledgements and background to this report

This paper constitutes an output from Project 3 "Evaluating PES [Payment for Ecosystem Services] Theory in Practice" within Work Programmes 1.3 and 1.2 of the Ecosystem Services Theme within the RESAS Strategic Research Programme 2011-2016. The remit for Project 3 is to "explore the extent to which PES schemes are or could be implemented within Scotland, with primary focus on water and forestry. It will likely include relevant CAP instruments such as "green payments" and SRDP measures, alongside PES-like schemes involving river management organizations and woodland trusts." This paper focuses on freshwater, but there are paragraphs on some other items and aspects mentioned in this remit.

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