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Towards a Comprehensive Research Perspective on Payments for Ecosystem Services

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1. Introduction

Sustainable development aims to integrate the environmental, social, and economic spheres to achieve environmentally friendly, socially fair, equitable, and economically viable development paths. Inter- and intra-generational justice and equity considerations are an equally important dimension of sustainability. Different theories of sustainable development coexist (Enders & Remig, 2015), and interdisciplinary cooperation has developed around this topic. Within the field of economics, questions of sustainable development are addressed by ecological economics, which grew out of cooperation between ecologists and economists (Remig, 2015, 2017).

Within the economist's toolbox, policy instruments that incentivise certain behavioural patterns, or that aim to disincentive others, have become popular. With regard to environmental resources and their management, the introduction of payments for ecosystem services (PES) is a policy choice supported by scientists, politicians, and practitioners alike. In a PES scheme, an ecosystem service buyer (a private actor, a company, or a state, for instance) makes a contract with an ecosystem service provider (for example, a farmer) to reward the provision of ecosystem services (such as carbon capture and sequestration, clean water, or landscape beauty).

This paper begins with an exploration of PES, which opposes neoclassical and ecological economics.[1] While neoclassical economics embraces incentive-based regulation and marketisation of the environment, ecological economics is much more critical of the economists' procedure. I argue in this paper that ecological economics provides an appropriate perspective for analysing interactions between economy and society. Friction between the economy and the environment is best addressed through an ecological economics approach.

Secondly, incentive-based policy instruments aim to disrupt established practices and routines with the aim of achieving behavioural change. PES schemes target, for example, shifts in land management practices. Including the literature on behavioural economics is thus an important theoretical addition for better understanding PES. My argument in this paper is that insights from social psychology are a suitable tool to better understand the working of PES schemes. I propose to extend PES research to the reasoned action approach (RAA) developed by Fishbein and Ajzen (2010). As a field of application, I focus in this section specifically on agriculture.

Finally, PES is often concerned with the provision of public goods. Carbon storage in forests, or landscape beauty can be conceived as public goods. Public goods are a very specific type of economic commodity because they are non-rival and non-excludable. Economists such as Ronald Coase considered the provision of public goods long before the advent of PES; accordingly, research on PES can benefit from this stream of literature.

These three sections are rather loosely connected and sketch a space wherein a critical appreciation of the PES instrument is possible. The paper is structured as follows: Chapter 2 considers the perspective of ecological economics on PES. Chapter 3 explores the linkages between ecological and behavioural economics, while chapter 4 considers how insights from Coase's work might apply to ecosystem services. Chapter 5 then draws conclusions for the governance of payments for ecosystem services.

[1] This Working Paper derives from my PhD research on Payments for Ecosystem Services, at the IASS and the University of Kassel.

2. Ecological economics' perspective on PES

2.1. Economics – thinking in closed systems

Economics has been defined by Robbins as a discipline that "studies human behaviour as a relationship between [given] ends and scarce means which have alternative uses." (Robbins, 2007 [1932]) This definition goes hand in hand with the methodological and normative options chosen by economists: "The methodology of neoclassical economics ignores how our culture and history affect how we know and how what we have known affects the systems we are studying." (Norgaard, 1989, p. 53) For Backhouse and Medema (2009), Robbins' definition of economics fostered a specific kind of economics – one that ecological economics seeks to avoid: "This laid a foundation that could be seen as justifying not only the narrowing of economic theory to the theory of constrained maximisation or rational choice but also the 'imperialism' of economists' ventures into the other social sciences" (p. 805). For the purpose of that article, I follow Coase, who emphasised the dynamics of the economic system. Under that definition, economics seeks to study "the working of the economic system" (Coase, 1998, p. 73).

In the worldview of neoclassical economists, the economy is conceptualised as a closed system. There are inputs (in particular labour and capital) and there is output (production); in between lies the production process that transforms labour and capital into goods and services. Land, ecosystems, natural resources, and ecosystem functions are seen here as inputs that enter the production process, subsequently leaving the process in an altered state. The environment is both a resource provider for the production process and a sink for by-products that leave the production process. Any further description of the environment is missing from that particular worldview. Neoclassical economics is interested in the efficient allocation of resources to maximise social welfare, and assumes that there is one possible state of equilibrium (contrary to complex systems, in which multiple equilibria exist).

With the development of the dominant capitalistic economic system, the problem occurs that, next to (conventional) goods and services, a third stream of mass is produced that was not previously a part of the economist's worldview. This stream occurs as a by-product of the production process and is not part of the contractually secured exchange process (money against goods and services). Yet, this by-product of the production process affects third parties directly and indirectly, locally and globally, immediately and over time. Economists have come to call these by-products externalities.

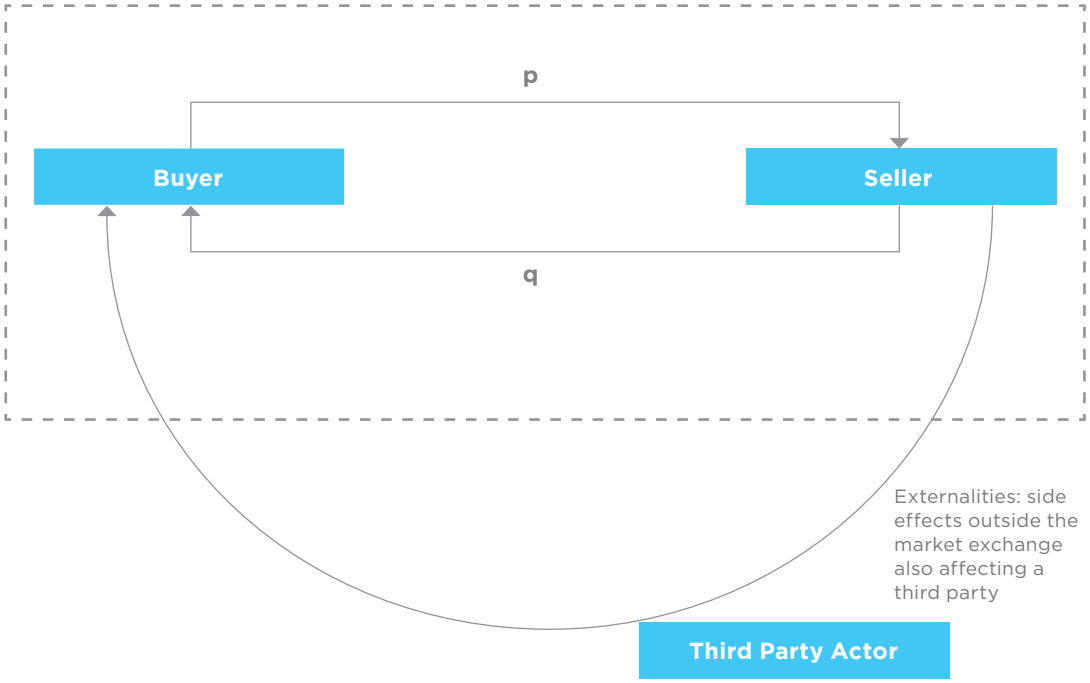

Figure 1:
Externalities occur when market processes affect third parties. The exchange of a quantity of goods (q) for a price (p) between a buyer and a seller affect a third party.

Source: own figure.

Economists seek to resolve externalities through internalisation. Many policy instruments (such as taxes or carbon pricing mechanisms) are thus designed to internalise the costs of negative externalities, i.e., to reveal to (economic) actors those costs that were not previously recognised. The economist sees in the case of externalities a gap between private and social marginal costs, which can be closed by taxes or subsidies. Pigou (1920) argues for taxes or subsidies that seek to equalise private and social marginal costs.

Coase (1960), in contrast to Pigou, proposes that an efficient outcome can be yielded by market negotiation – without state intervention. However, Coase assumes that there are no transaction costs and that property rights are well defined (neither assumption is true in real-world applications). Externalities and their internalisation are thus considered a mechanism for "closing-the-loop" (leaving the economist's worldview conveniently untouched). Yet, the question of whether complete internalisation of externalities is possible remains a point for discussion.

Economists such as Kapp (1950) and Altvater (1992) argue that externalities are inherent to the capitalistic production process. For Kapp, these externalities are "social costs" that contain both environmental and social externalities. According to Kapp, the capitalist economy functions only by virtue of its capacity to shift costs to the environment and the social sphere as externalities. External costs, the argument goes, are permanently shifted to the environmental or social sphere, and that cost-shifting is inherent to modern production patterns. Consequently, the internalisation of externalities – proclaimed by neoclassical economists – does not treat the problem at its root but rather tries to deal with it via an incremental (rather than a systemic) approach. Such approaches differ greatly to that of ecological economics.

2.2. Ecological economics: the sustainability school of economics

Over a period of more than a quarter of a century, ecological economics has established itself within the field of economics as the relevant school of thought on sustainable development. Ecological economics deals with "the science and management of sustainable development" (Costanza, 1989). It initially grew out of cooperation between ecologists and economists, who coupled their models and searched for interdisciplinary common ground. Ecological economics focuses on sustainable development, treated from inter- and transdisciplinary[2] perspectives, that is applied to various fields such as climate change, environmental policy instruments, justice and equity, biodiversity, and ecosystem services.

Ecological economics conceives the economic system as a subsystem of the social and environmental systems (Passet, 1979). Eschewing a closed-system perspective, the economic system is instead embedded within the social and bio-sphere (Holling, 2001). The economy is not self-referential (Georgescu-Roegen, 1971); its continued operation requires a permanent supply from the environmental (resources) and social (labour) system. Thus, nature is seen as an integral part of the production process. If sinks become too overloaded or natural resources are depleted, the consequences also impact the economy.

Ecological economists also highlight the limits of technical substitution for natural resources. Next to ecological considerations, ecological economics furthermore focuses on social justice and fairness, meaning that sustainable development pathways for the economic system transcend a corridor between ecological boundaries and social minimum standards.[3] Similarly to the dynamics of natural processes, ecological economics views the economy as a dynamic, evolutionary, highly complex system that can have multiple equilibria (Beckenbach, 2001). Norgaard (2010, p. 1220) states that "the more significant one thinks our environmental problems are, the more inappropriate has been the partial equilibrium and project-by-project approach for utilising the concept of ecosystem services."

Between the different systems (i.e., the economy and the environment), there is tension. Friction between the environment and the economy is to be expected – and is already manifest in many places. Here, I argue that these tensions must be anticipated, monitored, and evaluated. Agriculture is a prime case for analysing such friction between different systems. On the one hand, agriculture – a highly specialised and labour- and capital-intensive production process – produces normal goods and services. On the other hand, agricultural activities impact ecosystem services – and vice versa. Farmers depend on critical ecosystem services (such as soils, climate, and pollination) that cannot currently be replaced by technical solutions.

2.3. Ecosystem services – at the intersection of economy and nature

Ecosystem services can be seen as boundary object that connects the environmental and the economic spheres (Abson et al., 2014). They can be conceived as positive externalities, for which the ecosystem service provider is not yet rewarded in the market place, and can also arise as by-products of the production process.

The term ecosystem services was popularised by the Millennium Ecosystem Assessment (MEA). The MEA was a major assessment of the impacts of ecosystem change on human well-being, initiated by UN Secretary-General Kofi Annan in 2000. It defines ecosystem services as "the services and benefits that humans obtain from the environment" (Millennium Ecosystem Assessment, 2005). It further classifies these services in supporting, regulating, provisioning, and cultural ecosystem services.

[2] I understand the cooperation of different disciplines as interdisciplinarity, whereas transdisciplinarity incorporates non-scientific actors and person-based tacit knowledge within the research process.

[3] Raworth (2012) has coined the "doughnut" image of sustainable development that adds to planetary boundaries social aspects such as justice, fairness, and others.

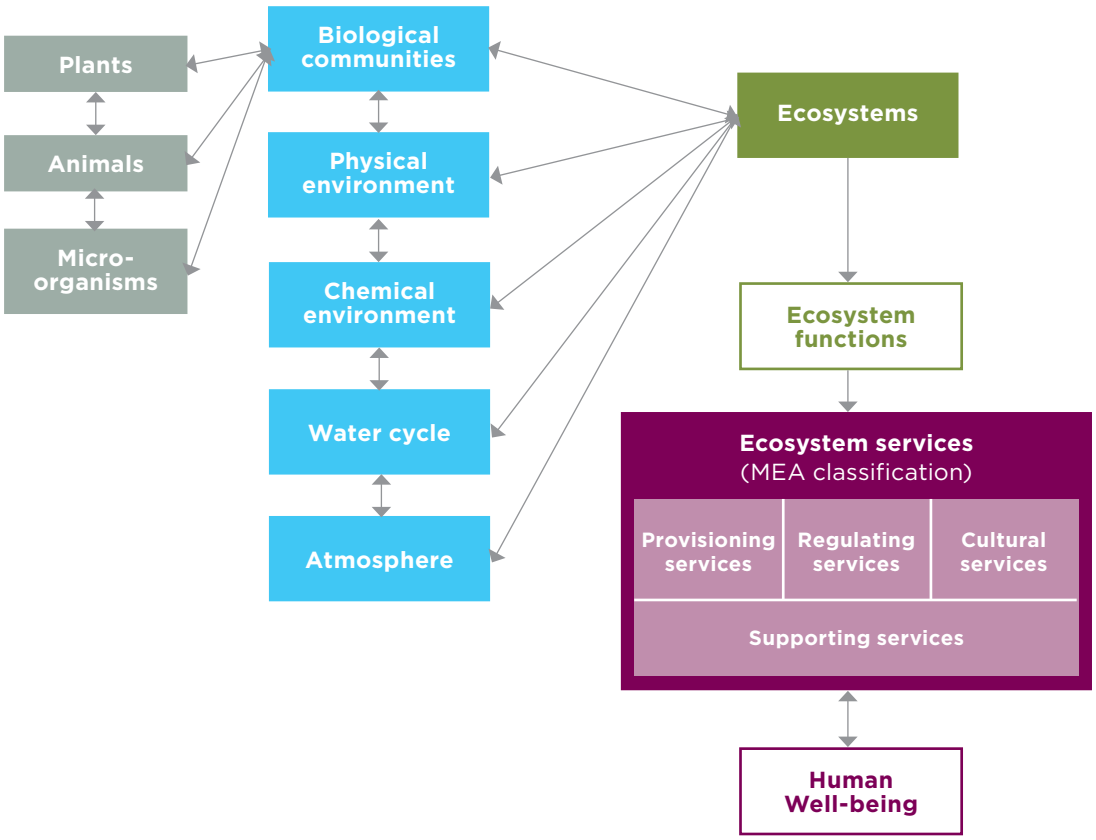

Figure 2:
Ecosystems consist of living and non-living components. Their functions can be transformed into ecosystem services, beneficial to humans.

Source: own figure.

Figure 2 illustrates the components of an ecosystem and how they relate to ecosystem services. Ecosystems are complex systems in which various parts interact:

> "An ecosystem consists of plants, animals, and microorganisms which live in biological communities and which interact with each other and with the physical and chemical environment, with adjacent ecosystems, and with the atmosphere." (Costanza & Folke, 1996)

The system's dynamics can be non-linear. Nevertheless, the system has ordering patterns due to self-organisation (Jansson, 1994). The complexity of ecosystems is manageable if some key parameters are known, i.e., the "complexity of living systems of people and nature emerges not from a random association of a large number of interacting factors rather from a smaller number of controlling processes" (Holling, 2001). Ecosystems are also characterised by diversity: biodiversity refers in most cases to species diversity that can be found at each level of the ecosystem. Spatial and temporal diversity, as well as genetic diversity, are equally important for the integrity of ecosystems. Resilience is the ability of a system (natural, social or an interaction of both) to retain its structure and function after disturbance (Holling, 1973).

As the concept of ecosystem services has gained ground, economists and ecologists alike have considered new policy instruments with a view to increasing the provision of ecosystem services and effecting behavioural change in land management practices. On the one hand, there are calls for monetising the environment so that as yet untraded goods may be allocated a market price and enter into the economic process. On the other hand, incentive-based instruments seek to influence behaviour by setting the "right" economic (often monetary) incentives to change behavioural routines (e.g., adopting organic farming) or to discourage certain undesirable behav-

iours (e.g., deforestation). Such incentive-based instruments include systems of payment for ecosystem services (Jack et al., 2008). Wunder (2005) provides the most commonly cited definition of payment for ecosystem services:

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

However, Wunder's definition should be taken with caveats, as environmental goods obviously differ from conventional goods (Vatn, 2000). Polanyi (1978 [1944]), for instance, analysed the results of "fictitious commodification" of land, labour, and money. In PES schemes, the buyer is not necessarily a buyer in the economic sense, while the provider is not a real producer. Even though the instrument is thought of as mobilising private money, in practice it is often the state that functions as a buyer; and, due to high transaction costs, intermediaries are often present in PES schemes (Vatn, 2010).

Behavioural change is one aim of PES schemes. In practice, these payment schemes often function as conventional subsidies. Payments for ecosystem services seek to negotiate the modalities of usage of ecosystem services economically. Figure 3 illustrates a system of payment for ecosystem services.

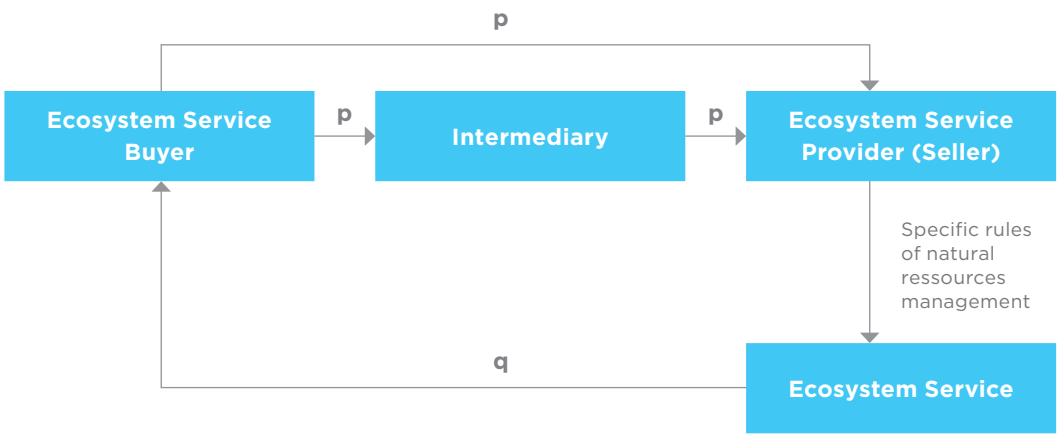

Figure 3: Schematic representation of a Payment for Ecosystem Service (PES) scheme. An ecosystem service buyer pays a price (p) to the ecosystem service provider, which in turn assures the provision of ecosystem services (q).

Source: own figure.

Norgaard (2010) correctly points out that there is a great variety of payment schemes for ecosystem services, and that complexity should be acknowledged. Tacconi (2011) classifies the different schools of thought as: the environmental economics perspective, ecological economics, and those who reject the notion of payments for ecosystem services. Some authors, for example Kosoy and Corbera (2010), criticise PES as an instrument of "commodity fetishism" (see also Vatn, 2010). They oppose what they view as the commodification of nature, and reject the economic language that speaks of nature's services. Nevertheless, the payment can be framed not as a commodification of nature, but as an incentive for behavioural change. With regard to its application to agriculture, PES can be conceptualised as an instrument that targets behavioural change rather than as an attempt to commodify nature.

3. Linking ecological and behavioural economics

Agriculture represents one sector for the application of PES schemes. Here, PES is used to shift land management towards more sustainable practices by setting appropriate monetary incentives. Economists have developed regulatory instruments such as taxes and subsidies as well as incentive-based instruments to foster so-called "agri-environment measures" (Nutzinger, 1994; Pannell, 2008). In the context of agriculture, the regulatory instruments shifted from production-based subsidies towards incentive-based policy instruments that promote more environmentally friendly production patterns. Farmers are thus not only rewarded for the (market) goods they produce but also for the provision of ecosystem services as well as cultural landscapes (Pascual & Perrings, 2007; Power, 2010). The European Common Agricultural Policy in particular relates subsidies to "greening" measures such as the provision of ecosystem services and cultural landscapes (Plieninger et al., 2012; Uthes & Matzdorf, 2013).

3.1. The behavioural gap in agricultural economics

"Agriculture is the one sector of economic life which is inescapably close to the biological processes and in which, therefore, the relations between biological and societal evolution are of particular importance." (Boulding, 1981, p. 792) Ecological economics studies those two domains and can be complemented by insights from behavioural psychology (Reasoned Action Approach, Fishbein & Ajzen, 2010). Such a specific behavioural focus is especially important for a better understanding of human behaviour.

The literature on the evaluation of policy instruments highlights the frequent lack of input from a behavioural economics perspective (Shogren & Taylor, 2008; Van Den Bergh et al., 2000; Venkatachalam, 2008). This perspective is particularly relevant in the context of PES if the incentive-based character of policy instruments is to be considered: "A better understanding of these behavioural and governance dimensions is needed, before we rush to adopt payments as the most appropriate policy option" (Muradian et al., 2013, p. 4).

Many authors argue for such a behavioural perspective in agricultural economics. Best (2010), for example, states that there are very few empirically sound and theoretically-based studies of farmers and their decisions to switch from conventional to organic farming. "There is only a small body of research on farmer's attitudes and behaviours regarding nature conservation, and this research rarely makes use of social psychological insights or theories" (Lokhorst et al., 2011, p. 338). I agree that we need to gain a better understanding of the importance of attitudes, social norms, and perceived behavioural control, and the ways in which these might be influenced.

3.2. The Reasoned Action Approach (RAA)

Making economic decisions is a complex procedure (Simon, 1986). Yet, neoclassical economists draw a straight line from a situation to a certain behaviour without regard for regulatory contexts or human psychology. As Coase (1988, p. 3) puts it: "We have consumers without humanity, firms without organisation, and even exchange without markets." The formalisation of decision-making in economics assumes that only the optimum incentive (i.e., price) has to be found in order to change behaviour. Such a treatment is overly simplistic and does not correctly reflect the decision-making process (Beckenbach, 2001, 2003). A behavioural economics approach is also appropriate in the case of PES schemes, given their aim of bringing about behavioural change: farmers, for example, are incentivised through payments to adopt more environmentally friendly agricultural practices.

As an extension of PES research, I propose to build on the reasoned action approach (RAA) developed by Fishbein and Ajzen (2010). "The Fishbein and Ajzen (1975) attitude–behaviour model, or theory of reasoned action, and more recently the related theory of planned behaviour (TPB) of Ajzen (1991) offer some useful insights into how economists could improve their understanding of human behaviour by studying social psychology." (Spash et al., 2009, p. 956) RAA presumes that behavioural intention is the best predictor of an individual engaging in that behaviour. The intention to perform a behaviour is influenced by attitudes towards the behaviour, social norms, and by perceived behavioural control. Socio-demographic influences such as gender, education, and others function as background factors.

Burton (2004) describes, in the context of agriculture, the application of socio-psychological approaches that complement economics: "Arguments for maintaining the behavioural approach are relatively simple and centre around policymakers' continuing need for repeatable and standardised methodologies and the increasing importance of policy-directed work as a funding source for research" (p. 368). Subsequently, de Snoo et al. (2013) argue that a better understanding of the motivations of farmers to adopt agri-environment measures is necessary for effective policy measures. Hansson et al. (2012) also provide significant findings by returning to the theory of planned behaviour: "The results show that underlying psychological constructs suggested by TPB play a significant role in farmers' choice of business development strategies, with the subjective norm construct and the attitude construct in particular showing significant influences" (p. 478).

If PES is understood as incentive-based policy instruments that seek to change behavioural routines, a theoretical approach based on behavioural economics in general – and the attitude–behaviour model of Ajzen and Fishbein in particular – is crucial to improving our understanding.

4. A Coasean perspective on PES: lighthouses and ecosystem services

In addition to the ecological and behavioural economics perspectives outlined above, I now consider PES and public goods – a research perspective that builds on the work of Ronald Coase. In terms of economics and the environment, Coase's (1960) seminal article on the "problem of social cost" continues to be widely cited within the literature. For many, the article represents a prime example of the prevailing marketisation in the regulation of external effects: notwithstanding who holds the property rights – the polluter or the pollutee – and with zero transaction costs, the so-called "Coase Theorem" is thought to show that a market solution yields efficient outcomes regardless of the initial distribution of property rights.

However, there are many different readings of Coasean economics, and Coase himself repeatedly asserted that his ideas had not been taken up correctly by economists: "My point of view has not in general commanded asset, nor has my argument, for the most part, been understood" (Coase, 1988, p.1). Although Coase is often cited, "most economists are unfamiliar with Coase's critiques and with the alternative approach that he is advocating, and are content, instead, to conveniently lump him into the Chicago mold" (Medema, 1995, p. 16). Here, I argue that Coase's view on economics is much richer than it first appears, and that the field of ecological economics would benefit from closer engagement with these arguments.

Coase was interested in the problem of providing hitherto untraded goods – a phenomenon with which economists are familiar. In economic debate, the lighthouse is often used as a metaphor for public goods. For economists, the navigational light provided by lighthouses is non-rivalrous (the navigational support consumed by one ship does not diminish the ability of other ships to benefit from the guiding light) and non-exclusive (the lighthouse-keeper cannot exclude certain ships from using the light for navigation). Economists therefore claim that state intervention is necessary to align private and social marginal costs for the optimal provision of public goods. Hence, within the economic discourse, the lighthouse represents a public good that needs to be provided by the state.

Yet the journey from lighthouses in economic textbooks to lighthouses on shorelines is full of surprises: contrary to conventional economic wisdom, Coase (1974) provides historical evidence that lighthouses in Britain were run profitably and efficiently by a private company (Trinity House). However, economists have tended to see the lighthouse as an example of a purely public good. Coase described this conclusion as "blackboard economics" (Coase, 1992), because no actual study of the working of the lighthouse system was undertaken. Thus, Coase concluded that a case-by-case approach is necessary to determine which governance structure best applies to public goods. Sometimes, state intervention is required and beneficial, whereas other times it is not.

Table 1 summarises the differences between lighthouses (navigational light) and ecosystems (ecosystem services) developed in this chapter.

4.1. Supply function

The supply function of the lighthouse and its navigational light is non-complex and quite easily controlled. For economists, a production function includes labour (L) and capital (K) (McCloskey, 1985, pp. 471–474). Of course, knowledge and materials are also required to build a lighthouse. Ecosystem services, by contrast, not only involve labour to a greater

extent, but also depend on the functioning of the ecosystem environment (see Figure 1): $Q(ES) = f(L, C, f(ecosystem))$. Labour in this case refers, for example, to a specific form of land management that is intended to provide the ecosystem service in question. Due to the co-production of ecosystem services by humans and ecosystems, their supply function is less controllable and more complex than that of the lighthouse.

4.2. Dynamics

As a commodity, lighthouses are stable and continuous. The provision of lighthouses is a simple production function and can be predicted reasonably well. In contrast, ecosystems are dynamic, complex, adaptive systems in which discontinuities are likely to occur (Levin, 1998). The dynamics of ecosystems are not as straightforward as those of conventional commodities. Seen from a management perspective, the ecosystem's resilience is to be preserved (Holling, 1973). The fit of the institutional governance regime should thus correspond to the dynamics of the ecosystem in question (Folke et al., 2005). The provision of ecosystem services depends on the dynamics of the ecosystem, which are not as easy to manage as a lighthouse.

4.3. Property rights

In the example of a lighthouse, property rights are usually well defined. However, in the case of ecosystems, the property rights structure is much more complex and property assignments are often unclear (Bromley, 1978). In comparison to conventional economic goods, the property rights regimes with regard to natural resources are often multi-layered. Schlager and Ostrom (1992) provide a useful classification of property rights regimes: groups that have access to the common-pool resource do not necessarily have the right to manage the resource. Given the complexity of property rights, it is difficult in some cases to assign specific responsibilities for the appropriate management of ecosystems and their services. For instance, many ecosystem services are generated by non-point sources with diffuse and barely identifiable provenience (see Jack et al., 2008, p. 2467). Coase presented the notion that markets work well if property rights are well defined. From this, we may imply the converse: that complex property rights structures are not best handled by the market.

Thus, in the management of common-pool resources, different governance options have developed, which are distinguished by their structure of property rights: "Private, Common, State, Open access" (Ostrom, 2003).

4.4. Transaction costs

One can assume that transaction costs for the construction and operation of lighthouses are low to medium. However, those incurred in the provision of ecosystem services can be considerably higher. Thus, many intermediaries assist in setting up PES schemes to reduce transaction costs (see also Figure 1) (Schomers et al., 2015; Vatn, 2010). Gathering information about ecosystems, services, and land management practices is costly (Muradian et al., 2010, p.1204): "practitioners normally face a trade-off between the need to estimate efficiency gains resulting from the intervention and the need to keep transaction costs low enough to make PES schemes feasible." Strict enforcement and monitoring schemes also result in high transaction costs for ecosystem management (Farley and Costanza, 2010).

4.5. Reach

While the lighthouse and the navigational light it provides are local public goods, ecosystem services provide benefits at the local, regional, and global levels. Market solutions are more likely to be successfully applied where the reach of ecosystem services is at the local level (consider, for example, an upstream factory and downstream fishermen) rather than more global public goods (for example, climate change mitigation). Using market incentives to shape land management practices that deliver ecosystem services at the local level is a promising approach. Markets already exist for local public goods such as pollination and attractive landscapes. Transaction costs in these local settings are much lower than for global public goods: "If PES benefits a small number of actors, incentives to free ride and transaction costs of coordinating a joint PES programme are relatively low" (Engel et al., 2008, p. 667). However, in the case of global public goods, free-rider effects and high monitoring and transaction costs make markets a less efficient solution.

		Navigational light	Ecosystem services
4.1.	**Supply function**	*Controllable, manageable*	*Partly controllable, co-production of services*
4.2.	**Dynamics**	*Static, continuous*	*Dynamic, non-continuous*
4.3.	**Property rights**	*Defined*	*Often unspecified*
4.4.	**Transaction costs**	*Low–medium*	*Medium–high*
4.5.	**Reach**	*Local*	*Local and global ecosystem services (different temporal and geographical scales)*
4.6.	**Kind of services provided**	*Life-supporting (risk-reduction); cultural service*	*Supporting, provisioning, regulating, cultural*
4.7.	**Rivalry**	*Non-rival*	*Often rival, sometimes non-rival*
4.8.	**Excludability**	*Non-excludable*	*Often non-excludable*
4.9.	**Monitoring**	*Technically feasible*	*Complex*

Table 1:
Comparison of lighthouses and ecosystem services. If ecosystems share the characteristics of lighthouses, market-based regulation can be successful. However, ecosystem services tend towards the characteristics shown in the right-hand column, thereby requiring mixed forms of governance.

Source: own table.

4.6. Types of services provided

Lighthouses provide a life-supporting service in their function as navigational aids to ensure the safety of shipping, cargo, and sailors. As aesthetically pleasing objects they also provide a cultural service. In the lighthouse example, we can imagine a realistic pricing system for both services: a fee collected from the ships that used the navigational light, and a fee collected from recreational visitors to the lighthouse (even though many will enjoy the lighthouse's beauty free of charge from afar).

Ecosystems often provide bundled services (Klain et al., 2014; Raudsepp-Hearne et al., 2010) that can include supporting, provisioning, regulating, and cultural services. "Most ecosystem services are produced as joint products (or bundles) from intact ecosystems." (Farley & Costanza, 2010, p. 2061). It is often difficult to disentangle these service bundles to reward the delivery of specific services. Payment schemes for ecosystem services often focus on one particular service rather than these bundles. In such cases, specific forms of land management carry a risk of optimising landscapes for the purpose of accessing one service only – CO_2 uptake, for instance – which can reduce the ecosystem's resilience (Kemkes et al., 2010, pp. 273–274).

4.7. Rivalry

The light provided by a lighthouse is non-rivalrous. In other words, the provision of light to one ship does not hinder other ships from benefitting equally from this service. In some cases, ecosystem services are also non-rivalrous. For example, one individual's enjoyment of a coastline's aesthetic beauty does not diminish the opportunity for others to experience the same coastline (this changes when a coastline or other attraction becomes overcrowded). Nevertheless, many ecosystem services are rivalrous – their consumption by one person diminishes the opportunities available to others.

4.8. Excludability

The lighthouse is used in economics as an example of a purely public good, because it is non-rival and

non-excludable. The lighthouse-keeper cannot direct the light solely to those ships that have paid a fee, nor does its use by one vessel deprive other vessels of the same benefits. Nowadays, with various technical advancements, including satellite navigation systems, one can well imagine contexts where a navigational aid might become an excludable good.

Various ecosystem services may be either excludable or non-excludable. A market situation is more likely to occur if excludability can be achieved. Yet, if we consider the example of climate regulation, forest managers cannot exclude third parties from the beneficial ecosystem services provided by forest resources. The same is true of many other global public good ecosystem services.

4.9. Monitoring

Coase describes in detail the monitoring of the British lighthouse system. The lighthouse company was able to monitor whether a ship had paid the requisite fee, which was collected at harbours close by: "The charges were collected at the ports by agents for the lighthouses. The problem of enforcement was no different for them than for other suppliers of goods and services to the ship-owner. The property rights were unusual only in that they stipulated the price that could be charged." (Coase, 1974, p. 375)

In the case of ecosystem services, monitoring is also a major concern, and solutions can prove very costly (Meijerink, 2008). PES schemes can be designed to reward outcomes or specific management practices (Gibbons et al., 2011). Whereas outcome-driven reward schemes are indifferent to management practices, incentivising specific management practices returns incomplete information with regard to the achieved outcome, i.e., the quantity of ecosystem services provided. Transaction costs, which Coase introduced to economics, are especially high in terms of monitoring PES schemes: "Most PES schemes rely on observable proxies, such as actions or outcomes (e.g., the presence of buffer strips or the amount of forest cover), because direct monitoring of ecosystem service outputs is difficult or costly" (Jack et al., 2008, p. 9467).

4.10. Implications for the governance of ecosystem services

The above analysis suggests that it is necessary to rethink governance schemes for PES and the scientific methods used for assessing, valuing, modelling, and managing ecosystem services (Van der Ploeg et al., 1987). In the case of ecosystem service governance, more complex approaches than purely market-based solutions are required (Beckenbach, 2001). The economists' proposal (get the prices right, clarify property rights, and let the market do the job) is of limited applicability when dealing with complex, adaptive systems: "The sustainability discourse in economics is all too often an attempt to describe systems, their evolution, and their interactions in the language of neoclassical economics, although their complexity by far exceeds the capabilities of such language" (Spangenberg, 2015, p. 101).

5. Conclusion

In this paper, I have argued that research about payments for ecosystem services should integrate three different dimensions. Firstly, PES schemes are at the intersection between the economy and the environment. This field of integration is a core competence of ecological economics, which – to date – is the school of economic thought relevant to sustainable development. A neoclassical treatment of the environment falls short of integrating normative aspects of sustainable development such as considerations for justice, fairness, and development within planetary boundaries.

Next to ecological economics, a second perspective on PES deals more with the specific behavioural aspects. I would not argue that PES is about monetising the environment and the economists' logic of putting a price tag on the environment in order to safeguard it. On the contrary, PES aims to achieve behavioural change through incentive-based policy instruments. Ecological economics can here be supplemented by insights from behavioural economics. RAA is an intention–behaviour model that integrates social psychology. Attitudes, perceived behavioural control, and social norms all influence the intention to perform a certain behaviour. PES research can therefore benefit from social psychology theory such as RAA.

Finally, research into PES can benefit from the literature on public goods. I derive from the Coasean analysis of the lighthouse the following criteria for the application of incentive-based instruments to enhance the provision of ecosystem services:

- If ecosystem services are akin to navigational lights (see Table 1), they can be provided efficiently by the market.

- The provision of ecosystem services is in many cases more complex than the provision of navigational lights (for an overview of the properties of ecosystem services, see the right-hand column of Table 1). The dynamics of ecosystem services are more complex than the continuous supply and demand curves with which economists are familiar. Multi-layered governance structures appropriate to ecosystems are required (Folke et al., 1998, 2007).

- There is no blueprint solution to the challenge of creating optimal institutional structures for managing ecosystem services. This insight goes hand in hand with Coase's argument for an economics based on empirical study (Schmid, 2000).

The combined consideration of these three research perspectives – ecological economics, behavioural approaches, and the study of public goods – as I argue here, will promote a better understanding of PES and foster improved application of this instrument in the field.

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