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Deconstructing ecosystem services: uncertainties and controversies around a socially constructed concept

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Abstract

Because of its success, the concept of ecosystem services (ES) is increasingly taken for granted, without sufficient questioning of the strong uncertainties and controversies that surround it. In this paper, we consider this concept as socially constructed and we analyze the surrounding controversies in order to decipher the process through which it is constructed. From a literature review, we identify five main domains of controversies: (i) scientific uncertainties relating to causal relationships that underlie ES production, (ii) multiple understandings of the very concept of ES due to different representations of human-nature relationships, (iii) diverging opinions regarding the idea of valuing ES and the notion of value itself, (iv) conflicts of interests, power plays, and scale issues associated with the management of ES, and (v) controversies around the policy tools derived from the ES concept. In conclusion, we advocate for a greater engagement of human geographers in these debates. We emphasize in particular the need to study the complex social interdependences underlying ES dynamics, and to engage in participatory research exploring the potential of collaborative options for the management of ES.

Keywords

Ecosystem services, social construct, political ecology, controversies, epistemology

1. Introduction

The concept of ecosystem services (ES), commonly defined as the benefits supplied to human societies by natural ecosystems (Daily et al., 1997), has been enjoying an increasing success in the last decade in both the scientific and political arenas dealing with environmental issues. The idea of services provided by ecosystems to people appeared at the end of the 1970s, with authors such as Westman (1977) and then Ehrlich and Mooney (1983). Their objective at that time was to open the public's eyes to the degradation of ecosystems due to human activities, the significance and diversity of benefits that such ecosystems supply to societies, and how difficult and costly they would be to replace. This idea, which was originally a simple metaphor intended to rally public opinion, progressively acquired the status of a scientific concept (Norgaard, 2010). Involving more than 1,300 experts from 95 countries, the Millennium Ecosystem Assessment (MEA), released in 2005, strengthened the concept – at least apparently – and launched it beyond the scientific arena (MEA, 2005). The MEA authors distinguished four main types of ES (this classification has often been questioned since then but remains the most frequently used): (i) provisioning services (e.g. food, wood, fresh water, fish), (ii) regulating services (e.g. regulation of climate, floods, water quality), (iii) cultural services (e.g. aesthetic and recreation values, spiritual enrichment), and (iv) supporting services (e.g. carbon cycle, soil formation) that are necessary for the production of the first three categories of services (MEA, 2005). Whereas the economic valuation of ES was only secondary in the MEA, it gave rise to numerous studies in the field of ecological economics (e.g. Costanza et al., 1997; Gallai et al., 2009; Woodward and Wui, 2001) and it was central to the broad research initiative "The Economics of Ecosystems and Biodiversity" (TEEB), launched in 2007 in Europe (TEEB,

2010). In the meantime, governments, development agencies, and NGOs started to develop diverse programs of payments for environmental services (PES) in both southern and northern countries (Wunder et al., 2008). These schemes, which can take various forms, are generally designed to incentivize preservation of ecosystems by compensating local resource users for the opportunity costs of alternative resource use.

All in all, the ES concept is nowadays increasingly present. Are we witnessing the emergence of "a new tyranny"¹? This concept has indeed become the key word of numerous calls for tender and therefore shapes more and more research and policy initiatives dealing with conservation and environment. Although it has its detractors, this concept is used by a wide range of stakeholders (scientists with different backgrounds, government agencies, NGOs, financial sector stakeholders...) in various domains (e.g. fishery, forestry, agriculture). However, although all these people use the same word, do they define it the same way? Do they share the same ideas, values, and norms regarding environment and development? The answer is obviously no. One might argue that this concept is a kind of "boundary object" (Star and Griesemer, 1989) that allows and stimulates exchanges and better mutual understanding among different kinds of people, and this is probably sometimes the case. However, one might also wonder whether or not these exchanges are sometimes only dialogues of the deaf.

The entry point of this paper is the observation that, because of its success and the apparent robustness that this success confers on it, the concept of ecosystem services is increasingly taken for granted, without sufficient questioning of the ideas, norms, and values that underpin it. Following Latour (1987, 2004), we adopt a constructivist perspective, considering that ecosystem services do not exist *per se*, but are socially constructed. Any claim or knowledge

¹ We refer here to the book edited by Cooke and Kothari in 2001, entitled *Participation. The New Tyranny?* (Cooke and Kothari, 2001)

about ES reflects the perception and interests of the individuals that produce that knowledge, in a given social and political context. We are in line with the geographers and political ecologists who traditionally like to question taken-for-granted ideas about nature (Blaikie and Brookfield, 1987; Castree and Braun, 2001; Forsyth, 1996; Robbins, 2004). In his sociology of sciences, Latour (1987) invites us to analyze "science in the making" by opening the black boxes of knowledge uncertainties (when there is not a unique and complete understanding of a phenomenon)² and looking at the controversies generated by these uncertainties. It is in the middle of these controversies, Latour suggests, that we can see how knowledge is actually socially constructed, with all its fuzzy contingencies. Following this idea, the objective of this paper is to review and analyze the uncertainties and controversies associated with ES (both the concept and the processes that refer to it) in order to decipher the process through which this notion is socially constructed. It is not our position here to consider uncertainties as problems that need to be reduced or eliminated. Rather, our goal is to warn against using the concept without being critically aware of these uncertainties.

We argue in this paper that geographers could make positive contributions to such an approach. A few of them are actually engaging with the concept of ES (Arnauld de Sartre et al., 2010; Dempsey and Robertson, 2012; Fletcher and Breitling, 2012; Kosoy et al., 2008; McAfee and Shapiro, 2010; McElwee, 2012; Potschin and Haines-Young, 2011; Robertson, 2004, 2013; Shapiro-Garza, 2013), and they offer much-needed contributions to scientific debates currently dominated by economists and ecological scientists. Potschin and Haines-Young (2011) emphasize that physical geographers could provide insights into the characterization of the biophysical dynamics of ES. They call in particular for more spatial and place-based approaches in ES assessments to provide more precise definitions of the service-providing units (Potschin

² We adopted the definition of uncertainty suggested by Brugnach et al. (2008).

and Haines-Young, 2011). As for Dempsey and Robertson (2012), they encourage economic and political geographers to engage with debates around ES policies, commodification of nature and neoliberalism. These authors provide a review of the debates and frictions within the mainstream ES policy literature regarding exactly how to measure and commodify nature. Our paper shares a number of features with their paper. Like them, we chose to review tensions and controversies around ES in order "to understand ES as an ongoing economic and political project with considerable variability" (p. 759). The major areas of controversies that we identified are partially similar to the ones that they identified (debates around definitions, values, and policies in particular). And like them, we call for more human geographers to engage with these debates. However, although we sometimes highlight the same points of debate, our analysis remains different because we do not have the same angle of analysis. Dempsey and Robertson (2012) purposely focus on tensions within the mainstream ES policy literature in order to highlight "neoliberalism's internal incoherencies" (p. 759). Whereas the concept of ES is commonly perceived as belonging to pure neoliberal doctrine, they show that the actual policies and practices are highly heterogeneous, and many of them deviate from the neoliberal doctrine. However, since they chose to focus on internal debates within the pro-ES policy literature, the tensions that they review "largely seek to measure or improve the 'impact' of ES policies rather than to examine their foundations" (p. 763). This is where our angle differs from theirs. We analyze controversies that question and examine the very foundations of the concept of ES, both within and outside the mainstream ES literature, in both social and ecological sciences, and not only regarding ES policies but also regarding ES as a scientific concept and more broadly as a way to look at the world. Dempsey and Robertson provide detailed and accurate descriptions of several technical debates among economists; we, however, do not go that far into these debates and rather focus on the points of frictions that relate to

differences in the way people perceive nature, human–nature relationships, and relations among people about nature. These are therefore two very complementary papers.

Our paper is organized around the five main domains of uncertainties and controversies about ES that we have identified: (i) scientific uncertainties relating to ecological processes and causal relationships that underlie the production of ES, (ii) multiple understandings of the very concept of ES because of the fundamental differences in the way people perceive the place of humankind in ecosystems, (iii) different perceptions of the notion of the value of ES leading to different positions on the economic valuation of services, (iv) conflicts of interests, power plays, and scale issues associated with the collective and public choices of services to be given priority for preservation; (v) controversies around the policy tools derived from the concept of ES.

2. Scientific uncertainties about causal relationships that underlie the provision of ecosystem services

When the notion of ecosystem services evolved from a metaphor into a scientific concept, it established a bijective relationship between ecosystems and societies. Potschin and Haines-Young (2011) talk of a kind of "production chain" (p. 577) linking ecological and social systems. Yet, the processes underlying this production chain for the provision of ES are highly uncertain and often poorly understood. In many (if not most) situations, scientists are not able to establish with certainty a causal relationship between the state of an ecosystem (e.g. land-use) and the actual provision of a service (e.g. water regulation). This can be illustrated, for example, by scientific controversies surrounding climate change (Murphy et al., 2004; Schneider, 2001) or the numerous debates concerning the role of upstream forests in the functioning of downstream catchment basins (Bruijnzeel, 2004; Locatelli et al., 2008). These uncertainties are admittedly not specific to ecosystem services - they are inherent in any

research on the functioning of ecosystems - but we argue that these uncertainties tend to be more overlooked in the case of ES than with other notions.

The success of the concept contributes indeed to a sort of reification of the processes it describes. It is just as if, by accepting this concept, people started to acknowledge the concrete, tangible, and measurable existence of services supplied by ecosystems to societies. Moreover, when economists assess their monetary value, it reinforces the impression that these services are effectively concretely provided. Finally, although the concept is not stabilized yet among scientists and the processes it describes are not fully understood, some politicians are already using it to justify conservation policies (Karsenty et al., 2010). Using the words of Latour (1987), politicians tend to act as if ES were in the domain of "ready-made science", with well understood causal relationships, certain, stable, and "cold" knowledge that is no longer put into question, while ES are actually in the domain of "science in the making", with uncertain and unstable knowledge.

However, does such cold, stable and certain knowledge actually exist in the domain of environmental management? The causes of uncertainties underlying ES provision are twofold, either because the knowledge is (still) insufficient or because the systems being considered are, by their very nature, unpredictable. The ecological functions and resulting ecosystem services indeed depend on interactions between multiple and diverse dynamics (not only ecological but also social and economic) that occur on different spatial (local, regional, global) and temporal (slow, fast) scales. Many authors have tried to understand how these complex socio-ecological systems function and now accept that their evolution is unpredictable (Holling, 1973, 2001; Pahl-Wostl, 2005; Walker et al., 2002) and non-linear with threshold effects and irreversibility (Limburg et al., 2002). Regarding ES, Potschin and Haines-Young (2011) consider that two critical questions remain open: whether there are critical levels of natural capital needed to sustain a flow of ecosystem services, and whether that capital can be restored once damaged.

With the acknowledgment of these uncertainties, we have come into an era of acting with uncertainty and adaptive management (Carpenter et al., 2006; Folke et al., 2002; Pahl-Wostl, 2007). Decision-makers, citizens and scientists need to accept that they have to take decisions even without a full understanding and predictability of causal effects. In other words, we remain constantly in the fuzziness of the "science in the making".

Latour (1987) suggests that this fuzziness allows us to see the extent to which our understanding of the world is socially constructed. For example, one can wonder why ecological scientists currently prefer this concept of ES over another. This concept is indeed for sure an opportune and promising way to support their cause, because it draws the attention of policymakers and the wider public to the necessity to protect (and study) ecosystems. They have now a concept that shows that their studies on ecosystems and ecological processes are useful for society. However, from a scientific perspective, is it a concept that allows them to go forward in their understanding of the phenomenon they study? The ecological economist Richard Norgaard (2010) doubts it and is worried about the oversimplification of descriptions of ecological processes that the ES concept generates. This author sees this concept as a "complexity blinder" that, because it relies mainly on a stock-flow framework, does not allow account to be taken of the complexity and the diversity of ecological processes underlying the interactions between ecosystems and human well-being. In the same vein, there are numerous debates over the respective definitions of ecosystem "functions", "goods", "benefits", and "services". The dominating MEA definition of ecosystem services is very broad and includes indistinctly those different things. Many scientists argue, therefore, that to fully understand the dynamics of ecosystem services, there is need to be more precise and consistent in the definitions. Several argue in particular for the need to make a distinction between the final ecosystem services that contribute to the well-being of a specific human beneficiary, and the intermediate ecosystem functions that represent the capacity of an ecosystem to give rise to ecosystem services

(Lamarque et al., 2011; Potschin and Haines-Young, 2011). Economists working on economic valuations also call for more consistency in these definitions in order to avoid the problem of double counting – i.e. counting the value of both the final and the intermediary products (Boyd and Banzhaf, 2007). This has in turn given rise to another controversy among economists (for more details, see Dempsey and Robertson (2012)) as Costanza and Wallace (2008) have countered this, arguing that the broad definition is appropriate, since it is not possible to apply the reasoning of neoclassical economy to ecosystems characterized by uncertainty, complexity and non-linearity. We see here that the scientific controversies around the processes to which the ES concept refers are actually closely intertwined with the controversies around the concept itself. In the next section, we analyze further these conceptual controversies to show that many of them originate from different perceptions of human-nature relationships.

3. Controversies on the concept : various perceptions of human–nature relationships

The most widely used definition of ecosystem services – the benefits people obtain from ecosystems (MEA, 2005) – is extremely simple, at least apparently, and this is probably one of the reasons for its success. This definition is outwardly so clear and simple that, a priori, it seems that, even if some people do not agree with the idea of using this concept, at least everyone agrees on its broad definition. From a constructivist perspective, we are here at the stage when, unconsciously, the concept is being enforced by its "taken-for-grantedness", i.e. when the concepts "slip into our thought worlds over time, cementing and directing how we categorize environmental reality without thinking about it" (Robbins, 2004) (p. 110). However, the concept of ES reflects a specific representation of human–nature relationships that is far from consensual (Raymond et al., 2013). And on closer examination, one realizes that people actually implicitly use this concept with very different meanings in mind, depending on their

intimate representation of human–nature relationships. The controversies we analyze hereafter reflect somehow battles of intimate representations. And as often in battles, the most powerful prevails, to the detriment of others. This is why it is important to highlight that there are actually more diverse representations than appear at first sight.

3.1. Are ecosystem services provided by people or by ecosystems?

First, within the scientific community working on ecosystem services, depending on authors and disciplines, ecosystem services are found to be provided either by the ecosystems or by people.

The authors who originally developed the concept consider that services are provided by ecosystems (Chapin et al., 2000; Costanza et al., 1998; Daily et al., 1997; Ehrlich and Mooney, 1983; MEA, 2005). They emphasize the role of the health of ecosystems on service provision. As for people and societies, they are, above all, the beneficiaries or users of these services. When these authors examine the influence of societies on the environment, it is either in terms of pressure on ecosystems and degradation of services (pollution, resource overexploitation) or in terms of preservation and protection of ecosystems.

On the other hand, another stream of literature on ES emphasizes the role of people in the provision of ecosystem services, through the positive impact of their activities on ecosystems (Engel et al., 2008; FAO, 2007; Fearnside, 1997; Gordon et al., 2010; Wunder, 2005; Zhang et al., 2007). Although the role of people in the transformation of ecosystems can be found in any type of ecosystem, this aspect is emphasized in the ES literature relating to agricultural ecosystems, with examples such as the influence of livestock grazing on biodiversity in

grasslands, the impact of agricultural land-use on pollination or the esthetic value of agricultural landscapes. A branch of this literature examines incentives to encourage farmers and landowners to adopt practices with positive impacts on ecosystem services, such as payments for environmental services (Corbera et al., 2009; McElwee, 2012; Pagiola et al., 2005; Wunder et al., 2008).

In terms of vocabulary, the words ecosystem services and environmental services are often taken as interchangeable without it being easy to distinguish clearly between them. And yet, the two terms have their origins in different bodies of literature (Bonin and Antona, 2012). The community of conservation ecologists, in line with the Millennium Ecosystem Assessment, speak of ecosystem services, whereas the literature on payments for environmental services speaks of environmental services. In general, we note that the authors who think of services as products of ecosystems use almost exclusively the term ecosystem services, whereas those who think of services as products of human activities speak of both environmental services and ecosystem services. However, although some distinctions between the two terms have been suggested, no consensus has yet been reached on the subject. The FAO suggests considering environmental services as a subgroup of ecosystem services, which would exclude provisioning ecosystem services (FAO, 2007). According to this definition, environmental services would correspond only to externalities of production activities. Conversely, Muradian et al. (2010) consider ecosystem services to be a subgroup of environmental services, which would exclude environmental services supplied by semi-natural or anthropic ecosystems. Ecosystem services would relate only to natural ecosystems.

We believe that this is not just a confusion of vocabulary, but more profoundly the sign of a greater confusion associated with different and sometimes contradictory ways of conceptualizing the relationships between societies and their environment. This question echoes

in particular the debates around the social construction of nature (Castree and Braun, 2001; Descola and Palsson, 1996). What is claimed to be constructed is not only the concept of nature but also the material things to which it refers (Demeritt, 2001). The idea is that "nature", like "wilderness", exists only in people's imagination because, concretely, the impact of humans' actions can be found everywhere, in any ecosystem. "Nature has never been simply 'natural' [...] Rather, it is intrinsically social" (p.5) (Castree, 2001). If we relate this to the dual representations of ecosystem services as being produced by people or by ecosystems, those thinking of ES as produced by ecosystems would implicitly assume the existence of ecosystems that are external to human beings, whereas those thinking of ES as being produced by people would emphasize the socially constructed part of nature.

These different understandings can lead to very different management and policy devices. In other words, the social construction of the concept has an influence on the society's concrete actions on nature. To illustrate this, we suggest to look at how different schools of thought in economics can lead to different policy responses to, for example, the negative impact of agriculture on biodiversity in a given area. Aznar and Pierret-Cornet (2003) identify three main schools in economics concerning the notion of ES: ecological economics, environmental economics, and the economics of services. In the first vision, ecological economics, where the term ecosystem services is used most of the time, services are provided by ecosystems, people are essentially degraders or users of these services; authors in this field look at the contribution of ecosystems to the uses and benefits that societies make of them and the value that they produce (Costanza et al., 1998; de Groot et al., 2002). Following this vision, a response to degraded ES would be the prohibition of agricultural activities within a protected area that provides some services of particularly high value. Conversely, in the environmental economics vision, where environmental services is the dominant term, services are considered as positive

externalities of productive human activities, like agricultural production (Abler, 2004). People, and especially farmers, are perceived as unintentional contributors to the production of environmental services. At a normative level, the objective is to internalize these externalities, i.e. to reward farmers to give them an incentive to produce these services (for instance, through payments for environmental services) (Engel et al., 2008; Pagiola, 2007; Wunder, 2005). Since the service is an externality of a production activity, the farmers are incentivized to change this production activity, they are not incentivized to change ecosystems directly and intentionally. Following this second vision, a policy response to biodiversity degradation could be a program of subsidies to incentivize farmers to cultivate crops or associations of crops that have positive effects on local biodiversity (to incentivize them to provide the service indirectly and unintentionally). Finally, in the economics of services vision, ES are conceptualized from the perspective of intentional services: people still produce the services, but this time it is intentional. There is a contractual service relationship between a supplier and a user of a service through a supporting good, which is the ecosystem (Aznar and Perrier-Cornet, 2003). Following this vision, a response could be a program of subsidies in which farmers receive payment in exchange for planting strips of mixed flowers that attract pollinators (since the strips are not productive, this is not an externality of production; the farmers provide a service directly and intentionally).

Human geographers have a role to play in elucidating such linkages between the social construction of the ES concept and the resulting concrete management policies. The work of the geographers McAfee and Shapiro (2010) is meaningful in this respect. They suggest that different assumptions regarding human–nature relationships lead to different stances regarding payments for ecosystem services, and they analyze the confrontation of these different stances in the implementation of the national program of Payments for Ecosystem Services (PES) in

Mexico. The initial program reflected the World Bank's vision of a “de-socialized” notion of nature, prioritizing conservation over social goals, but, because of the involvement of federal agencies and rural activists, the program came to reflect a paradigm in which environmental services are coproduced by nature and communities, and this shifted the program's emphasis toward poverty alleviation (McAfee and Shapiro, 2010).

3.2. The concept of ecosystem service: integrated or dis-embedded perception of human–nature interactions?

Another controversy implicitly underlying the ES literature is whether or not this concept offers an integrated perception of ecological and social dynamics. We argue here that it is mainly a matter of perspective. To natural scientists whose main initial domain of expertise is the functioning of ecosystems, integrating the idea that ecosystems provide benefits to people is certainly a way to put social dynamics back into the picture. However, the very definition of the concept, i.e. “*benefits supplied to human societies by natural ecosystems*”, originates from a principle of separation between natural ecosystems on one side and human societies on the other side, or, to use Descola's words, a principle of separation between nature and culture (Descola, 2005).

This controversy echoes indeed old epistemic, philosophical, and ethical issues about the place of humankind in the planetary ecosystem (Descola, 2005; Morin and Kern, 1993; Passet, 1979; Serres, 1990). The philosopher and anthropologist Descola has shown that only modern Western societies have a naturalist and segregationist vision based on the idea of nature existing independently of humankind (Descola, 2005). Most other societies (in particular animist and totemist societies) have a more integrated vision, based on the idea that humankind is part of

nature, that there is no distinction between nature and society, establishing a continuum between human and non-human life, by attributing for example human characteristics to elements of the non-human world.

It should be recalled here that the idea of ecosystem services was introduced by the scientific community, predominantly from the West. It was admittedly rapidly adopted by certain non-scientific actors, for example some managers of protected areas who use it to justify conservation funding (Boisvert and Vivien, 2010; Daily and Ellison, 2002), but several authors now query whether this notion of service matches local people's perceptions of human–nature relationships (e.g. Raymond et al., 2013; Sullivan, 2009). Sullivan (2009) argues that the concept of ES cannot match with the way many communities in Southern countries, especially animist communities, conceive and construct their relation with the non-human world. She notes, for example, that in many of them, nature – the non-human world – has a sacred character: is it then acceptable for these populations that nature is seen as a supplier of services for society, with the idea of subjugation (nature at the service of society) that this can imply?

Taking this one step further, authors such as Hansson and Wackernagel (1999) query whether the main cause for environmental degradation may be found in this conception of a separation between nature and society. They argue that this segregationist conception of human–nature relationships has generated a process of dis-embedding: modern societies have become dis-embedded from the context of local ecosystems, resulting in diminishing knowledge of, and attention to, ecosystems. In other words, people have forgotten that their survival depends on ecosystems that have limited and non-substitutable resources and this has led modern societies to the current environmental crisis. According to these authors, work on economic evaluation of ES is not the solution to the problem as it is just a step further in the dis-embedding process.

As they put it, the scientific community might be making the mistake that Einstein warned us not to make, namely, that of trying to solve a problem with the thinking that created it (Hansson and Wackernagel, 1999).

In the same vein, the philosophers C. and R. Larrère (1997) suggest that technical development may have led to the belief in an almighty human power in the management of human–nature relationships, but contemporary challenges demand that we go beyond both the vision of nature as needing to be protected from humankind and the belief in societies' capacity to control the nature. They defend a position which they call a-modern, characterized by the prudence of a humanity discovering, through scientific progress, the limits of its knowledge and of its control.

4. The value of ecosystem services: intrinsic, objective, or negotiated value?

The third aspect of the work on ecosystem services that raises many – and probably most – controversies relates to the economic valuation of these services. A parallel can be made with the example cited by Latour (1987) of a team of computer scientists who develop a new kind of computer. According to him, in the domain of "ready-made science" (stabilized knowledge, no more controversies), the scientists would seek to develop the most efficient machine, whereas in the domain of "science in the making" they have to first agree upon how to define efficiency. Concerning ES valuation, if we were in a domain of stabilized knowledge, we would simply value the services in order to decide which one should be preserved in priority, but things are actually more complicated because we need to decide first on which criteria we should make such valuations. Moreover, Latour suggests that in the "science in the making", the content of the produced knowledge is closely intertwined with the context of knowledge production. This is particularly relevant in the case of ES valuation : decision makers creating new regulation tools based on ES need values and urge scientists to provide them with numbers,

even though valuations are still controversial, and this in turn contributes to reinforcing the controversies.

Our objective in this section is not to make a detailed review of these often technical controversies among economists. Such a review can be found in the paper of Dempsey and Robertson (2012). Instead, we argue that many of the controversies around valuation, and not only among economists, originate in different conceptions of the very notion of value and of the idea of valuing nature.

In our analysis of the literature on ES, we found marked differences between three large bodies of research: (i) research on the analysis of the biophysical dynamics of ES, (ii) research on the economic evaluation of ES, and (iii) research on remuneration mechanisms for environmental services such as PES.

The first body attempts to understand and quantify the ecosystem services, and the underlying biophysical and ecological mechanisms (Chapin et al., 2000; Diaz et al., 2007; Gordon et al., 2010; Zhang et al., 2007). Among these researchers (but not only), there are people who believe that the intrinsic value of nature cannot be assessed by humans: ecosystems have the right to exist irrespective of people's desires or of the value that people attribute to them (Norgaard and Bode, 1998). For example, if one asks people which they value most, the white bear or invisible and unknown bacteria, they will probably value the white bear more highly than the bacteria. And yet, the bacteria might be of very high importance for the functioning of ecosystems and for the benefit of society, but people do not know that. As early as 1991, Ehrlich and Wilson (1991) warned against these potential pitfalls of economic valuation of biodiversity.

The second body of literature develops and applies methods for economic valuation of ES. These valuation methods are generally based on the importance people attach to these services (preference-based methods) or on the cost required to restore, or substitute for, the service being evaluated (Costanza et al., 1997; de Groot et al., 2002; Patterson and Coelho, 2009). For the authors belonging to this body of literature, attributing a value to ES is both unavoidable and necessary. It is unavoidable because the notion of service is by its nature anthropocentric: if a service is rendered, there is always someone somewhere who attaches a value to it (Perrings, 2005). It is also necessary if the environment is to be preserved: the objective of ES economic evaluation is to raise decision makers' awareness of the importance of these services so that the costs associated with their loss can be taken into account in the decision-making process (Costanza, 2006; McAfee, 1999; Westman, 1977). For example, when planning a new railway route, decision makers could take into account the costs associated with the destruction of a given ecosystem for society and might decide to change the railway route to preserve that ecosystem³.

Finally, the third main body of literature on ES, i.e. work on remuneration mechanisms for environmental services, consists of analyzing or developing financial incentives to prevent resource users from degrading ecosystems that are providing services, or to encourage them to adopt practices that produce services. Mechanisms of the PES type are paramount in this area (Karsenty, 2004; Pagiola, 2007; Wunder, 2005). Although the authors working, respectively, on ES economic evaluation and PES mechanisms agree on the importance of assessing the human-based value of ecosystem services, they do not base their conception of value on the same idea. Whereas the former try to establish an objective value for each service identified in

³A recent study has shown however that the literature rarely reports cases where decision makers actually made use of economic valuation of ecosystem services (Laurans et al., 2013).

the main ecosystems – for example, the total value of the world's coastal ecosystems services was estimated to be 4,062 US \$ per hectare and per year in 1997 (Costanza et al., 1997) – the opposite is true for PES, which rely on the idea of a value that is negotiated on a case-by-case basis between the beneficiaries and the suppliers of a given ecosystem service (Wunder, 2005).

This objective value *versus* negotiated value duality resonates with the recent work of the geographer Robertson (2013) working on the wetland banking credits in the United States. He suggests returning to value theory and old academic debates over value in political economy to understand the controversies among U.S. state actors in their attempt to define values for wetland ecosystem services. His central finding is a cyclical tendency for conflicts to arise over whether to define value as something either inherent (e.g. to a physical process) or essentially relative.

Both types of value raise specific questions. The objective or inherent value raises, for example, the question of the homogeneity and transferability of the values (Is the value of a service in A valid in B? Is the value obtained for 1 ha valid for 100 ha?). On the other hand, in the case of a value that is negotiated on a case-by-case basis, the level of conservation induced by the remuneration mechanism is not necessarily optimal either. Even though all the different viewpoints are theoretically taken into account in the negotiation, in fact some of them tend to be left out. The environmental viewpoint, for instance, is never directly represented: some talk about “dumb nature” (Billaud, 1996), others about “absent actors” (Sébastien and Brodhag, 2004). Two cases can actually be distinguished: the case in which the beneficiaries of ES are well identified and localized (for example downstream population affected by land-use changes in the upper catchment of a river), and the case in which the

beneficiaries are diffuse and global (for example the whole of humanity is potentially affected by climate change). Negotiating the value of the ES is obviously more difficult in the second case.

Controversies about ES economic valuation tend to be heated because they involve profound differences about the intrinsic values and motivations of people towards the environment. The word *value* is used here to mean something that gives sense to, guides, and justifies one's actions. Some work on environmental ethics has shown that long-term preservation of the environment may result from egoistic (preserve nature for oneself), altruistic (preserve nature for others) or bio-centered (preserve nature for itself) values and motivations (Stern and Dietz, 1994). Besides, in her work in social psychology, Kergreis (2009) describes how consensual collective values (in particular environmental protection) clash with a number of individual values (e.g. fulfillment, autonomy, conformism, safety). The issue of ES maintenance relates therefore to fundamental societal choices and to the balance between individual and collective choices. We address this point in the following section.

5. Who benefits from ecosystem services? Complex power plays and scale issues

Researchers in natural or biotechnical sciences (ecology, agronomy) tend to see the concept of ES as a means of describing the properties or the functioning of an ecosystem and disconnect these dynamics from their social context. Now, behind every ecosystem service there are individuals and groups of individuals, be they beneficiaries of services or actors contributing to the production, degradation, or protection of these services. Natural scientists are not the only ones who overlook this social complexity. Some critical geographers claim that advocates and designers of PES programs also tend to “de-socialize” ecosystems and should better contend

with social institutions at various scales, from the local landholders, who have their formal and informal organizations, to the state with its various agendas (McAfee and Shapiro, 2010; McCarthy, 2005).

Whereas in the previous sections of the paper, we focused on controversies among scientists who have different perceptions and interests regarding ES, we extend here our constructivist perspective to non-scientists' arenas, by looking at the diversity of stakeholders' perceptions, interests, and practices regarding ES, and the complexity of the social dynamics that underpin ES management. We choose to stress in particular the social interdependences underlying ES dynamics because being aware of being interdependent is considered as a necessary step towards coordinated action (Leeuwis, 2004). Used to highlight social interdependencies among people, the ES concept could then foster collaborative management.

We distinguish between three main types of social interactions associated with ES: (i) among beneficiaries of services, (ii) between beneficiaries and providers of services, and (iii) among providers of services.

5.1 Interactions among beneficiaries of ecosystem services

The methods for economic valuation of ES generally aim to determine the value of different services in the eyes of society as a whole, without seeking to analyze the preferences of different actors or groups of actors. Now, depending on their interests and the organizational level at which they intervene, different people accord different importance to different services (Hein et al., 2006). Furthermore, not all of the ecosystem services can be supplied at the same time. One local practice or environmental policy may lead to the supply of one service to the detriment of another : this is known as trade-offs among ecosystem services (Rodríguez et al.,

2006). Consequently, it is essential to clearly understand which services are important in the eyes of which actors, and why. Trade-offs among ecosystem services should be seen as the site of social trade-offs or compromises among people, thus becoming the subject of explicit social choices.

Hein (2006) emphasizes that different actors will have different interests concerning the services depending on the scale on which they operate, taking as an example the services supplied by a marsh zone in the Netherlands. In this case study, he shows that municipal actors greatly value the provisioning services, the fish, and the reeds, which generate their main income, as well as recreational services (swimming, recreational fishing), but they have little interest in biodiversity conservation. At national level, the opposite is true: actors have little interest in provisioning services but value regulation services highly, and NGOs are very active in protecting this area. Therefore, depending on the level at which one governs and at which decisions are made, the policies implemented will prioritize different services. For many ecosystem services (e.g. climate regulation, scenic beauty), beneficiaries are diffuse and global. This raises the question of how to articulate local and global interests. While researchers and practitioners in the fields of natural resource management and conservation have traditionally operated at a local scale, the ES concept is challenging them to search for methods and solutions across a wider range of spatiotemporal scales and institutional levels (Du Toit, 2010; Nelson et al., 2009).

5.2. Interactions between providers and beneficiaries of services

The concept of ecosystem services also highlights interdependences between providers and beneficiaries of services. These are precisely the kinds of social interdependences on which payments for environmental services schemes draw: providers are paid by the beneficiaries of

the services. But here again, scales matter. The nature of the social interactions between providers and beneficiaries depends largely on the scale on which the ecosystem services dynamics take place, and whether beneficiaries are local or global. Another way to address this question is to distinguish ES according to their rivalry (a rival service means that if someone uses this service, there will be less for someone else) and their excludability (an excludable service means that someone can keep someone else from using it) (Fisher et al., 2009). ES can have the properties of private goods (rival and excludable, like timber), club goods (non-rival but excludable, like scenic beauty in a national park), common-pool resources (rival, but non-excludable, like pollination or common pastures), or public goods (non-rival and non-excludable, like climate regulation or pest regulation). These different kinds of services imply different kinds of interactions between providers and beneficiaries, and raise different governance challenges. Many regulation and cultural ES fall into the public and common good categories, and so far, their regulation has been mostly mediated either by public action (for example through policies that use public money to encourage farmers to change their practices), or by market-based instruments (such as carbon markets or wetland bankings). In line with the work of Elinor Ostrom who has shown that in the field of common-pool resources management, collective action can be a valuable alternative to market and state-based regulations (Ostrom, 1990), some scholars are exploring the potential of collective action (Stallman, 2011) or hybrid regimes of governance (Muradian and Rival, 2012) for the management of ES.

A key question about interactions between providers and beneficiaries of services is whether both sides are aware of being interdependent. The ES concept has the potential to increase such awareness and therefore to open the way for negotiated agreements or collective action. For example, payments for environmental services schemes between upstream and downstream populations can be seen as win-win negotiated agreements (upstream populations are compensated for adopting practices that preserve ecosystems, and downstream populations get

the benefits in terms of non-polluted water). Another example is the collaborations between bee-keepers and farmers: bee-keepers provide breeding and resting habitat to honeybees, and therefore contribute to provide a pollination service that benefit to farmers, but the quality of the honey produced by their bees depend of the foraging habitats provided by the farming crops (Stallman, 2011). Arrangements between them are therefore commonly observed. In these two cases, beneficiaries and providers of ES take advantage of their interdependence to achieve collective benefits. However, an increase in awareness of interdependence can also have negative impacts. Karsenty (2010) has pointed out, for example, an undesirable effect of carbon markets that attempt to prevent deforestation, a sort of ecological blackmail in which some actors may say "If you don't pay me, I will destroy my forest". This illustrates that the potential of ES to reveal interdependences among people has social consequences (both positive and negative) that need to be studied.

5.3. Interactions among providers of ecosystem services

Providers of services are often overlooked in work on ES. They are even absent from the famous framework proposed by the Millennium Ecosystem Assessment: there are services that are provided by ecosystems, there are people who benefit from these services, but there is no mention of people who provide services through the impacts of their actions on the ecosystems. And yet, many ES are provided by ecosystems only if there are people who modify or maintain these ecosystems through their practices. As seen in section 3, this corresponds to a major controversy about the concept of ES. Rounsevell et al. (2010) have proposed a framework for ecosystem service provision that better describes how service providers are included in the system. Going one step further, we suggest looking at social interactions among providers of ES. Many ES are provided on the landscape scale, and their supply requires that farms be

managed in a coordinated way across landscapes rather than as independent units (Goldman et al., 2007; Stallman, 2011). Several studies have shown, for example, that the structure and the composition of the landscape (e.g. land-use, hedgerows) have an impact on the dynamics of populations of pest insects, since ecological habitats are more or less favorable to pest insects and their natural enemies (Bianchi et al., 2006; Landis et al., 2000; Vialatte et al., 2007). And yet, pest control is usually dealt with by farmers individually on the field scale. Integrating the landscape scale dynamics opens the way to exploring innovative modes of biological control of crop pests through concerted management of agricultural landscapes among stakeholders such as farmers, landowners, and foresters. More generally, when the provision of ES requires the coordination of diverse stakeholders, it is necessary to ask the following questions. Is it in their interest to coordinate their actions with the other stakeholders? Under what conditions could collective action be interesting and possible? These questions actually echo the controversies around the policy tools derived from the ES concept, which we develop in the next section.

6. Including the concept of ES in policy: are metrics and incentives necessarily monetized?

The political ecologists and critical geographers who adopt a constructivist perspective have long claimed that our understandings and concepts of nature have consequences that "lead us into much more than debates over meaning; they take us into a complex terrain of power and politics" (Braun and Wainwright, 2001). Several papers in the recent critical geography literature have analyzed various PES programs and pointed out that, although PES are commonly considered a paradigmatically neoliberal market-based conservation mechanism, most of these programs actually do not strictly follow the pure neoliberal vision (Dempsey and Robertson, 2012; Fletcher and Breitling, 2012; Matulis, 2013; McElwee, 2012; Shapiro-Garza, 2013). Beyond that, there are controversies around the very use of monetized and market-based

mechanisms to deal with conservation matters (Maris, 2014). One can argue that this is not specific to ecosystem services – some environmental market-based mechanisms existed before the launch of the concept of ES into policies. However, ecosystem services are nowadays commonly associated with the idea of payments for environmental services, and more generally with a neoliberal vision of conservation. This statement raises three controversial issues, which we address in this section.

The first issue concerns the methods of valuation of ES and in particular the choice of measurement unit: why stick to only one (economic and monetized) indicator? Although there are admittedly some scientists using non-monetary valuations (e.g. Luck et al., 2009), economic valuations of ES are currently predominantly based on monetary measurement units. Some consider that these financial and economic arguments are in the present world a necessary stage for environmental concerns to be taken into account by decision makers (Balmford et al., 2002). However, retaining only one measurement unit (the monetary one or another one) may result in a simplistic vision of the human–nature relationships under consideration. Some authors argue that a valuation system based on a diversity of criteria and measurement units would be better able to convey the diversity of stakeholders’ perspectives on these relationships (Haines-Young, 2011; Koschke et al., 2012).

The second issue concerns the incentive mechanisms for preserving or producing ecosystem services. A critical stream of literature has emerged, pointing out the limits and the side-effects of the existing PES programs. Many authors question, for example, their fairness, given that the poorest actors have limited access to these payments (Börner et al., 2010; Grieg-Gran et al., 2005). North–South relationships induced by these types of mechanisms also raise issues. Many of them link, directly or indirectly, communities from Southern countries who produce

environmental services to Northern countries who benefit from these services. Perceived by some as a potential source of income for the South (Karsenty, 2004), this process is seen by others as a new form of Northern interference in the South (Boisvert and Vivien, 2010). Over and above these questions, a range of authors are critical of the very idea of commodification of nature (Maris, 2014; McAfee, 1999; McCauley, 2006; Norgaard and Bode, 1998). Even Robert Costanza and his colleagues, key promoters of ES economic valuations, recently published a paper in which they emphasize that valuation should not be associated with commodification, and that since many ES are considered common-pool resources or public goods, market-based instruments might not be the most appropriate ones to manage them (Costanza et al., 2014). Finally, ranging from market-based to subsidies mechanisms, most, if not all, incentives to preserve ecosystem services are monetized. Several terms are used (payments, rewards, compensations, markets), but all of them imply a monetized remuneration. Is this unavoidable? Sullivan (2009) points out the associated risks of losing cultural diversity and homogenizing human-nature relationships: “We are critically impoverished as human beings if the best we can come up with is money as a mediator of our relationships with the non-human world” (p.26).

The third question we want to raise here is whether this predominance of monetary and market-based tools is inherent in the concept of ecosystem service or whether it is simply related to how the concept is used. Yet again, opinions diverge. Some argue that the concept did not originally have a monetary or market connotation but was appropriated by economic actors. Others consider instead that the word service, in today’s world, unavoidably echoes a market relationship, which is then inherent in the concept of ecosystem service. This debate is related to the idea that the scientific concepts about nature have consistently reflected the dominant metaphors and the language of the societies in which they were formed (Botkin, 1990; Robbins, 2004). For example, because it emerged during the high industrial age, the science of ecology

depends strongly on metaphors and concepts from mechanical engineering (with cyclical processes, balance, and symmetry). Following this idea, our society would have come up with the notion of ecosystem services because we are in a market-oriented society and this is the kind of language available to us at the present time. The promotion of alternative natural resource management and conservation mechanisms that would not be monetized or market-based would then imply exploring alternative concepts. For example, the term *ecological solidarity* (Mathevet et al., 2010) is a concept that refers to the same idea of human dependence on ecosystems, but without the economic connotation of the word service.

7. Conclusion

We have shown in this paper that, beneath its apparent robustness, the concept of ecosystem services is beset with uncertainties and controversies at several levels: the very conceptualization of the concept, the material processes to which it refers, their economic valuation, the social systems in which they are embedded, as well as the policy tools derived from the concept. At all these levels, we have seen that the concept and the associated knowledge are far from stabilized, and that it is in the middle of these controversies that the idea of ecosystem services is currently being socially constructed. We have shown that this construction process is not straightforward : different people promote and use this concept with very different representations in mind, and its detractors have other perceptions that are not monotypic either. This social construction process looks like a mix of battles of intimate representations of the human–nature relationships and conflicts of economic and political interests, not only between different scientific communities with different backgrounds and perceptions, but also among them and various stakeholders, from local farmers to national decision makers and international agencies. The concept of ecosystem services should thus not

be taken for granted, and be used cautiously, with an awareness of the diversity of values that underlie it and the controversies that it raises.

We believe that human geography has a role to play in the work on ES by acknowledging, analyzing, and eventually even benefitting from these uncertainties. Controversies might be indeed an opportunity to increase dialogue and mutual understanding among people and disciplines whose relationships are often based on mutual ignorance and prejudices. To achieve this, human geography needs to reconcile itself with ecological studies and to better assume its social engagement. We have identified three main avenues of research for such a geography, namely to question, to understand, and to accompany.

First, in line with this paper, we propose *questioning* the values underlying the concept of ecosystem services. Going one step further than this paper, there is a need for critical geographers and political ecologists to raise the question of who benefits from the promotion and use of the ES concept. In the above-mentioned battles of representations and conflicting interests, who are the winners and who are the losers? What are the consequences? As Dempsey and Robertson (2012) suggest, a yet-to-be written critical genealogy of the ES concept would join geographic work on the issue of power regarding other nature-related concepts.

Second, social geography has a role to play *in understanding* the complexity of social interplays underlying the evolution of ecosystem services (degradation, restoration, or provision of services) as well as their management. We have seen in this paper that critical geographers are starting to raise their voice to analyze the social complexity of various programs of payments for environmental services (Fletcher and Breitling, 2012; Matulis, 2013; McAfee and Shapiro, 2010; Robertson, 2004; Shapiro-Garza, 2013; Wynne-Jones, 2012). More broadly, there is scope for human geographers to engage in research on ecosystem services that includes:

analyzing the diversity of representations that actors have of their environment and of their relationships with the environment, which cannot be understood in all their complexity using the concept of ES alone; analyzing what services (or another term better fitted to local people's representations) are important to what actors, on which scale, and why; analyzing the complexity of social interactions, power plays, and scale issues among providers and beneficiaries of ES.

Third, social geographers should get involved and *accompany* local stakeholders in collective learning processes to allow them to acknowledge and deal themselves with the uncertainties underlying the ES concept. Funtowicz and Ravetz (1994) argue that, in contexts where scientific uncertainties and social controversies are relatively limited, the classic expert-based research posture is appropriate: scientists play the role of experts producing knowledge intended to enlighten decision makers. On the other hand, in situations with strong scientific uncertainties and social controversies - as is the case for ES-, scientists must leave their ivory tower, recognize that the knowledge they produce is both biased and uncertain, and engage in a dialogue with decision makers and citizens. This is a way to answer Sullivan's call to produce more emancipatory knowledge and to overcome the swing between a post-structuralist demolition of the validity of Western natural science and a positivist confidence in the fact that science can accurately reveal what is really happening (Sullivan, 2000). Social geography, which has a tradition of social engagement, is well positioned to undertake such participatory and emancipatory research (Pain, 2003, 2004). The objectives of such participatory processes would be to allow, for a given region or within the context of a given policy, the different actors who are involved (including researchers) to meet and confront their viewpoints; to encourage debates about the very notion of ecosystem service (with the possibility that the actors may reject its use); to identify collectively which ES (or another notion) are important to which

stakeholders, and why; to confront the different types of knowledge (empirical and scientific in particular) regarding the ecological processes; to explore different scenarios of management of ES and their impacts on different categories of actors; and to encourage discussions about trade-offs and synergies among services so that these trade-offs can be the site of explicit negotiations among actors, without overlooking the strong power plays and conflicts of interest associated with these trade-offs. We suggest to stress in particular the social interdependences underlying ES dynamics. The ES concept has indeed the potential to highlight interdependences among people who were previously unaware of being interdependent, which is considered to be a necessary step towards collective learning and coordinated action. Such an approach would lead to considering modalities of action for the management of ES that are no longer based only on the market or on state intervention, as is the case today, but also on local capacities and collective action.

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