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Institutional Economics of Agricultural Soil Ecosystem Services

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Abstract: Who owns the soils? What seems to be a straightforward legal issue actually opens up a debate about the ecosystem services that can be derived from soils and the distribution of benefits and responsibilities for sustaining functioning and healthy soils. In particular, agricultural land use may be constrained by a lack of properly defined property rights. Using the new institutional economics perspective, we show that multifunctionality of soils and an attribute-based property rights perspective substantiate the intuition that land property implies special obligations towards the common good. The concept of ecosystem services can illustrate the variety of beneficiaries of multifaceted soil ecosystem services. This allows identification of reasons for unsustainable soil management that result from imperfections in the definition of property rights. We suggest implications for improved governance of agricultural soils using two case studies in the EU context: the EU Common Agricultural Policy and the use of planning instruments to steer agricultural soil use in Germany. Thus, we contribute to achieving the societal goals of more sustainable land use by detecting causes of shortcomings in current land regulation and by suggesting governance approaches to support a more sustainable management of agricultural soils.

Keywords: ecosystem services; governance; institutions; land; property rights; soils; sustainability

1. Introduction

Soil, or, more generally, the pedosphere, is an essential element of most ecosystems. Without it, terrestrial life is virtually impossible. Anthropogenic land use change has progressively challenged the availability of healthy soils that provide the ecosystem services necessary to sustain human life. Accordingly, recent research, policy documents, and initiatives have emphasised the importance of well-functioning soils: the International Year of Soils 2015, the EU Soil Thematic Strategy (STS), and the Global Soil Partnership (GSP) are just a few examples. At the same time, soil degradation remains a global challenge [1–3]; effective governance structures for sustainable soil management are lacking [4]; and in the EU, the plans to adopt a Soil Framework Directive have failed [5]. Soils are a highly heterogeneous, essentially nonrenewable resource. If they are lost (e.g., due to erosion processes), their regeneration takes decades to centuries—thus, from the perspective of most societal actors, their loss is irreversible.

Historically, land and soils have mostly been treated as private property [6]. Since private property is highly protected in modern democracies, this may constitute a challenge for sustainability—if soil management generates externalities, their internalisation implies that property rights must be infringed to some extent. This is true for both spatial and intertemporal externalities. However, the status of land and soils as private property need not imply that they actually are rightly considered so [6,7]. For instance, it may simply be the result of the (prohibitive) transaction costs that would arise under a more nuanced property rights allocation [8].

In recent years the concept of ecosystem services has gained increasing interest [9]. It has also been related to soils via definition of soil ecosystem services [10–12]. The idea behind this perspective is to point at the diverse ways through which soils contribute to human well-being and to highlight the necessity of soil protection. Furthermore, the ecosystem service perspective can help identify and distinguish stakeholders, beneficiaries, and providers in the context of soil management. The fact that soils provide bundles of ecosystem services is useful in order to connect these considerations with design options of governance and institutions that seek to define an adequate framework to properly regulate soils.

The aim of the present paper is to suggest an answer to the question "who owns soils?" in order to discuss what this means in terms of governance. We use an institutional economics perspective and show that soils are multifunctional, and as such require a nuanced analysis of property rights. Here, the concept of ecosystem services is helpful for illustrating different beneficiaries of soil functions, which are the precondition for the provision of soil ecosystem services. Specifically, we build upon the application of Lancaster's attribute-based consumer theory [13] in property rights economics to (i) identify reasons for unsustainable soil management that result from imperfections in the definition of property rights and (ii) derive implications for an improved governance of agricultural soils. Our overall perspective in this paper is derived from New Institutional Economics (NIE), where the definition of property rights regimes is taken as a starting point for developing institutional rules and governance structures for soil management. Recently, the interrelation of the environment and economic transactions has received attention in NIE [14,15]; we build upon these insights and apply them to soil ecosystem services.

First, however, we will discuss some definitional issues, reviewing and refining existing approaches that framed the contribution of soils to human well-being in terms of the ecosystem service concept (Section 2). In the next step, we then turn to property rights issues that arise when soils are viewed through the lens of ecosystem services (Section 3). In Section 4, we derive from this discussion implications for the sustainable governance of agricultural soils, using two case studies in the EU context: the EU Common Agricultural Policy and the use of planning instruments to steer agricultural soil use in Germany. Section 5 offers a brief conclusion.

The analysis developed in Sections 2 and 3 is fairly general and should be applicable to most political and cultural contexts. The case studies in Section 4 are context-specific, but their results should be informative also for most developed country contexts.

2. Soils and Ecosystem Services

The application of the ecosystem service concept to soils has gained some prominence in recent years [8–10,12,13,16]. As already mentioned in the introduction, the ecosystem service concept is helpful in analysing the societal relevance of soils because of its emphasis on multifunctionality [17]—soils are not just supporting one function like agricultural production, nor are they relevant only because of the huge biodiversity they contain. Rather, they provide and support a bundle of ecosystem services or (an older but related concept) soil functions that provide benefits for human well-being.

One difficulty pertaining to the relationship of soils and ecosystem services is that virtually all terrestrial ecosystem services depend on well-functioning soils. What, then, are soil ecosystem services? In their influential classification, Dominati et al. [11] propose a long list of "ecosystem services from soil natural capital", which range from spirituality and knowledge through flood mitigation and carbon storage to provision of food and fibre. This is a rather imprecise classification, as some ecosystem services mentioned are directly provided by soils (e.g., carbon storage, water filtration, or the archive function), while for others soil is a basis but the actual "ecosystem-service-providing units" (SPUs) [18] are arguably different. For instance, while soils are essential for agricultural production, it is the vegetation above or below the ground that should count as the SPU. Of course, it can be argued that some vegetation-provided ecosystem services are determined by soils to a relatively larger extent (e.g., food production) than others (e.g., microclimate regulation). Nonetheless, there is a difference between *soil-provided ecosystem services*, where soil clearly is the SPU, and *soil-related ecosystem services*, whose provision depends heavily on soil but where soil is not the (only or main) SPU (an apparently related distinction between soil-provided and land-provided ecosystem services was made—but not elaborated upon—by Schwilch et al. [12]). Soil-related ecosystem services are effectively those services that are dependent on *supporting services* [19] provided by soil. For instance, crop production is dependent on the soil-provided supporting service of soil fertility; soil fertility itself, however, cannot be consumed or appropriated in any direct way and is thus not a *final* soil-provided ecosystem service [20]. While we are fully aware that the distinction between soil-provided and soil-related ecosystem services is challenging in practice, this distinction might help to better understand the relationships between soils and ecosystem services. Furthermore, an additional complication enters if we include *soil functions* [21] in the discussion, as they are the prerequisites for both soil-provided and soil-related ecosystem services. In the following, we focus on soil ecosystem services, which we use as a generic term encompassing both soil-provided and soil-related ecosystem services, and refer to this distinction explicitly only when it is relevant. On the relationship between the concepts of soil ecosystem services and soil functions, see Baveye et al. [16], Dominati et al. [11], and Adhikari and Hartemink [10]. Soil management influences both types of soil ecosystem services via its influence on soil functions [22].

With respect to management and governance, a further specification of soils might be helpful. According to Dominati et al. [11], who analysed soils as stocks with a focus on their sustainable capacity, soils have different types of characteristics. Some of them can be influenced by human activities, while others cannot. For example, landscape slope, soil depth, cation exchange capacity, and clay types can hardly be influenced by humans and are thus "soil-inherent", while soluble phosphate, mineral nitrogen, organic matter content, and others are shaped by human management practices and are thus called "soil-manageable properties". In an ecosystem service management concept, while acknowledging the character of soil-inherent properties, it is the manageable properties that deserve specific attention, as they provide entry points for farmers, agronomists, land managers, and other stakeholders to influence soils and their qualities and, thus, the ecosystem services that flow from soils [11]. In a similar vein, Vogel et al. [21] argue to focus on "functional soil characteristics", which are a result of internal soil processes and interactions (physical, chemical, and biological characteristics of soils) in response to soil management at a timescale of days to months. Contrarily, "inherent soil properties" represent rather stable soil formation characteristics (e.g., mineral composition, texture, layering, depth) which cannot be affected by soil management at a timescale of less than decades. Neither are observable "soil state variables", which are changing in minutes due to external forces (e.g., water content, temperature, redox potential) and are relevant for management because of their high natural fluctuation.

Soils are complex systems; from the point of view of society, they are highly multifunctional, providing different types of ecosystem services. The use of multifunctional systems usually involves trade-offs [17]; not all soil ecosystem services can be had at once. Each management approach will enhance the provision of some ecosystem services and negatively influence the provision of others; for instance, ploughing a field contributes to food production, but it undermines other soil ecosystem services, such as carbon storage or microbial biodiversity. On the other hand, no-till management leads to other problems (especially in terms of pest control). We still do not understand these relationships properly in the context of soils [21]. Yet, as soils are highly heterogeneous, with their heterogeneity not being easily observable, these relationships can be expected to be highly context-specific; their assessment needs to be spatially and temporally explicit, also for the purposes of governance [23]. This biophysical complexity is further aggravated by economic and social factors, including property rights. To this issue we turn now.

3. Soil Ecosystem Services and Property Rights

The questions "who owns the soil?", "who is responsible to manage the soils?", and "is public regulation of soils justified—and to what extent?" are questions that can be answered by applying a property rights approach. In the most general sense, property rights define the rights of particular actors to undertake actions towards clearly specified objects: "[t]he allocation of scarce resources in a society is the assignment of rights to *uses* of resources" [24]. The assignment of property rights and their enforcement by the state are a response to scarcity [8]. Note that not all types of property rights are/have to be enforced by the state. Common-pool resources are usually managed by the communities that use them—though it has been observed that the *recognition* of a common property regime by the state is supportive of the regime's success and sustainability [25].

Given the increasing scarcity of soils [26,27], the definition of property rights for soils appears highly important. Relevant actions related to land and soils are [28,29]

- access, i.e., the physical interaction with land/soils;
- withdrawal, i.e., enjoyment of the "fruits" provided by land/soils;
- management, i.e., modifying and regulating land/soils and their properties;
- exclusion, i.e., preventing others from access, withdrawal, and/or management;
- alienation, i.e., transferring the land to another person or entity (by selling or giving away).

The rights to these actions can be in the possession of a single person or entity, but it is also quite common that different persons or entities possess different rights towards an object. For instance, while the tenant may temporarily possess the exclusive right to cultivate a piece of land (access, withdrawal, and probably also management and exclusion), the landlord retains the right to sell the property in question (alienation). Property rights can be possessed by individuals, groups, or larger entities like the state (private, common, and public property rights). Also, some objects or resources are open access—no specific property rights are defined for them, usually because it is physically or politically difficult to do [25], i.e., due to high transaction costs.

Usually, property rights are understood as linked to specific (scarce) goods or assets or, more generally, objects, including land and soil [7]. However, as shown by Lancaster [13], people do not consume or demand objects, but rather their characteristics or attributes. In this sense, goods or assets are primarily bundles of valuable attributes—and for each of these attributes, (different) property rights can apply [8]. This perspective necessitates deviations from the Schlager/Ostrom [28] classification of "permitted interactions" resulting from property rights (see list of property rights actions above), as their focus was on physical resources, not on their attributes. Particularly, access and alienation can only be sensibly applied to physical objects or resources, while withdrawal (at least in the broad sense of enjoying the fruits of something), management, and exclusion are applicable also to attributes—at least if they are private goods. For collective-good attributes (e.g., soil biodiversity), exclusion from withdrawal is per definition impossible or at least prohibitively expensive.

All these considerations are summarised in Figure 1 below: while only land (and, to some extent, soil) can be accessed and alienated, exclusion is possible only from the enjoyment of private-good attributes such as soil fertility (this is linked to physical exclusion from "entering" land); exclusion is not applicable to collective goods (public goods and commons) by definition. Both private-good and collective-good attributes (e.g., biodiversity) can be enjoyed (derived utility from) and managed. From the perspective of the attribute-based property rights theory, Coasean [30] conflicts over resources can be viewed as resulting from undefined or poorly defined property rights or relationships between property rights and different attributes of a resource (Ronald Coase was one of the founders of new institutional economics; he argued that resource-use conflicts can be resolved through negotiation between the involved actors with the goal of assigning property rights). This is especially due to the fact that when it comes to natural resources such as soils, management is usually linked to the legal property title to the object (e.g., a piece of land); thus, while it is conceivable to manage *for* specific attributes, in practice, management is usually focused on only some of them—those that are in the interest of the managing actor. Other actors may enjoy other attributes, but it is difficult for them to influence the management: "[w]hile land may be parcelled out, many processes or 'services' linked to it cannot be easily demarcated" [31] (p. 171).

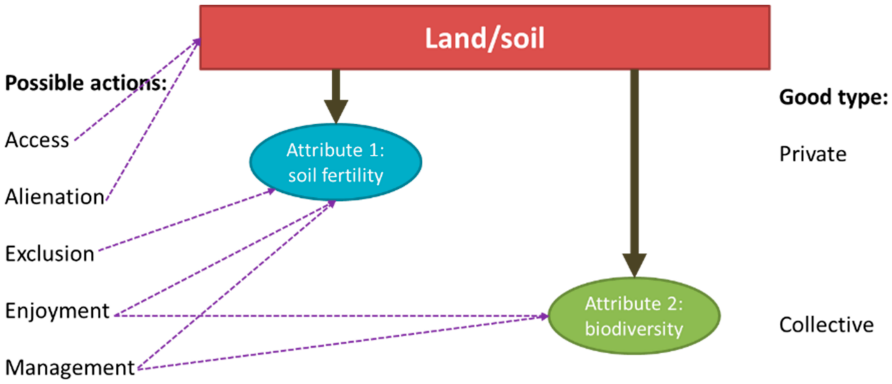

Figure 1. Conceptual framework of relationships between different types of attributes of land/soil and different actions that are influenced by property rights.

Furthermore, in this context the distinction of soil and real property for land is noteworthy [32]. Real property is a specific economic good that differs crucially from other economic goods. Physically speaking, real estate is a particular piece of land on the Earth's surface along with the things that are semipermanently attached to it, such as buildings, trees, and soil. In addition to the real estate itself, real property includes all the interests that are attached to the property, such as future use rights or tenancy rights. Real estate trade is strictly regulated all over the world. There is practically no other good whose property rights are so well defined and so strictly controlled, e.g., by zoning laws. On the other hand, at least for agricultural land, regulations are much less strict regarding other "transactions" [14], such as soil management. In Germany, for instance, there are no specific planning instruments for determining the use of agricultural land, while for nonagricultural land (e.g., urban areas), plans are quite specific and the regulator's discretionary power quite large [33] (see Section 4).

Even when considered as one resource or object, land (including soil as its main element) is special in terms of property rights [34]. As Bromley [6] argues in his historic essay, the perception of land has evolved from "general irrelevance" before the Neolithic Revolution, through "social ownership", "classical feudalism", and "centralized nation state", the latter generating (e.g., via enclosures) and protecting private property to land in a Lockean fashion (i.e., based on a contract theory between the state and private landowners), to today's growing recognition that land is, in a sense, public property and that private property rights to it imply social obligations. However, this is only limitedly reflected in the current property rights regime. In this sense, the abstract right to hold property should be distinguished from the reach of a specific property title, which cannot be viewed as absolute and inviolable [7]. In fact, the central German constitutional notion that private property implies social obligations (*Sozialpflichtigkeit des Eigentums*; Art. 14 Basic Law) is of particular relevance for land property. The Federal Constitutional Court on this [35]:

> Real estate is subject to special obligations with regard to its functional use in accordance with Article 14 (2) of the Basic Law. The inreproducibility of land prohibits its use completely being left to the free play of forces and the will of the individual [. . .]. The Constitution allows the legislature to promote the interests of the general public to a greater extent in matters of land management than in the case of other assets.

Multifunctionality of soils and the attribute-based perspective on property rights together help to substantiate this intuition.

At this point, the concept of ecosystem services can help in defining property rights. As was discussed above, soils are multifunctional complex systems—they contribute to the provision of multiple ecosystem services. As such, they cannot be sensibly viewed as one good implying one (type of) property right; rather, they are bundles of different properties/characteristics that generate different ecosystem services (attributes), implying different property rights and different potential property right holders. Thus, soil properties, soil functions, and the related ecosystem services determine the nature of *transactions* or activities related to their use and appropriation [14,15]; ideally, each of those should be considered separately.

This attribute-based perspective on property rights can help identify different property rights elements of soils. The above distinction in soil-provided ecosystem services and soil-related ecosystem services can help in defining different attributes of the good "soil". The focus on soil functions and soil ecosystem services can force decision-makers at various levels (agronomists, farmers, politicians who decide about land use, etc.) to explicitly take these attributes into account. This conceptual lens facilitates a focus going beyond selective soil functions and ecosystem services, instead focusing on the whole bundle of such services, including the often-neglected regulating and cultural services, but also the soil-manageable properties that influence their provision.

Of course, this is not always possible due to transaction costs—they are the main reason why only some soil ecosystem services are attributed legal property rights and, particularly, why these are usually reflected in property titles to land (or real estate, see above), which in the case of agricultural land do not distinguish between different attributes in the bundle. This property rights indeterminacy leads to land use conflicts and asymmetric focus in the management of soils on particular soil functions and ecosystem services, particularly biomass production. Most other ecosystem services related to soils exhibit public-good character and are thus underprovided under a private (Lockean) property rights regime. They can be considered externalities in need of internalisation.

In practical terms, the challenge is thus that usually property rights are defined with respect to land [6,7], which is actually a bundle of goods, the most important of which is soil—itself a bundle of properties, functions, and related ecosystem services. Furthermore, different ecosystem services and the different soil processes and components that are "responsible" for their provision are also different from a property rights perspective. Thus, of course, they are considered in different ways by the relevant actors. For instance, the "main" soil-related ecosystem service in agricultural landscapes—food—is obviously a private good. Soil biodiversity is on the other end of the spectrum, as it constitutes a public good with numerous positive externalities, such as gene pool or biodiversity's contribution to ecosystem functioning [36,37]. While it does provide benefits also to the property owner, e.g., as insurance [38] or a pool of options for future uses [36], its social value exceeds those benefits [39,40]. In between the two extremes there are numerous "grey cases" of soil ecosystem services that are only partly considered by those who manage soils directly (i.e., mostly farmers), at least partly constituting externalities. These externalities need not necessarily constitute public goods; in many cases, they can be private goods, but either the beneficiaries differ from those managing the soil (i.e., usually, the owners of land) or the (future) benefits are unknown or underappreciated by the beneficiaries–managers due to informational, cognitive, cultural, legal, economic, or other types of constraints [41].

This is additionally complicated by the fact that much agricultural land in developed countries is rented, so even the property rights to the whole bundle of attributes are not held by one person or entity, but are rather split among two or more persons and/or entities. However, they are split in a way that does not reflect the attribute-based nature of land- and soil-related property rights. It has been observed in both theoretical and empirical literature [42,43] that this creates disincentives to adopt a long-term perspective and to invest in those attributes that generate long-term *private* benefits. Therefore, even those ecosystem services that benefit soil managers—but do this only in the long term—are underinvested in and, thus, underprovided. The public benefits generated by these ecosystem services and others that are (approximately) pure public goods enter the calculus to an even lesser extent.

To sum up, we argue that the property rights for soils and their attributes (soil ecosystem services) are underdetermined due to (i) their being bundled together in bulk (private) property rights for land, and (ii) the public-good nature of many of them, which implies a lack of incentives for landholders to invest in them. The latter point is further aggravated by (iii) tenancy and the resulting disincentives for long-term investments even in private benefits. At the same time, discussions in the economic, political, and legal literature show that there are good reasons for the state to "infringe" private property rights in land to alleviate these problems [6,7,44]. In the following section, we derive from this implications for the governance of agricultural soils.

4. Governance Implications

Already some 20 years ago, the institutional economist Daniel Bromley argued that "[f]inally, we come to the contemporary setting in which property *rights* in land are giving way to the social *obligations* of property owners," which also implies the question as to "why those who own land should be granted special privileges as against those who hold other assets in their portfolio" [6] (p. 42). Today, in the face of an increasing severity of environmental crises, many of which can be linked to agriculture [45], societal demands for land management that is more oriented towards the common good (i.e., protecting biodiversity, securing ecosystem services) are increasing [46]. However, these interests and demands are currently not properly represented in the property rights regime in the context of agricultural land and soils. On the other hand, at least in the EU, where "agricultural exceptionalism" is still being practiced [47] and the state's influence on agriculture is large, there is (untapped) potential for improvement and alignment of agricultural practices with societal demands of sustainability.

In this broad context, a fully developed concept of soil ecosystem services could enlighten ways to identify societally important attributes of soils and the according definition of property rights. In what follows, we first discuss two general approaches to react to the imperfections of the current property rights regime. Second, we highlight the current deficits and suggest ways forward by using two case studies: (i) the EU's Common Agricultural Policy (CAP) and (ii) the differences between agricultural and nonagricultural areas in the German planning system. We chose these two case studies mainly based on our own expertise and because of the EU's pro-environmental rhetoric also in the agricultural policy context. In addition, Germany appears to be a particularly interesting case given the role of social obligations of land property as formulated in Article 14 of its Basic Law.

4.1. Two General Approaches for More Common-Good Oriented Soil Property Rights Allocation

As discussed above, land can be conceived of as a "nested" bundle of attributes: on the first level, soil is the main attribute of land, along with other attributes like remoteness, land cover, local climate, infrastructure, etc.; on the second level, soil provides or contributes to the provision of a bundle of ecosystem services with different good characteristics (private vs. collective goods) and resulting different ideal-type property rights. Due to high transaction costs, the best solution of a clear disentanglement of the various property rights and their translation into legal property titles (implying a Coasean solution) is unavailable. There appear to be two generic second-best options to align agricultural management of soils with societal demands directed at the ecosystem services that are thus influenced: (i) the "Georgist" solution of implicit collective ownership of unproductive land expressed in land taxation to capture land rents (after Henry George; similar ideas have been voiced by the German *Freiwirtschaft* movement); (ii) an amendment of the current system with strong incentives regarding those attributes that would be assigned extra property rights in an (unattainable) best solution.

The "Georgist" approach is originally rather justice-oriented: it is based on the assumption that land is inherently a collective good, but that its private cultivation and management promises its efficient use. From this perspective, ownership of (a piece of) land is to a large extent the result of a set of random events in the past. At the same time, since land is absolutely scarce and of different quality (due to differences in the values of its attributes), its sole ownership generates rents, i.e., profits derived by landlords simply by virtue of the fact that they own land. Thus, Henry George famously called for taxation of land rents [48]. However, while it is interesting in its own respect, the consequences of such an approach for land and soil management are unclear; its basic tenet is that the owner of land retains the right to those fruits that she generates through its management. Consequences for the other fruits (attributes) that are affected by this management are uncertain and likely not captured by the land rent tax. As such, the Georgist approach may address a question of justice and the intuition also discussed by Bromley (see above) that land is inherently social property, but it will not solve the problem of soil-related externalities and the related property rights as a standalone. This leads us to a politically more promising and much-discussed option of incentive-based instruments that would target those soil ecosystem services (attributes of the resource soil/land) that are not taken into account by landlords and farmers because of their focus on private-good attributes—this option can be used both in the current system and in combination with a Georgist land reform. In the following we discuss two specific variants of this approach: agri-environmental measures within the EU's Common Agricultural Policy and agricultural land use planning in the German context.

4.2. Case 1: Soil Ecosystem Services and the CAP

The Common Agricultural Policy of the EU in its historic and current form is largely incompatible with the notion of attribute-based property rights to multifunctional soils. Today, the largest share of CAP funds is distributed as area-based direct payments—i.e., indiscriminately on the basis of property rights to a piece of land. While reception of direct payments is linked to the fulfilment of some minimal ecological requirements (in the post-2013 CAP, cross-compliance and greening; in the current, 2018 reform proposal, conditionality and eco-schemes [49]), it has been shown that these requirements are largely toothless and do not have significant positive influence on the environment [50,51]. Direct payments are complemented by various instruments of the second pillar of the CAP, including agri-environmental and climate measures (AECM), but their overall environmental effects are limited [52]. With regard to soils specifically, the effects of European policies, including the CAP, have been found to be largely inconclusive [53]. Thus, currently, the large bulk of CAP payments benefits farmers and landlords [54], thus targeting only a small number of soil ecosystem services and ignoring the large part of the ecosystem service bundle that does not exhibit private-good characteristics.

To counter this and other environmental problems linked to agriculture, it has been proposed to replace direct payments by incentive-based payments for the provision of collective goods [55], i.e., those attributes of land/soil that are usually not taken into account by land managers (farmers, landlords). In a CAP system in which AECM (or similar instruments) would make up the large share of distributed funds, the legal property titles to land would remain unaffected; however, farmers receiving incentive-based payments would become *stewards* for the public, taking care of land/soil attributes that society at large demands but does not "own" because the best solution to the property rights problem is unattainable.

The attractiveness of incentive-based instruments in this context, particularly of result-oriented ones [56,57], lies in their flexibility: while it would be imaginable to steer land and soil management towards more sustainability and less negative environmental impacts by means of fostering, e.g., organic agriculture (the CAP already now includes payments specific to organic farming), this might lead to unnecessary and potentially problematic lock-ins and path dependencies [58]. Incentive-based instruments have the overall effect of strengthening the management for collective-good soil ecosystem services without generically forcing particular actions, which might actually be detrimental given the high heterogeneity of soils and also agriculture in general.

Another option that may complement centrally organised CAP payments of whatever kind may be in private contracts trying to establish implicit property rights (though not legal property titles) of the kind discussed above. In addition to the widely discussed payments for ecosystem services (PES) [59], which at least according to the original idea (but not necessarily in practice [31]) are based on contracts between private entities and would directly bring together beneficiaries of different soil ecosystem services, another option recently discussed in Germany is tenure contracts [60]. Here, landlords may be incentivised to include in land tenure contracts environmental management standards that the tenant is supposed to fulfil, over and above regulatory standards and voluntary instruments such as AECM. The downside of such a decentralised solution is, of course, high transaction costs. Thus, it can only complement a more coordinated AECM-like system, in which the state (or the EU) represents collective interests by means of incentive-based policy instruments.

While a political economy analysis is beyond the scope of our article, debates around the current plans to reform the CAP (post-2020) suggest that there is strong opposition against farther-reaching reform of the EU's agricultural policy. While there is strong evidence that the CAP does not deliver according to its goals [52], and the goals themselves are being questioned, a transformation towards a more explicitly public-good-oriented system does not seem probable in the short term. Nonetheless, a common-good-oriented agri-environmental policy would require a far-reaching reform of the CAP.

4.3. Case 2: Agricultural Land Use Planning

The attribute-based property rights perspective on soils, together with the ecosystem service concept, indicate that there are reasons for societal restriction of property rights to agricultural land and soils, as the latter have attributes that are relevant primarily for the broader society. Since soil management affects them, there are reasons to incentivise farmers or even to restrict their option space so that their management activities reflect this complex property rights situation.

In this context, planning instruments are of high relevance due to the spatially explicit control options they provide. In Germany, there is a multilevel planning system which goes down to the communal level, where specific plans are defined. This follows the constitutional principle of communal self-government (*Selbstverwaltungsrecht*), as "The municipalities must be guaranteed the right to regulate all matters of the local community within the framework of the law on their own responsibility" (Art. 28(2) Basic Law). However, there is a surprising divergence in planning law between urban and agricultural land. Despite the already-mentioned constitutional "social obligation" of property (*Sozialpflichtigkeit des Eigentums*; Art. 14 Basic Law) that has historically been linked especially to land, the planning options for communes with respect to agricultural land are rather limited. In fact, while in urban planning, the local community (via communal administration) can determine by means of the development plan (*Bauleitplanung*, functional zoning), in a binding way, very specific restrictions of what may be built on the land, how much of its surface may be sealed, how high or large buildings may maximally be, etc., no such restrictions are present in planning for agricultural land use. In Germany, development plans and the more regional spatial plans mainly determine where and how nonagricultural activity (e.g., industry, housing, infrastructure, etc.) may take place, while agricultural land can only be designated as to be kept free from construction. No restrictions whatsoever are possible to steer agricultural activities in these plans. Currently, German law offers only the possibility to restrict agricultural land use in the case of a land consolidation procedure (*Flurbereinigung*) [44] and in areas designated as nature or water protection areas. However, this requires that these areas are particularly in need of protection. As a result, despite the constitutional principle of communal self-government, communes cannot control the type and extent of agricultural land use on their territory.

However, it is thinkable to use well-established instruments of urban planning and apply them also to agricultural areas by transforming and extending urban planning to comprehensive land use planning with external binding plans (*außenverbindliche Pläne*) for *all* land uses. This would allow the communes and their citizens to influence particularly beneficial use of land from a social point of view for all areas, without far-reaching legislative activities or the introduction of new planning instruments [33]. Different uses of agricultural land with restrictions to, say, monocultures or genetically engineered crops could be discussed like restrictions to height of buildings or industrial use in residential areas, or buffer strips to support biodiversity like minimum distance regulations or sealing maximums for light and noise protection of neighbours. This would not necessarily require detailed, comprehensive plans for the entire municipal area, but rather the designation of particular areas as requiring specific types of management (for a hypothetical example, see Figure 2). For instance, there could be restrictions along water bodies; in areas prone to soil-erosion, conservation agriculture or similar management approaches could be required; suitable areas could be reserved for grass- or woodlands, etc. Such adapted planning law would be much more in line with constitutional principles and would increase the level of participatory influence of citizens on the cultural landscapes in which they live [61]. It would also be very much in line with the argument developed in this paper, showing that legal property titles to land are not necessarily a perfect reflection of (idealised) property rights to the different attributes of land and soils. Planning could help to bring them closer to each other on a local level.

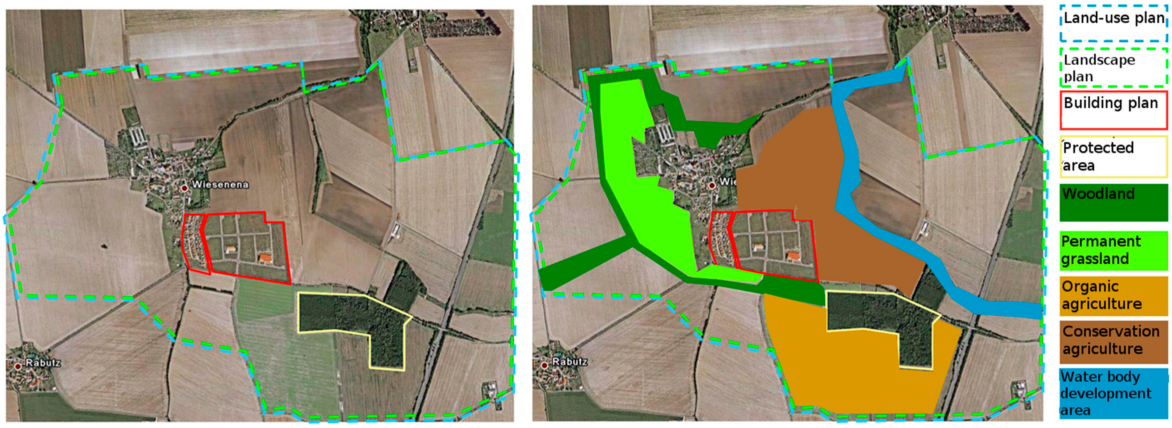

Figure 2. Actual (**left**) vs potential (**right**) reach of communal planning in Wiesenena, Germany; dashed lines: nonbinding plans, continuous lines: external binding plans, filled areas: hypothetical options [Map data: Google, DigitalGlobe].

Of course, opposition especially from farmers (and their associations), who would face additional restrictions on "their" land, can be expected to arise if the planning law would be transformed according to the suggestions formulated here. On the other hand, especially given Article 14 of the Basic Law, it is highly unclear "why those who own [agricultural] land should be granted special privileges as against those who hold other assets in their portfolio" [6] (p. 42). From a fairness point of view, there is a strong case in favour of adapting the planning law. A combination with the above-discussed incentive-based reform of the CAP would increase coherence of the agri-environmental policy mix and thus likely relieve some of the opposition.

5. Conclusions

Sustainable land management is challenged with inadequate consideration of the complexities and full spectrum of soil functions, which make up fertile, healthy, and well-functioning soils, and which are the basis for the many soil products demanded in modern (bio-)economies. This paper focused on the investigation of property rights related to soils, showing that common private soil ownership is likely accompanied with externalities which are not internalised in agricultural markets.

Applying New Institutional Economics and the ecosystem service concept to the analysis of soil property rights, we shed light onto a set of specific aspects. As an entirety, the individual parts are falling into place and illustrate how the ecosystem services approach can be applied to inform better soil governance that enables more efficient and sustainable agricultural land use decisions.

First, we have provided a characterisation of soils and ecosystems services. We pointed out the role of soil-provided versus soil-related services. Furthermore, we have emphasised the complexities, context-specificity, and heterogeneity of soils, which farmers can only partly influence by soil management and where trade-offs exist regarding the demands by different stakeholder groups. Soil ecosystem service assessment needs to be spatially and temporally explicit, also for the purposes of governance.

Second, in our reassessment of soil ecosystem services and property rights, we showed that multifunctionality of soils and the attribute-based perspective on property rights together help to substantiate the intuition expressed, e.g., by the German Federal Constitutional Court that land property is subject to special obligations towards public interests and the common good. The complex and nested setting of soil characteristics explains conflicts regarding the sustainable use of soils as resulting from imperfectly defined property rights or relationships between property rights and the different attributes of soil as a resource. Despite today's growing recognition that private property rights for land ownership imply social obligations, we find this only limitedly reflected in the current property rights regime. We have shown that the concept of ecosystem services is promising to support the identification of property rights that link more specifically to the bundles of distinct characteristics of soils that generate the different ecosystem services (attributes), implying different potential beneficiaries and (ideal-type) property right holders. The potential and limitations of the ecosystem service perspective to identify and distinguish stakeholders, beneficiaries, and providers in the context of soil management could be indicated. We have emphasised that the fact that soils provide bundles of ecosystem services is useful in order to connect these considerations with design options of governance and institutions that seek to define an adequate framework to properly regulate soils.

Third, potential governance implications have been outlined. As a first step, we discussed two general approaches in the form of either a "Georgist" solution of explicit collective ownership expressed in taxation of land rents, or an amendment of the current system with implicit assignment of additional property rights by means of incentive provision for farmers as *stewards*. Second, we focused on the latter approach, which we found complementary with the former, and discussed its implications using two case studies. For CAP, we have found implementation of the second approach in the form of more incentive-based payments for collective good provision as reflecting well the attribute-based property rights perspective adopted here. It implies motivating farmers to become stewards for the public and future generations, taking care of sustainable provision of the multitude of soil ecosystem services. Also, reform of tenure regimes is briefly discussed, pointing also to the challenges of lock-in effects and path dependencies as big hurdles. Agricultural land use planning approaches demonstrate that certain property rights can be kept with the state, e.g., in the form of land use restrictions in order to prevent unsustainable uses or foster sustainable ones. We show that in the German case, this would only imply applying the same standards to urban and agricultural planning. Both case studies demonstrate the applicability of the conceptual ideas developed in Section 3 to inform the assessment and evaluation of policy instruments.

Several questions arise from our analysis that require further investigation. These range from more theoretical to applied issues. On the one end, further discussion is needed to better understand how institutions involved at the intersection of the environment and economic transactions in the soil context are developing over time and how the ecosystem service concept can be applied to inform the transactions-linked emergence of nature-linked institutions. On the other end, the question is how to facilitate in practical conditions a shift of property rights regimes to ensure a better reflection of actual ecosystem service stakeholders from current and future generations—be it through instruments of planning, amended CAP, or other measures. Particularly, analyses from a political economy perspective and in transdisciplinary real labs would help uncover relevant transaction costs, interests, and interest conflicts as well as the trade-offs inherent to social–ecological systems that counteract the implementation of a more sustainable property rights regime for agricultural land and soils.

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