Chapter 12
Economic and Social Perspective of Climate-Smart Forestry: Incentives for Behavioral Change to Climate-Smart Practices in the Long Term

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Abstract In this volume, the concept of climate-smart forestry (CSF) has been introduced as adaptive forest management and governance to address climate change, fostering resilience and sustainable ecosystem service provision. Adaptive forest management and governance are seen as vital ways to mitigate the present and future impact of climate change on forest. Following this trajectory, we determine the ecosystem services approach as a potential adaptive tool to contribute to CSF. Ecosystem services as public or common goods face the traditional social dilemma of individual versus collective interests, which often generate conflicts, overuse, and resource depletion. This chapter focuses on the ecosystem service governance approach, especially on incentive tools for behavioral change to CSF in the long term, which is a basic precondition for the sustainability of ecosystem integrity and functions, as well as ensuring the continuous delivery of ecosystem goods and services, as per the CSF definition. Payments for ecosystem services (PES) are seen as innovative economic instruments when adding a social dimension by involving local communities and their values to ensure the long-term resilience and adaptation of forest ecosystems to climate change. We argue that tackling climate change adaptation requires the behavioral change of ecosystem service providers to a collaborative and integrated PES approach, as also emphasized by the Sustainable Development Goals (SDGs) of the Agenda 2030.

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12.1 Introduction

The concept of climate-smart forestry (CSF) has recently been introduced in order to contribute to climate change adaptation and mitigation from the forestry sector that is aimed at reducing GHG emissions, fostering resilience, and increasing productivity and incomes (Nabuurs et al. 2017; Bowditch et al. 2020). Such adaptive management and governance are seen as vital to mitigate the present and future impact of climate change on forest, ensuring the survival of forest stands. A relatively minor change in climate can have a devastating effect upon forest by increasing vulnerability to drought, insect attack, and fire. In this volume, CSF has been understood as adaptive forest management and governance to address climate change, by fostering resilience and balancing climate change mitigation measures with long-term multiple goods and services provision (e.g., biodiversity, water services, or surface cooling) and sustainably increasing forest productivity and long-term environmental benefits and economic welfare based on forestry. Forest management and planning must consider the expected future impact of climate change on, e.g., tree species' distribution, productivity, risk of hazards (fires, pests, etc.), and drought (Schelhaas et al. 2015), while incorporating uncertainty (Lindner et al. 2014) and adaptation and resilience concepts (Lexer and Bugmann 2017). More active and flexible forest management, and the improved protection of forest areas, can not only reduce CO_2 emissions but also significantly reduce fire risk and thus land-use change. This aspect is also stressed by Yousefpour et al. (2018), who highlight that CSF implementation requires multipurpose and diversified forest management strategies. Diversity in forest management can support various ecosystem services and thus contribute to increasing forest resilience to climate change threats.

To deal with the abovementioned challenges in forest management and increase the provision of multiple ecosystem services and thus reach CSF, it is important to understand the complexity of relationships within ecological systems and the complex nature of social-ecological systems. The concept of ecosystem services (ES) for describing the relationship between human societies and the natural environment is historically quite recent (Gomez-Baggethun et al. 2010). It puts emphasis on the values of natural systems and socioecological dynamics in the planning of economic policies by providing incentive for sustainable use and increasing the convergence of sectoral policies. The concept is expected to induce a paradigm shift in the management of natural resources (Cowx and Portocarrero-Aya 2011) and link natural systems and human well-being (Amsworth et al. 2007; Skroch and Lopez-Hoffman 2009) to propose effective strategies for the management of vulnerable natural resources and their ecosystem services, especially under the risk of climate change (Kluvánková et al. 2019; Primmer et al. 2021). Most ES fall within the types of goods that are considered either "common-pool resources" or "public goods" (though ownership of the resource base might be private, public, or communal) characterized by two particular features: excludability and rivalry. If there is no excludability in supply and no rivalry in demand, the goods and services are public (most supporting, regulating, and cultural ecosystem services), whereas if there is no excludability in supply but rivalry in demand, the goods and services are common, which is the case of most provisioning ecosystem services (Farley and Costanza 2010; Ostrom 2010; Muradian and Rival 2012; Muradian and Gómez-Baggethun 2013).

The combination of governance structures and hybrid governance (positioned between markets and hierarchies) is necessary when the provision of particular ES (such as climate regulation) is characterized by the high complexity of their functioning, high levels of uncertainty, imperfect and asymmetric information between transacting parties, and cognitive barriers in assessing the service itself (Williamson 1991; Muradian and Rival 2012; Otto and Chobotová 2013; Kluvánková et al. 2019). Such regime in vulnerable areas can be seen as effective governance for ES governance to overcome the social dilemma of individual interests, directing sectoral policies toward a more integrated approach of EU regions and at a lower cost than hierarchy or market (Muradian and Rival 2012; Kluvánková et al. 2019). In this way, ES governance can contribute to the sustainable management of socio-ecological systems in the long term (Primmer et al. 2021).

The analysis of the emerging concept of PES in recent decades is considered as one of the most promising tools for enhancing or safeguarding the provision of specific or bundled ES. PES schemes are expected to generate a continuous flow of ES in the long term while also maintaining their quality. Although PES has been extensively analyzed in terms of potential positive and negative impacts on the poor (e.g., Suyanto et al. 2007; Bulte et al. 2008; Randrianarison et al. 2017; Blundo-Canto et al. 2018), not enough attention has been paid to examining the role of PES in the context of adaptation and mitigation to climate change (van de Sand 2012). The common pool or public nature of most ES implies that market mechanisms are not always suitable as governance tools of climate change problems, since markets tend to be more effective in dealing with private goods.

Following this trajectory, this chapter focuses on discussing whether PES is an appropriate and promising approach to promote CSF. It contributes to these debates by focusing on the PES design, especially the aspects (Fig. 12.1) that influence the behavioral change to climate-smart practices in the long term, the capacity of actors dealing with climate change, and the continuous delivery of multiple ecosystem goods and services, as per the CSF definition. In this regard, long-term behavioral change is a basic precondition for the sustainability of ecosystem integrity and functions. Moreover, several authors argue that PES can be seen as more effective innovative economic instruments for adaptation to climate change within CSF when adding a social dimension by involving local communities and their values to ensure forest ecosystems' long-term resilience and adaptation to climate change (Sattler and Matzdorf 2013; Brownson et al. 2019). Additionally, we determine that by targeting multiple ES via the CSF approach, it has the potential to contribute to climate change adaptation and mitigation. To tackle the abovementioned issues, the present chapter aims to reveal in which way the PES schemes currently implemented in Europe contribute to climate change mitigation and adaptation.

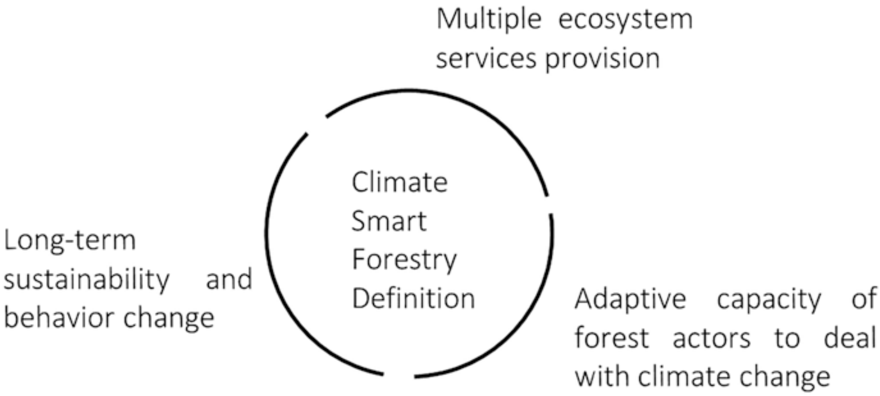

Fig. 12.1 The aspects of PES in the context of adaptation and mitigation to climate change based on CSF definition

The following section reviews what we mean by PES schemes and how this concept has been framed and defined by different scholars. Then, the next subsections focus on the different aspects of CSF definition and especially elaborate on how various PES contribute to enhancements in the provision of multiple ES, how various PES designs and implementations can influence the ability of various actors to deal with climate variability and change, and in what way PES can contribute to providing a long-term incentive mechanism to adopt specific measures for adaptation and mitigation to climate change. The last section summarizes the paper and suggests potential areas for future PES and climate change-related research.

12.2 Payments for Ecosystem Services (PES)

According to Tognetti (2016), forestry measures at the regional scale (i.e., forest mountain areas) should be implemented, along with bridging the gap between local development via FES (forest ecosystem services) provision, ecosystem resilience, and climate change adaptation and mitigation strategies and policies inclusive. The successful development of CSF calls for policymakers to create incentives for investments needed to activate forest management and finance mitigation and adaption measures, which include protecting biodiversity and other ES (Verkerk et al. 2020). A possible solution in that sense is the implementation of PES in CSF (Bartczak and Metelska-Szaniawska 2015; Matthies et al. 2015). According to Wunder (2005), PES are defined as voluntary transactions where a well-defined ES is bought by a buyer (i.e., someone who is willing to pay for it), if and only if the provider secures the provision of such service. However, this prescriptive definition is problematic because it excludes a variety of PES schemes operating under different principles with ill-defined ES or under inefficient provision levels (Muradian et al. 2010). The revised Wunder's definition defines PES as "(1) voluntary transactions (2) between service users (3) and service providers (4) that are conditional on agreed rules of natural resource management (5) for generating offsite services" (Wunder 2015). These transactions are labelled as "Coasean PES" (Coase 1960; Pagiola and Platais 2007) or "private PES" (Wunder 2005). Those PES which satisfy most but not all of Wunder's criteria are generally called "quasi-PES" or "PES-like" (Wunder 2008) and usually come with government intervention that is mostly characterized by subsidies (Vatn 2010; Sattler and Matzdorf 2013).

In reality, few real-world schemes meet all five of Wunder's definition criteria (i.e., voluntariness, clarity in defining ES, conditionality), while the number of PES-like schemes is much larger (Wunder 2008; Kosoy and Corbera 2010; Sattler et al. 2013). The latter can be defined more broadly as a transfer (monetary or nonmonetary) of resources between social actors, which aims to create incentives to align individual and/or collective land-use decisions with social interest in the management of natural resources (Muradian et al. 2010). They include, for example, those programs financially supported by public governments that "buy" ES on behalf of their taxpayers who, strictly speaking, cannot decide whether or not to participate in the program (Russi et al. 2011). This wide range of real-world existing or potential schemes focuses on influencing the ES providers through monetary or in-kind incentives. In most cases, the payment amount is not based on a monetary evaluation of the ES value but rather on lengthy negotiations among providers and users, informed by the opportunity cost associated with the required land-use practices (Russi et al. 2011).

PES and PES-like initiatives are now being promoted around the globe to incentivize the sustainable management of numerous ES (e.g., Kosoy et al. 2007; Pagiola et al. 2007; Muñoz-Piña et al. 2008; Tallis et al. 2008; Wunder and Albán 2008; Wunder 2008; Stanton et al. 2010; Brouwer et al. 2011). However, there are few PES examples in the European Union. Although PES/PES-like schemes have been widely adopted at the local, national, and international levels to reflect FES value in decisionmaking processes (Kemkes et al. 2010), a limited number of studies have so far examined the role of PES in improving the mitigation strategies of forests in Europe, especially considering CSF.

12.2.1 PES and Multiple ES

Designing and implementing policy and market tools to support synergies between ecosystem and ES relationships and reduce trade-offs among them is particularly crucial in forest ecosystems that represent important carbon sinks on the global scale. This makes them key ecosystems relevant for the regulation of ES that contribute to mitigating climate change via carbon uptake from the atmosphere and precipitation reduction of solar heating (Bonan 2008). As also emphasized by the EU Biodiversity Strategy for 2030, EU Forest Strategy and proposed new EU Forest Strategy of the European Green Deal, sustainable forest management and multiple

FES provisions are considered a long-term strategy to mitigate climate change impacts. In CSF definition, the multiplicity of ES provision is an important factor for supporting smart decisionmaking in forestry (Bowditch et al. 2020). Regulatory services, such as water regulation or erosion control, can to some extent buffer the natural and social system against the impacts of climate change (such as floods or droughts). Provisioning services (e.g., food and fiber) can provide an alternative source of food and income in the case of extreme events. Cultural services of forest ecosystems contribute to health and well-being and thus contribute to the social system's adaptive capacity (Millennium Ecosystem Assessment 2005; Locatelli et al. 2008).

Policymakers and forest managers need to make decisions to manage forest ecosystems sustainably, even while a gap remains in our understanding of the ecosystem-ES relationships (Mach et al. 2015; Van Wensem et al. 2016). They should seek to align the economic incentives with regulation to avoid environmentally irresponsible behavior by economic players. The forest environment is heavily exploited for the goods and services it provides and also faces global pressures such as climate change. This adds uncertainty to sustainable management as it is unclear how these pressures affect ecosystem resilience and adaptive capacity to climate change or the services provided by those vulnerable ecosystems (Knights et al. 2013; Mach et al. 2015).

Interactions between ES have been the subject of an increasing number of studies because their understanding is essential to the design and implementation of public policies, management strategies, and PES schemes that can foster the sustainability of ecosystem service provision (Demestihas et al. 2019; Mouchet et al. 2014). However, the commoditization of ES via PES schemes usually entails the identification and commercialization of single services (Muradian and Rival 2012). Such a focus on single services might be problematic due to the existence of trade-offs that may induce changes in the structure and functioning of the resource base, which may in turn jeopardize the supply of other services and even the service whose provision is being promoted (Corbera and Brown 2010; Kosoy and Corbera 2010; Muradian and Rival 2012).

The enhanced provision of a single service can also lead to disadvantages for users at the local scale, as trade-offs are often involved in enhancing different ES for different scale and purposes (Chan et al. 2006). According to Lee and Lautenbach (2016), trade-offs are mostly dominant between regulating and provisioning services. An often-cited example for such trade-offs is the establishment of trees for global benefit (fast-growing tree species, such as eucalyptus for carbon sequestration), which not only might replace more biodiversity-rich areas but could also have implications for the water table and thus increase system sensitivity to drought (van de Sand 2012). Gomez-Baggethun et al. (2011) reported significant cork tree forest destruction and consequent biodiversity loss due to eucalyptus plantation in Doñana National Park, Spain. Such project interventions may affect the flow of provisioning services, as well as the stakeholders whose livelihoods are related to ecosystem production functions. Corbera and Brown (2010) found that in some carbon forestry payment schemes that they reviewed, access to grazing land was restricted, and degradation of soil and vegetation occurred. Thus, although some ES can be increased, others might be eroded, thereby potentially increasing rather than decreasing the vulnerability of those dependent on the services to climate variability and change.

Although markets for multiple services might involve considerable transaction costs, targeting multiple FES rather than single FES (e.g., biodiversity) reduces contradictions among providers and users and may positively affect the transformation from sectoral to ES governance. Targeting multiple ES via payment schemes is particularly relevant as there is a dominance of single provider and multiple users of ES. In many payment schemes, provisioning FES and cultural FES are addressed in combination with other FES rather than separately (ibid.). This can be supported by the research of Brnkaľáková et al. (2019), where they showed that a synergistic relationship was dominant between different regulating services and between different cultural services (positive relationship); yet the review of Lee and Lautenbach (2016) illustrated that the relationship between regulating and provisioning services was trade-off dominated. Comprehensive information is required for well-informed management and policy decisions that take account of ecosystem complexity and relationships among ES.

According to Matthies et al. (2016), the goal of bundling or stacking multiple ES within a single PES scheme is to reduce the risk of adverse intraservice trade-offs, which is done by incentivizing the co-provisioning ES. Moreover, such bundling could decrease marginal service provisioning costs to society per unit of service provided. They highlighted that the stacking of biodiversity conservation and climate change mitigation objectives is possible if appropriate care is taken to determine those management interventions that are complementary to achieving the correct balance between the equitable and aggregate achievement of desired outcomes (ibid.).

Demestihas et al. (2019) in their study analyzed the patterns of ES relationships in agroecosystems to address the challenge of supporting regulating ES while maintaining or enhancing provisioning services. Such an example can be used in promoting PES that focus on the provision of multiple ES. PES that go beyond the food production service may support the provision of multiple non-marketed services (such as soil structure and fertility, water quantity and quality, biological pest control, pollination, and climate regulation through carbon sequestration and greenhouse gas (GHG) mitigation). Despite this recognition, non-marketed ES have been undervalued in policy, which has led to biodiversity loss and ecosystem degradation (TEEB 2009).

When designing PES schemes, it is important to focus on the temporal variation of trade-offs and synergies among multiple ES throughout and after the PES period. Although some PES initially focus on single ES, over time they may also support the provision of other related ES. Even though PES can support several ES, most are designed for each ES separately. However, analyses of the effects of PES schemes should focus on multiple services to allow the capture of trade-offs among them and explore system complexity (Lester et al. 2013; Mach et al. 2015; Cavanagh et al. 2016). Consequently, such analyses will help to quantify and forecast changes to ES under different PES and management measures (Daily et al. 2009; Mach et al. 2015). According to Broszeit et al. (2019), such an approach would ideally help to understand if or why PES or other types of policy interventions that aim to halt biodiversity loss and the decline of ES have failed or succeeded (Carpenter et al. 2009).

In order to achieve successful CSF, implementation of PES requires a balancing act between wood production, biodiversity, and other important ES. According to Verkerk et al. 2020, the optimal balance will vary from country to country and region to region, depending on the socio-ecological and technological framework, climate change impacts, but also cultural aspects. This approach demonstrates a step toward customizing PES within CSF to fit individuals and regional differences and local priorities and capacities to tackle climate change issues.

12.2.2 PES and Adaptive Capacity

European forests currently face changes in ecosystem functionality and resilience due to climate change (e.g., increased severity of disturbances such as hazard risk, storms with consequent insect attacks, fires, drought, etc.) (Schelhaas et al. 2015; Kulakowski et al. 2017). Apart from reducing GHG emissions, Millar et al. (2007) proposed forest management adaptation via behavior change, promoting the resilience of forests and increasing the adaptive capacity of forest users to climate change. Such transformations in turn influence FES availability (Thom and Seidl 2016) and finally affect sustainable development in forest areas (e.g., Beniston 2003).

As stated by CSF definition, the key objective of CSF is to adapt forests and forest management to the gradual changing of climate. PES not only can contribute to increasing forest resilience and adaptive capacity through the provision of multiple ES but could also strengthen the adaptive capacity of users and providers through the way in which PES is implemented and designed. In line with common pool resource theory and numerous empirical evidence (Ostrom 2010), PES can increase the capacity of local governance regimes, strengthen local economies, and improve the social capital that are essential features of adaptive capacity for sustainable long-term FES provision. van de Sand (2012), in her review, has shown that PES can potentially increase the adaptive capacity of involved actors via the establishment of institutional structures, increased access to and generation of financial resources, generation of knowledge between ecosystems and land-use practices, and supporting conflict resolution.

However, the long-term nature of many PES contracts may prevent ES providers from implementing certain adaptation strategies that would involve CSF, changing land-use practices via crop diversification, or leaving the agriculture or forestry sector altogether. According to Chobotova (2013), despite the mixed evidence of PES's role in the long-term behavioral changes of users and providers toward sustainability, significant interest in PES can nevertheless be explained by schemes that encourage greater transparency and more flexibility in allowing actors to reach a certain goal. Moreover, she reported that PES actors have problems with the long-term commitment inherent in PES, due in particular to unclear property rights and rules in use (Schlager and Ostrom 1992), multiple ownership structure, or land rental contracts that are often subject to change and speculation. Most landowners usually rent land to farmers for only shorter periods, with rental periods of less than 5 years, making land users ineligible for PES (ibid.). Short rental periods are generally insufficient for ES provision (e.g., increased biodiversity by restoring species-rich communities), which may demotivate land users from participating in such schemes or implementing certain adaptation strategies. Therefore, PES flexibility is an important factor for implementation.

In some cases, it may be that a tree species is not adapted to changing climatic conditions and has to be replaced by other tree species. In Slovakia, for example, foresters in mountain areas are replacing nonnative coniferous trees by mixed stands of species that are likely to be well adapted to emerging environmental conditions and changing climate (Brnkaláková et al. 2019). CSF in this case suggests selling (in a sustainable manner) timber in order to finance the conversion of disturbance-vulnerable forests to a more resilient new forest type (Yousefpour et al. 2018). If ES providers see the need for and are willing to undertake adaptation measures to climate change yet lack the appropriate means for implementation, there is thus an opportunity to tailor PES compensation in such a way that it provides direct incentives for adaptation measures (van de Sand 2012). PES compensation schemes for the provision of ES and as a direct incentive for adaptation and mitigation measures can often be made in kind, in addition to or instead of using cash payments (e.g., Wunder 2008), which is a strong sign of intrinsic motivation (Muradian et al. 2010). Brnkaľáková et al. (2019) reported that foresters are willing to join PES schemes if they are targeted at the forest machinery important for CSF, as such investment is far beyond their own budget.

Investing in climate-smart practices can result in short-term income losses (Haile et al. 2019), which often inhibits forest actors from investing in adaptation measures, which could generate long-term economic and environmental returns (Neufeldt et al. 2011; Ndah et al. 2014). Also according to Lipper et al. (2011), actors value short-run costs much stronger than longer-term benefits. In both cases, PES can help cover short-run costs and contribute to continuous payoffs, thereby increasing profitability and lowering investment risk (Engel and Muller 2016). Therefore, changing the timing of payments in a PES program may trigger a change in actors' behavior in favor of CSF, which has economic and ecosystem benefits.

If a PES program compensates foresters for the investment costs associated with adopting CSF in initial years when cash outflows characterize the investment, foresters are willing to engage in environmentally conscious practices, and there is a high possibility of large-scale adoption of the innovation across Europe. Within the Iceland PES scheme, each farm's afforestation grant covers 97% of establishment costs, including fencing, trails, site preparation, planting, and precommercial thinning (Brynleifsdóttir 2017; Icelandic Forest Service 2017).

van de Sand (2012) mentioned that payment could take the form of drought-resistant seeds as an adaptation measure against drought or more generally climate variability. Haile et al. (2019), in the case of climate-smart agroforestry, highlighted that farmers are willing to receive a low amount if the mode of payment is food rather than cash; they also reported that the failure of output markets could explain such a preference. In areas characterized by vulnerability to climate shocks and associated severe food shortages, in the absence of well-functioning markets and where cash transfers are vulnerable to price increases of food items, farmers rationally choose the end goods (food) rather than the means (cash) (ibid.).

12.2.3 Long-Term Sustainability

PES have been heralded as an effective strategy to increase tree cover in forest or agricultural landscapes and thus contribute as a climate change mitigation measure, but their efficacy beyond the payment period has rarely been evaluated. The permanence of activities (the extent to which the induced change is permanent after the finalization of funding) in the event of PES reduction is debatable. The temporal limitation of PES schemes has important implications as to whether payments foster an environmental attitude or, in the words of Swart (2003), an attitude of "no pay, no care." Ultimately, the sustainability of environmental outcomes following short-term PES programs needs to be tested rather than assumed (Calle 2020). In recent years, several studies have shown that the permanence of PES interventions is highly context dependent (Prokofieva and Gorriz 2013; Calle 2020).

Whereas the rational choice approach of most PES programs states that permanent outcomes require ongoing payments, forestry PES schemes anticipate that because changing forestry practices would soon become profitable, landowners (or land users) would, therefore, permanently adopt such practices (Calle 2020). According to Prokofieva and Gorriz (2013), permanence beyond an agreement period is not secured especially in the absence of additional financial resources. However, when landowners' private interest is strong or activities are aligned with their personal values, it is expected that high additional costs are not imposed on landowners and any costs complement their activities. This is consistent with the predictions of self-determination theory, according to which behavioral changes outlast the withdrawal of external incentives only when intrinsic motivation is strong enough (e.g., Deci 1971; Green-Demers et al. 1997; Deci and Ryan 2002). On the other hand, according to Frey and Oberholzer-Gee (1997), the use of price incentives needs to be reconsidered in all areas where intrinsic motivation can empirically be shown as important. They suggest that in policy areas where intrinsic motivation does not exist or has already been crowded out, the relative price effect, and thus the use of compensation, is a promising strategy (ibid.), even if payments are short term.

Ezzine-de-Blas et al. (2019) stressed that the willingness to maintain behavior after incentives are discontinued, or "crowding-in," results when satisfaction with the new practices gradually strengthens intrinsic motivations, eventually replacing the external incentive as the main driver of behavioral change. So, the crowding-in effect means that people conform and entrain with a new norm, which may also become a new moral standard (Vatn 2010). Monetary incentives can support long-term sustainability and climate change adaptation, if implemented as a local social norm, and aligned with cultural and interpersonal values. Kolinjivadi et al. (2015) confirm the link between motivation crowding-in and collective PES, if the latter aligns with social norms and the social capital is strong. In a context where social capital is strong (i.e., reciprocity norms exist, people trust each other, and leaders are respected), collective PES can increase intrinsic motivations (Andersson et al. 2018; Bottazzi et al. 2018). Prokofieva and Gorriz (2013) in their review of three European PES forest initiatives claimed that success and durability rely on the strong self-interest of involved forest owners, shared values and priorities, social capital that permits strong local networks to form, positive environmental attitudes, and local networks.

Moreover, crowding-in has been mostly observed for practices that provide long-term financial benefits. On the other hand, motivations for involvement in PES schemes do not relate to purely monetary logic. It has also been seen for practices that are easier to maintain, such as delivery of other services (e.g., water regulation) or in-kind benefits (e.g., soil fertility), or difficult to reverse (e.g., forest reclearing) (Kissinger et al. 2013; Swann 2016; Dayer et al. 2018), such as improved land tenure security and community organization, increased recipient knowledge about the importance of forest conservation (Kosoy et al. 2007; Wunder 2015), and information about (and experience with) the risk and negative effects of climate change.

PES programs can also be considered in the context of the broader effects of climate change. Forest cover or woody vegetation cover can increase slightly as a result of changed climate conditions and consequent rural migration, land abandonment in areas that became too dry for agriculture, and reforestation programs. Where progress in changing forest landscape management is achieved during the short-term payment period and has been retained (i.e., permanence), it suggests that forest owners can understand the benefits of maintaining trees even without payments (crowding-in) (Calle 2020). Whether forester owners opt to maintain reforested areas at the end of contract periods remains to be seen. These longer-term landowner decisions will ultimately determine whether the program is an effective strategy in addressing climate change issues. Assuming that CSF practices are – by definition – more profitable for the farmer in the longer run, temporary payments should be sufficient to induce a permanent change in forestry practices. Also according to Lipper et al. (2011), actors value short-run costs much stronger than longer-term benefits. In both cases, PES can help cover short-run costs and contribute to continuous payoffs, thereby increasing profitability and lowering investment risk (Engel and Muller 2016).

Our literature review confirms that with well-designed PES, some forest landowners will not only *adopt* but also and more importantly *maintain* climate-smart practices. CSF can transform production forests into heterogeneous landscapes that support higher productivity, biodiversity conservation, carbon sequestration, and the flow of ecosystem services and are, therefore, an important component of climate change adaptation and mitigation measures. Since foresters' participation in adaptation and mitigation to climate initiatives remains marginal at best, even short-term PES can be a useful policy tool to facilitate the widespread adoption of CSF.

12.3 Discussion and Conclusions

To date, countries have been more specific in setting ambitious restoration or reforestation targets than in anticipating or implementing strategies to ensure the longevity of their restoration and reforestation outcomes (Calle 2020). The greater the synergies and the fewer the trade-offs between climate policy and other societal, forest-related goals, the more likely climate objectives will be effectively implemented and maintained in practice (Nabuurs et al. 2017). Therefore, trade-offs between design features and the quest for particular objectives in PES implementation reflect how specific paradigms or discourses about deforestation, climate change, poverty, or the role of incentives in motivating specific human behaviors need to be understood and thus mainstreamed in such implementation (Moros et al. 2019).

Where payments have been made to individual farmers, a critical issue that emerged from the review is that in many cases, payments were not based on the opportunity costs of ES providers and often tended to diminish over time, thus risking the long-term sustainability of the scheme. In some cases, however, the longevity of strategic remnant or restored ecosystems can only be ensured via the strict enforcement of conservation areas or long-term PES schemes.

On the other hand, policies and programs are not commonly funded in perpetuity, and they suffer budgetary and implementation adjustments along the way (Moros et al. 2019). In many of the studies we have reviewed, short-term contracts are found to be essential attributes that positively influence actors' decisions to take up a contractual arrangement. As foresters or other landowners seek more climate-resilient forestry systems, and representatives grapple to meet ambitious national and global climate policy targets, opportunities to align foresters' needs and climate policy goals are emerging. From the policy perspective, short-term PES interventions that can trigger positive and lasting change are especially promising (Calle 2020).

Knowledge continues to be lacking about specific impacts of climate change or the technology and strategies to implement certain adaptation measures (such as CSF) (van de Sand 2012). More needs to be known if more knowledge and information about climate change can influence the willingness of various actors to adopt climate strategies and measures and the extent to which climate change consideration can influence the willingness of ES users to pay for ES provision. Moreover, future research is needed about how specific PES design can contribute to the increased adaptive capacity of different forest actors and the options which exist to provide incentives for adaptation strategies through specific forest PES and alternative governance regimes.

It is important to stress that the role of PES alone in reducing CO_2 emissions from land-use activities with the aim of reaching to carbon neutrality by 2050 is limited. This is due to the potential implementation scale of PES, particularly compared with other initiatives (such as REDD+) or carbon pricing schemes which are almost nonexistent in Europe. We acknowledge that the combination of government regimens and several policy instruments to preserve forests and avoid deforestation should be urgently pursued in the coming years in order to reduce the share of land-use change emissions in Europe, which currently account for 24% of Europe total CO_2 emissions.

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