Global Environmental Change 30 (2015) 31–42

Contents lists available at ScienceDirect

Global Environmental Change

journal homepage: www.elsevier.com/locate/gloenvcha

Payments for Ecosystem Services (PES) in the face of external biophysical stressors

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ARTICLE INFO

Article history:
Received 29 May 2014
Received in revised form 17 October 2014
Accepted 18 October 2014
Available online 24 November 2014

Keywords:
Blue carbon
Ecosystem stability
Permanence
REDD+
Regime shift
Transaction costs

ABSTRACT

Economic instruments such as Payments for Ecosystem Services (PES) schemes are increasingly promoted to protect ecosystems (and their associated ecosystem services) that are threatened by processes of local and global change. Biophysical stressors external to a PES site, such as forest fires, pollution, sea level rise, and ocean acidification, may undermine ecosystem stability and sustained ecosystem service provision, yet their threats and impacts are difficult to account for within PES scheme design. We present a typology of external biophysical stressors, characterizing them in terms of stressor origin, spatial domain and temporal scale. We further analyse how external stressors can potentially impinge on key PES parameters, as they (1) threaten ecosystem service provision, additionality and permanence, (2) add challenges to the identification of PES providers and beneficiaries, and (3) add complexity and costs to PES mechanism design. Effective PES implementation under external stressors requires greater emphasis on the evaluation and mitigation of external stressors, and further instruments that can accommodate associated risks and uncertainties. A greater understanding of external stressors will increase our capacity to design multi-scale instruments to conserve important ecosystems in times of environmental change.

1. Introduction

Many ecosystems are facing severe declines in areal extent and quality due to the impacts of local and global environmental change, with concomitant declines in biodiversity and ecosystem service provision (e.g., Butchard et al., 2010; Dobson et al., 2006; Leemans and Eickhout, 2004). Ecosystem service losses can have profound physical and socioeconomic consequences; for example, tropical deforestation contributes up to 14% of total anthropogenic CO_2 emissions (Harris et al., 2012), while declining fisheries catches represent billions of dollars in annual losses, threatening coastal livelihoods and food security (Ehrlich and Ehrlich, 2013). The scale of ecosystem service losses due to habitat destruction and degradation have prompted growing interest in Payments for Ecosystem Services (PES) schemes to incentivize widespread conservation measures (Wunder, 2007).

PES schemes involve the transfer of resources between social actors to create incentives that align individual and collective natural resource management decisions with the social interest (Muradian et al., 2010). PES rewards actors that enhance ecosystem service provision, or, most often, compensates them for the costs they bear when stopping practices that act as a stressor. This may involve incentive-based schemes such as direct market transactions, rewards for conservation actions, and/or green subsidies. Although incentive-based environmental protection has been in place for decades, PES gained mainstream attention in the 1990s/2000s following increased awareness of the economic value of ecosystem services (TEEB, 2010). PES schemes have since been implemented in both developing and developed country contexts, targeting a broad range of habitats and

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http://dx.doi.org/10.1016/j.gloenvcha.2014.10.013
0959-3780/

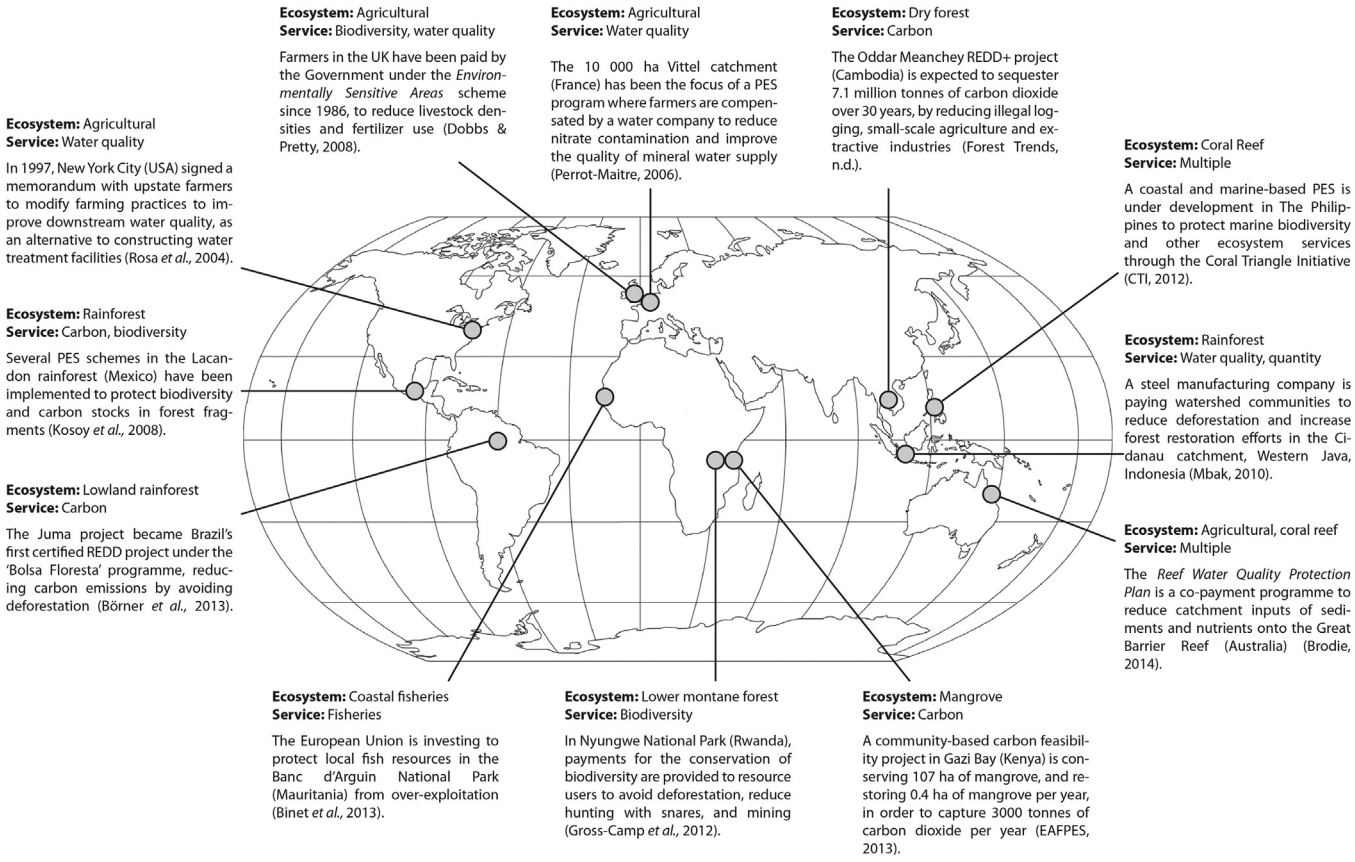

Fig. 1. Payments for Ecosystem Services schemes have been established, or are proposed across a range of ecosystems and regions, targeting different services, and relying on diverse governance arrangements. See References (Binnet et al. (2013), Borner et al. (2013), CTI (2012), Dobbs and Pretty (2008), EAFPES (2013), Forest Trends (n.d.), Gross-Camp et al. (2012), Kosoy et al. (2008), Mbak (2010), Perrot-Maître (2006), Rosa et al. (2004) and Woolridge (2009)).

ecosystem services (Schomers and Matzdorf, 2013) (e.g., Fig. 1). PES schemes have been targeted for their potential to enhance climate change mitigation efforts at the global scale, by creating new financial incentives to reduce carbon emissions from land use change (e.g., through schemes for Reducing Emissions from Deforestation and Degradation [REDD+] and the conservation of "blue carbon").

However, PES schemes on the ground are often more complex than the simple provision of incentives in exchange for the provision of target ecosystem services (Ghazoul et al., 2010; Muradian et al., 2013). A number of socio-economic and governance factors have been noted to shape PES function, including the governance contexts within which schemes operate (Karsenty and Ongolo, 2011), surrounding land-uses and the leakage of deforestation activities (Wunder, 2008), and a range of social equity dimensions (Pascual et al., 2014) such as underlying land tenure claims, local rights, and benefit distribution (e.g., Beymer-Farris and Bassett, 2012; Larson et al., 2013).

Growing awareness of these types of issues highlights how seemingly 'outside' factors can fundamentally shape PES function. Similarly, there is a need to evaluate the external physical and ecological factors that can also shape sustainable, long-term ecosystem service provision through PES. In particular, biophysical stressors that are external to PES sites, such as forest fires, pollution, temperature changes, sea level rise, and ocean acidification, can deeply affect ecosystem stability and service provision (Schröter et al., 2005). Associated uncertainty and risks can add substantial complexity to PES design. We examine the implications of external stressors on effective PES design and operation. We present a typology of external stressors to illustrate their effects on key PES parameters related to (1) defining ecosystem service provision; (2) identifying ecosystem service providers and potential payers; and (3) designing effective PES compensation mechanisms. We further examine mechanisms to cope with external stressors in PES, identifying approaches and strategies to address risk, costs, liability and uncertainty.

2. A typology of external biophysical stressors

2.1. Defining external stressors

External biophysical stressors include a diverse set of (physical, biological and chemical) drivers of ecosystem loss and/or degradation, characterized by origins outside the individual sites targeted for conservation. For instance, external stressors in terrestrial ecosystems may include stochastic weather events and pest outbreaks (Galik and Jackson, 2009), invasive species (Funk et al., 2014) or forest fires (Hurteau et al., 2012). External stressors in aquatic, coastal and marine environments are equally diverse, including increasing nutrient loads from agriculture (Carpenter, 2003), sea level rise (SLR) and ocean acidification (Harley et al., 2006), thermal stress, aquatic invasive species (De'ath et al., 2012), etc; all threats that can affect ecosystem functions and associated services of a targeted conservation area, despite originating outside area boundaries. Ecosystem stressors related to climate change are a particular challenge to habitat managers and land planners, as they are largely outside of their control (Tingley et al., 2014), and are already having clear impacts on ecosystem functioning and service provision (Groves et al., 2012). External stressors in these examples may lead to differing levels of ecosystem service reduction, from low level service disruption to complete ecosystem service loss, depending on stressor scale,