Global Environmental Change 46 (2017) 60–71

Contents lists available at ScienceDirect

Global Environmental Change

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

Community forest management in Indonesia: Avoided deforestation in the context of anthropogenic and climate complexities

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ARTICLE INFO

Keywords:
Community forest management
Hutan Desa
Impact evaluation
Indonesia
Peatland
Spatial matching

ABSTRACT

Community forest management has been identified as a win-win option for reducing deforestation while improving the welfare of rural communities in developing countries. Despite considerable investment in community forestry globally, systematic evaluations of the impact of these policies at appropriate scales are lacking. We assessed the extent to which deforestation has been avoided as a result of the Indonesian government's community forestry scheme, Hutan Desa (Village Forest). We used annual data on deforestation rates between 2012 and 2016 from two rapidly developing islands: Sumatra and Kalimantan. The total area of Hutan Desa increased from 750 km^2 in 2012 to 2500 km^2 in 2016. We applied a spatial matching approach to account for biophysical variables affecting deforestation and Hutan Desa selection criteria. Performance was assessed relative to a counterfactual likelihood of deforestation in the absence of Hutan Desa tenure. We found that Hutan Desa management has successfully achieved avoided deforestation overall, but performance has been increasingly variable through time. Hutan Desa performance was influenced by anthropogenic and climatic factors, as well as land use history. Hutan Desa allocated on watershed protection forest or limited production forest typically led to a less avoided deforestation regardless of location. Conversely, Hutan Desa granted on permanent or convertible production forest had variable performance across different years and locations. The amount of rainfall during the dry season in any given year was an important climatic factor influencing performance. Extremely dry conditions during drought years pose additional challenges to Hutan Desa management, particularly on peatland, due to increased vulnerability to fire outbreaks. This study demonstrates how the performance of Hutan Desa in avoiding deforestation is fundamentally affected by biophysical and anthropogenic circumstances over time and space. Our study improves understanding on where and when the policy is most effective with respect to deforestation, and helps identify opportunities to improve policy implementation. This provides an important first step towards evaluating the overall effectiveness of this policy in achieving both social and environmental goals.

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http://dx.doi.org/10.1016/j.gloenvcha.2017.08.002
Received 7 December 2016; Received in revised form 4 August 2017; Accepted 7 August 2017

1. Introduction

Much of the world's biodiversity and terrestrial carbon is found in the remaining forests of developing countries, some of which are subject to high rates of deforestation and forest degradation (Hosonuma et al., 2012; Sloan and Sayer, 2015). Deforestation contributes substantially to global greenhouse-gas emissions and consequently to climate change (Harris et al., 2012). At the same time, many people living in or close to these forests are highly dependent on forest resources and their livelihoods are threatened by deforestation and non-sustainable forest use (Sunderlin et al., 2005). Governments and international funding organizations are therefore seeking solutions to conserve forest resources and improve the welfare of local communities, while recognising indigenous forest rights (Persha et al., 2011). Community forest management programs have emerged as a popular strategy, with many developing nations at various stages of developing and implementing policies and trial projects (Resosudarmo et al., 2014; Rasolofoson et al., 2015, 2016). An estimated 4 million km^2 of land is being considered as community forest land in countries such as Indonesia, Madagascar, Bolivia, Colombia and Peru (Sunderlin et al., 2008).

Despite considerable investment in community forest programs globally, systematic evaluation of the impact of these policies at a landscape scale are lacking (Bowler et al., 2012), especially compared to studies investigating the effectiveness of protected areas in reducing deforestation. Impact evaluation studies of protected areas have used statistical matching to control for confounding factors, such as accessibility and agriculture productivity, to ensure that areas compared with and without the intervention of interest have similar baseline characteristics (Joppa and Pfaff, 2010; Andam et al., 2013; Ferraro et al., 2013). In contrast, there are few examples of statistical matching applied to evaluations of community forestry (e.g. Somanathan et al., 2009; Rasolofoson et al., 2015, 2016; Wright et al., 2016). Additionally, previous studies on the effects of community forestry or other forest protection schemes in reducing deforestation have usually employed accumulated deforestation data over several years (Brun et al., 2015; Rasolofoson et al., 2015), which can overlook variability in performance at fine temporal resolutions, such as the impact of extreme climate events.

Indonesia is one of the most biodiverse countries in the world and has several types of government-approved community forestry schemes that are implemented in both primary and secondary natural forest. Indonesia also has high rates of forest loss (Abood et al., 2015) primarily due to agricultural expansion. The area of large-scale industrial plantation concessions has doubled since the early 2000s (Santika et al., 2015; Gaveau et al., 2016b). Complicated forest tenure systems, unclear legal status of customary land tenure, and vested interests from government and the private sector have undermined efforts to curb high deforestation rates (Brockhaus et al., 2011). This situation has led to the land rights of smallholders and local communities to be largely ignored by large-scale investors, with land-use conflicts being increasingly prevalent (Obidzinski et al., 2012; Abram et al., 2016); a pattern that is common in other tropical countries (e.g. De Oliveira 2008; Araujo et al., 2009).

Recognising the apparent success of community forest schemes in other countries, the government of Indonesia has recently announced an ambitious plan to allocate some 12.7 million hectares of land to marginalized communities between 2015 and 2019 under the Social Forestry Initiative (RI, 2014). The areas that have been allocated and proposed for social forestry are described in the Social Forestry Indicative Maps (PIAPS) (MEF, 2016a). Currently about 31% of the total PIAPS area is located on the island of Sumatra and about 29% in Kalimantan (equating to an area of 35,000 and 33,000 km^2, respectively). One scheme that has been put forward is *Hutan Desa* (HD) or Village Forest. The first HD was granted in Sumatra in 2009 and in Kalimantan in 2011, and the 2500 km^2 that has been allocated to date has typically been granted in watershed protection forest (*Hutan Lindung*) and production forest (*Hutan Produksi*) (MEF, 2016a).

HD aims to improve the social welfare and forest use rights of marginalized communities, by allowing forest to be managed communally through the authority of a village head following license approval by the central government (Myers and Ardiansyah, 2014). The scheme has been advocated as a first step towards securing land tenure and resolving conflicts between local communities and forest concession companies (e.g. logging, timber or oil palm plantation), thus providing a pre-condition to REDD+ projects (Akiefnawati et al., 2010; Atmadja et al., 2014; Resosudarmo et al., 2014). There have been several small scale studies of the performance of HD and other community forestry management schemes in Indonesia. These studies, however, have been focussed on sites with long-term partnerships with non-governmental organizations (NGOs) (Akiefnawati et al., 2010; Feintrenie and Martini, 2011; Intarini et al., 2014; De Royer et al., 2015). As such these studies represent a partial, and possibly biased, picture of the effectiveness of community forestry. The key lessons emerging have been that effectiveness is determined by multifaceted socioeconomic and political factors, the motivation of the local communities, and support from external organizations (Feintrenie and Martini, 2011; Rianawati, 2015; Sahide et al., 2016). Biophysical factors are likely to also influence the effectiveness of HD, and these are likely to vary spatially and temporally.

In addition to pressure from agriculture and problems with a weak land tenure system, forest management in Indonesia is further challenged by a changing climate, which has had major impact on the frequency and intensity of fires, and consequently there is a growing risk of wildfire-related deforestation (Langner and Siegert, 2009). Under global warming, Indonesia is projected to experience significant changes in rainfall patterns, with substantial decreases in rainfall in coming years (Lestari et al., 2014) and increased frequency of extreme El Niño events (Cai et al., 2014). Therefore, identifying the likely performance of HD under prolonged dry conditions will further inform appropriate regional climate change adaptation measures.

This study aims to assess the relative performance of HD in avoiding deforestation in Indonesia. Our study covered the islands of Sumatra and Kalimantan (1 million km^2 total extent), with 2500 km^2 of total HD area granted between 2009 and 2015. We extended a standard matching method (Dehejia and Wahba, 2002) controlling for variables that could confound the analysis of effectiveness (such as land use history, accessibility, agricultural productivity and seasonal rainfall) and characteristics that influence whether sites are granted HD licences. We assessed the performance of HD based on a counterfactual analysis of the likelihood of deforestation in the absence of HD tenure.

2. Materials and methods

2.1. Study area and unit of analysis

Our study area covered the islands of Sumatra (470,000 km^2) and Kalimantan (530,000 km^2), the Indonesian portion of the island of Borneo (Fig. 1). Land use in these islands is jurisdictionally categorized into two broad classes: Forest Estate or *Kawasan Hutan* and Non-forest Estate or *Area Penggunaan Lain* (APL) (Fig. 1 and Table 1). Forest Estate is designated by the government to be permanently used for forestry and conservation purposes and under the authority of the Ministry of Environment and Forestry (MEF). This can contain both forested and deforested areas, including protected areas (PA, e.g. national parks, wildlife reserves, nature reserves), watershed protection forest or *Hutan Lindung* (HL), and three types of production forest: limited production forest or *Hutan Produksi Terbatas* (HPT), permanent production forest or *Hutan Produksi Tetap* (HP), and convertible production forest or *Hutan Produksi Konversi* (HPK). HP can be converted to plantations, but ought to remain for forestry uses (e.g. industrial timber plantation), whereas HPK can be cleared for agricultural purposes. Because land clearing is