Biological Conservation 221 (2018) 357–364

Contents lists available at ScienceDirect

Biological Conservation

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

Rain, forests and farmers: Evidence of drought induced deforestation in Madagascar and its consequences for biodiversity conservation

Sébastien Desbureaux*, Richard Damania

The World Bank, USA

A B S T R A C T

Cropland expansion is the primary driver of deforestation worldwide. Since land and rainfall are two crucial inputs for agricultural production, a lack of rainfall may have severe consequences on yields, which in turn may lead to a change in cultivated areas, with possible impacts on deforestation rates. Our paper explores this issue of drought induced deforestation that has been largely neglected in the literature. By focusing on Madagascar where agriculture is mostly rainfed, we demonstrate that between 2000 and 2013, clearing additional forests was a strategy that farmers employ to cope with the negative impacts of droughts. Using remote sensing data and fixed-effects panel regressions, we find that droughts increased deforestation by 7.6% compared to years of near normal weather. The impact was most severe in dry and semi-arid areas (up to +17%). When droughts occurred across consecutive years, deforestation declined, a result that is consistent with risk averse behavior of farmers. We show that these results are not driven by ecological mechanisms or by accidental fires. We then study the implication of these outcomes for conservation policy and demonstrate that protected areas were partly effective at buffering against upsurges in deforestation induced by droughts. Our results reinforce the notion that when deforestation is an agricultural problem, agricultural solutions must be combined with conservation policies to decrease deforestation.

1. Introduction

Seven and a half percent of the world's forests have disappeared between 2000 and 2012 (Hansen et al., 2013), with dramatic consequences for species losses (Ceballos et al., 2015), for climate change (van der Werf et al., 2009) and for poverty alleviation. Over one billion people depend on access to forests for their livelihoods (WRI, 2005), which may account for almost a third of their incomes (Angelsen et al., 2014). Since forest biomass is more resilient to short term rainfall fluctuations than is crop production, forest products can provide a crucial safety net for poor rural households in times of natural disasters such as droughts and floods (Pattanayak and Sills, 2001; Angelsen and Wunder, 2003; Wunder et al., 2014). Yet, the pace of global forest loss continues unabated despite widespread recognition of the problem and its far reaching adverse ecological and developmental impacts, especially upon the forest-dependent rural poor.

The drivers of forest loss are reasonably well documented with a vast empirical literature that consistently identifies agricultural expansion as among the primary causes of deforestation (Geist and Lambin, 2002; Rudel et al., 2009). The most recent research exploits high-resolution spatial data and finds that 80% of cleared forests have been transformed into croplands (Hansen et al., 2013).

Our paper explores a related but largely neglected issue in the literature – the consequences of droughts on deforestation. Since land and rainfall are two crucial inputs for agricultural production, a lack of rainfall may have severe consequences on yields, which in turn may lead to a change in cultivated areas, with possible impacts on deforestation rates. Statistical evidence of these links is however sparse, while the predictions from economic theories and agronomic models are ambiguous and consequently provide limited policy guidance. Some behavioral models suggest that if droughts lower the profitability of agriculture, this will induce farmers to diversify into other activities thereby lowering pressures on cropland and forests (Fafchamps et al., 1998). Other theories predict that the opposite could occur (Ellis, 2000; Barrett et al., 2001). For instance, the safety-first models of subsistence farming and of cash crops economies suggest that if droughts reduce farm incomes, this may encourage further forest clearing as farmers seek to recoup for lower earnings by expanding cropland where this is feasible (De Janvry and Sadoulet, 2011). The response is also likely to vary with the duration and frequency of droughts. Consecutive and severe droughts could erode household savings and signal to farmers the need to lower their exposure to rainfall risks (Dillon and Scandizzo,

* Corresponding author at: The World Bank, 1818 H Street NW, 20433 Washington, District of Columbia, USA.
E-mail address: sdesbureaux@worldbank.org (S. Desbureaux).

https://doi.org/10.1016/j.biocon.2018.03.005
Received 8 October 2017; Received in revised form 22 February 2018; Accepted 5 March 2018
0006-3207/ © 2018 Published by Elsevier Ltd.

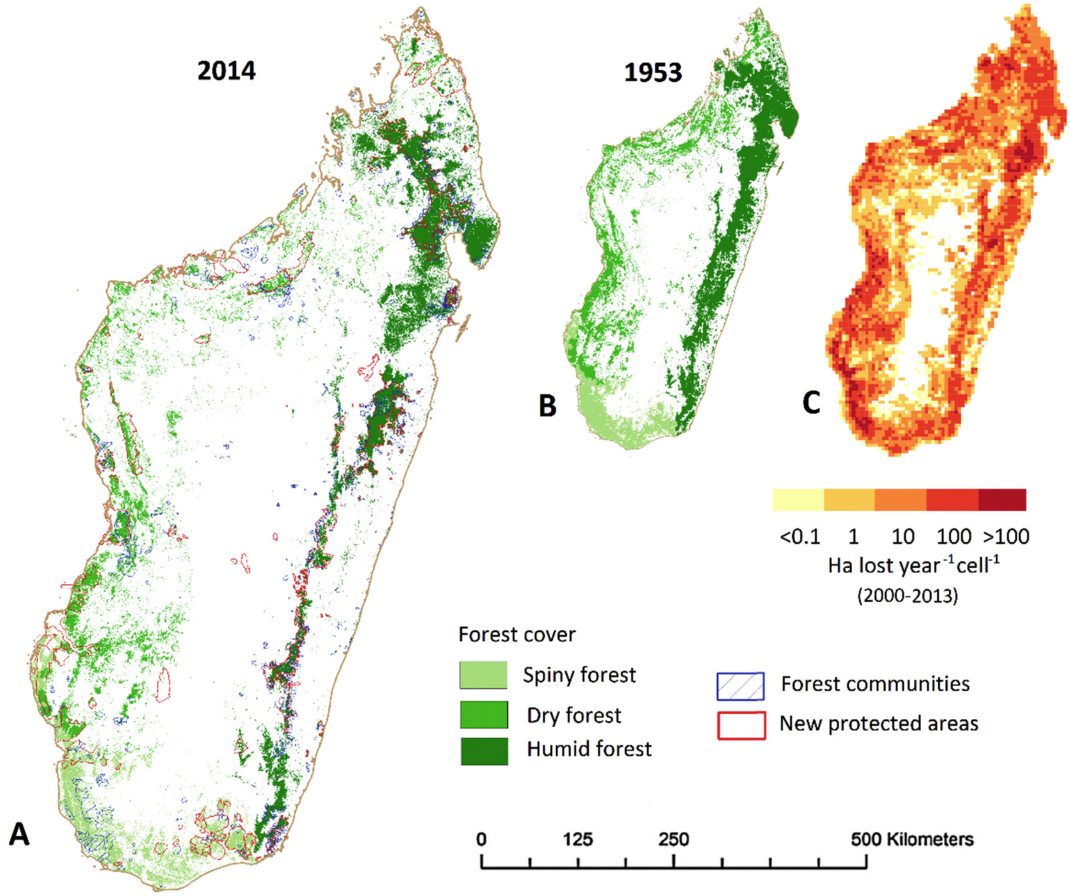

Fig. 1. Forests and deforestation in Madagascar, 1953–2014.
This figure shows forest cover in Madagascar as in 2014, and as in 1953 (B). We also display the average yearly forest lost by cell (0.1 degree) over the period we study. Forest cover in early 2014 based on our computations from the BioSceneMada project and Hansen et al. (2013). Protected Areas from Ministry of the Environment and CIRAD.Forests in 1953 from BioSceneMada project. Forest loss between 2000 and 2013 from Hansen et al. (2013).

1978; Yesuf and Bluffstone, 2009) by diversifying into other non-farm forms of employment that could result in a reduction in deforestation rates. It has been shown in West Africa that droughts in the twentieth century have pushed hundreds of thousands of cocoa planters to migrate from savanna regions to forests in the search of a wetter climate and more fertile lands. It has led to an increase in deforestation in the West African rainforest, as in Côte d'Ivoire (Brou, 2005; Ruf et al., 2014).

We study the relationship between droughts and local deforestation in the context of Madagascar. The island of Madagascar, with its immense forests and exceptional biodiversity, presents an apt case study for this exercise for at least three reasons. First, Madagascar is one of the most significant hot spots for nature conservation (Myers et al., 2000). It covers less than 1% of the Earth's terrestrial surface, but is home to more than 5% of global biodiversity, with an astonishing 90% of living species being endemic to the island (Goodman and Benstead, 2003). Forests are located in three ecoregions that all have their own ecological characteristics. The eastern part of the country with its humid climate is home of rainforests, dry forests are found in the dry west and spiny forests cover the semi-arid south part of the island (Fig. 1). Habitat loss due to deforestation remains exceptionally high. Studies suggest that Madagascar may already have lost 50% of its forest cover between 1950 and 2005 (Harper et al., 2007) with little sign of a reduction in habitat loss as shown in Fig. 1 (Harper et al., 2007; Mayaux et al., 2013). Recognizing these threats, the 2017-3 IUCN monitors 1535 threatened species on the island - the highest number in Africa. Second, Madagascar provides a suitable context in which to test the links between droughts, agriculture and forest loss. Rainfed agriculture, which uses rainfall as the main source of water for crop production, is the primary activity for more than 80% of the population and is also the primary driver of deforestation (Styger et al., 2007; Zaehringer et al., 2015). Around one million people depend on access to forests for their livelihoods (Desbureaux, 2016), and forests provide to these inhabitants a broad range of ecosystem services (Neugarten et al., 2016). Agriculture is dominated by slash and burn cultivation mainly for rice production in the east and central part of the island, and for maize production in the drier regions. In a context of rapid population growth, +2.7% in 2016 according to the World Bank's figures, existing fallows are not sufficient to provide sufficient land for agriculture, leading farmers to clear forests. A third reason to focus on Madagascar is the geographic variation in its climate. Rainfall in the western and southern regions of the country is rare, and Madagascar has one the most unpredictable climates on the planet (Dewar and Richard, 2007), partly because of the El Nino Southern Oscillation (Kreppel et al., 2014). With erratic and scarce rainfall, it is highly likely that famers have developed different strategies to cope with extreme weather events, including flooding (Blanc-Pamard and Ruf, 1992; Brimont et al., 2015) and droughts (Harvey et al., 2014). While the setting of our study is geographically limited to Madagascar, its context is relevant for many other developing countries which predominantly rely on rainfed agriculture, and will likely experience an increase in the variability of rainfall over the coming decades because of climate change.

We combined multiple sources of vegetation and weather satellite data to provide quantitative causal estimates of the impact of droughts on deforestation in Madagascar between 2000 and 2013. We show three main results. First, droughts significantly increased deforestation,

Download English Version:

https://daneshyari.com/en/article/8847345

Download Persian Version:

https://daneshyari.com/article/8847345

Daneshyari.com