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Land related grievances shape tropical forest-cover in areas affected by armed-conflict

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Armed-conflicts often occur in tropical areas considered to be of high ‘conservation-value’, termed as such for their biodiversity or carbon-storage functions. Despite this important overlap, few studies have assessed how forest-biomass is affected by armed-conflicts. Thus, in this paper we develop a multinomial logit model to examine how outcomes of the interactions between carbon-storage, armed-conflict and deforestation rates are linked to social, institutional and economic factors. We use Colombia as a case study because of its protracted armed-conflict, high forest-cover, sustained deforestation rates and on-going peace processes. Our empirical results show that the impacts of armed-conflicts on forest-cover are connected to specific socio-economical processes, such as unequal land distribution and land-grabbing, which typically occurs as part of ‘agricultural colonization’. Findings address a research gap by providing statistically sound evidence for associations between armed-conflicts and land-related grievances, which has rarely been demonstrated empirically. Our results also suggest that forest commons are associated with reduced armed-conflict, and simultaneously provide contributions to carbon storage and to meeting basic needs. Moreover, our forest-conflict transition models provide useful visual means to capture and relay to policymakers-the causes of forest cover-changes in a conflict-affected country. Finally, our findings imply that in dedicating their efforts to resolving land-ownership disputes, the Colombian government might uphold their international climate change commitments via reducing deforestation and hence forest based carbon emissions, while pursuing their national security objective via undermining opportunities for guerrilla groups to operate.

1. Introduction

The global demand for increased forest-biomass for climate change mitigation (Harris et al., 2012), in combination with the need for peacebuilding in many countries with large tracts of tropical forests (Hanson et al., 2009), makes the relationship between forest-biomass and armed-conflicts particularly important. That is, tropical forests not only play a key role in global climate change, they also host many of the world's armed-conflicts. Despite this important overlap, the ways in which tropical forest-biomass and armed-conflicts are linked is unclear, as are the ways that specific contextual factors interact and determine forest-cover loss, or conversely help to conserve it (Aide & Grau, 2004; Burgess, Miguel, & Staton, 2015; Butsic, Baumann, Shortland, Walker, & Kuemmerle, 2015; Hecht & Saatchi, 2007; Ordway, 2015; Sanchez-Cuervo & Aide, 2013).

A better understanding of these relationships could assist policymakers demonstrate the impacts of conflict and post-conflict scenarios on forest-cover, therefore permitting them to justify peacebuilding measures as contributions to carbon-storage efforts and, ultimately, to climate change mitigation (Bates, 2016; Castro-

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The mechanism for reducing forest-based greenhouse gas emissions (known as REDD+), agreed under the United Nations Framework Convention on Climate Change (UNFCCC) negotiations, is a concrete tool that may be used to jointly address carbon storage and peacebuilding. For instance, when the later successful 2016 peace agreement between the Government of Colombia (GoC) and the Revolutionary Armed Forces of Colombia (FARC) was negotiated, the GoC submitted a Forest Reference Emissions Level (FREL) to the UNFCCC arguing that the cessation of conflict will increase forest-based emissions in the Colombian Amazon by 10% mostly as a result of deforestation due to increased forest access (MADS, 2014). However, there is, in fact, no agreed theoretical framework for understanding how forest-biomass might be affected by either the continuation or cessation of armed conflicts (Ordway, 2015).

Causal links between forest-cover and armed-conflicts originate in the 'environmental security' field (de Jong, Donovan, & Abe, 2007). Environmental security literature generally groups such linkages into three possible mechanisms: natural resource scarcity or unequal sharing (Homer-Dixon, 1994); accessibility and competition (Peluso & Watts, 2001); or opportunities that forested areas present for illegal armed groups' covert operations (Collier & Hoeffler, 2004). Moreover, these three foci indicate that forested landscapes are linked to areas with: (1) weak state presence, (2) high-value natural resources for financing combatants and armed groups' hideouts, (3) grievances (for example due to disputes over resources rights and access), (4) a civil population that has been attacked and displaced by armed groups attempting to accumulate assets and expand their territorial control (Collier & Hoeffler, 2004; Rustad & Binningsbø, 2012; Rustad, Rød, Larsen, & Gleditsch, 2008; de Jong et al., 2007). However, despite many arguments linking forests with armed-conflicts, much empirical research indicates that the mere condition of 'tropical forest-cover' is a poor predictor of conflict (Harwell, 2010; Rustad et al., 2008).

Meanwhile, forest-cover changes are principally caused by agricultural expansion, wood extraction and infrastructure, which in turn are driven by various factors including social and political unrest (Geist & Lambin, 2002). Consequently, empirical studies of conflict and post-conflict periods' impacts on forest-cover provide varied and often divergent findings (Baumann & Kuemmerle, 2016; Burgess et al., 2015; Ordway, 2015). Increases in forest-cover have been attributed to: forced migration (Aide & Grau, 2004); a variety of social, institutional and economic behavioural patterns, such as reduced agricultural production due to remittances (Hecht & Saatchi, 2007); and post-war economic development (Rudel, Perez-Lugo, & Zichal, 2000). In other analyses, forest-biomass loss has been linked to armed groups' natural resource exploitation (Butsic et al., 2015; Ordway, 2015; Sanchez-Cuervo & Aide, 2013). More recently, it has been argued that the impacts of armed-conflicts depend on specific contextual factors (Baumann & Kuemmerle, 2016), which include armed groups' strategic use of forested areas (Castro-Nunez et al., 2016). Analyses, however, might be faulted for their focus on national and sub-national correlations between tropical forest-cover and armed-conflict variables, without considering other factors contributing to both conflict and forest-cover changes. That is, these studies often fail to account for the complex interplay of social, economic and institutional contexts related to natural resource and forest use (Harwell, 2010). As a result, in contexts of armed conflict, it remains unclear which social, economic and institutional factors are related to positive (increased forest biomass and biodiversity) or negative outcomes (reduced forest biomass and biodiversity).

The objective of this paper is thus to improve the understanding of the links between tropical forests-biomass and armed-conflicts. To this end, we examine how carbon-storage, armed-conflict and forest-cover change are jointly linked to social, institutional and economic factors by using publicly available municipality-level data from Colombia. Specifically, our analysis focuses on how outcomes of the interactions between carbon-storage, armed-conflict and forest-cover change (defined by classifying Colombian mainland municipalities based on three variables carbon storage, armed actions and deforestation rates), are associated with eight factors, namely: demography; conflict victims; illegal activities; land inequality; institutional performance; accessibility; poverty; and forest commons. These factors were selected because each has been associated, albeit in varying ways, with forest-cover changes (Armenteras, Cabrera, Rodríguez, & Retana, 2013; Chadid, Dávalos, Molina, & Armenteras, 2015; Dávalos et al., 2011; Dávalos, Holmes, Rodríguez, & Armenteras, 2014; Etter, McAlpine, Phinn, Pullar, & Possingham, 2006b; Geist & Lambin, 2002; Sanchez-Cuervo & Aide, 2013), as well as with various levels of conflict in Colombia (Albertus & Kaplan, 2013; Ibáñez & Moya, 2010; Ibáñez & Vélez, 2008; Ross, 2007).

2. The study site

Colombia, located in north-western South America, covers an area of 1.1 million km^2, and is inhabited by approximately 45.4 million people. The country comprises 32 departments (sub-national jurisdictions), which are divided into 1123 municipalities (including those located in the Archipelago of San Andrés, Santa Catalina and Providencia). Colombia's economy is based on agricultural production (mainly coffee cultivation and cattle ranching), mining and oil production and with an estimated 14% of earth's biodiversity the country has the third highest biodiversity in the world (Armenteras, Rudas, Rodriguez, Sua, & Romero, 2006; Orme et al., 2005). Therefore, many people regard protection of Colombia's forests and biodiversity as a global conservation priority (Myers, Mittermeier, Mittermeier, da Fonseca, & Kent, 2000; Olson & Dinerstein, 1998).

Since the 1940s, Colombia has hosted some level of armed-conflict, led by illegal armed groups such as guerrilla insurgencies, paramilitary forces and drug traffickers. Over the last few decades a combination of factors (including unequal land distribution and land grabbing) have displaced more than 3.5 million people from rural areas, thus perpetuating the state of conflict and undermining long-term peace consolidation efforts (Albertus & Kaplan, 2012; IDMC, 2006; Ibáñez & Vélez, 2008; Ross, 2007). Nonetheless, in November 2016, in culmination of over three years of negotiations, GoC and the Revolutionary Armed Forces of Colombia (FARC) signed a peace agreement. This process was facilitated by various countries, including the governments of Norway, Venezuela and Cuba (Zuleta, Villaveces, & Andonova, 2013). In parallel to this process, the GoC was developing its National REDD+ Strategy (ENREDD), which is intended to contribute to climate change mitigation via forest conservation and development activities.

Yet, the causes of Colombia's deforestation are not fully understood. The literature indicates differences between regional and local -level drivers of deforestation (Armenteras, Rodriguez, & Retana, 2013, 2009; Sanchez-Cuervo & Aide, 2013), which in turn reflects the country's diverse socio-economic (Armenteras, Rodriguez, Retana, & Morales, 2011), demographic (Armenteras et al., 2011), political (Sanchez-Cuervo & Aide, 2013), institutional (e.g. regime categories) (Armenteras, Rodriguez, & Retana, 2009) and biophysical (Sánchez-Cuervo, Aide, Clark, & Etter, 2012) -contexts. Some studies claim that the overwhelming driver of land-cover change, across Colombia, is the conversion of forests to livestock pasture (Dávalos et al., 2011; Dávalos et al., 2014; Etter, McAlpine, Phinn, Pullar, & Possingham, 2006a, 2008; Vina &