



## Overlapping land allocations reduce deforestation in Peru

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### ABSTRACT

Overlapping land use allocations, in which one parcel of land is allocated two or more times for different uses, either intentionally or unintentionally, are common globally. We assess how overlapping land use allocations impact forest cover change using Peruvian government data for the lowland Amazon. Results are based on propensity score matched difference-in-differences methods using 1-ha resolution forest loss data for 2000–2014, along with Peruvian government land use allocation data. We find that deforestation is lower in overlapping than in same-type, non-overlapping allocations. This finding is consistent across all types of overlapping land use allocations. These results support the hypothesis that multiple use management decreases deforestation, and provide no evidence indicating that overlapping allocations are a form of tenure insecurity that might increase deforestation. Our findings inform conservation policy related to multiple use management, land tenure security, and conflict avoidance.

### 1. Introduction

In support of conservation and land use policy, extensive research has analyzed the conditions under which land use allocation<sup>1</sup> increases or decreases deforestation (Geist and Lambin, 2002; Kaimowitz and Angelsen, 1998; Lambin et al., 2014; Oliveira et al., 2007). Among different types of land use allocation, research has been most prolific on protected area allocations, for which recent research using quasi-experimental matching methods confirms that protected area allocations such as national parks suffer less deforestation than non-protected area land use allocations (Andam et al., 2008; Joppa and Pfaff, 2011; Miranda et al., 2014; Nolte et al., 2013b; Pfaff et al., 2015). Less research has focused on examining deforestation in land use allocation types outside of protected or indigenous-controlled areas (Blackman et al., 2014; Bruggeman et al., 2015; Nelson and Chomitz, 2011; Porter-Bolland et al., 2012). To our knowledge, no studies have used quasi-experimental matching methods to consider the case of deforestation in overlapping land allocations, which occur frequently on forested lands

throughout the tropics.

Overlapping land allocations are cases in which the same parcel of land is allocated to more than one use, such as logging concessions overlapping with oil concessions, indigenous territories overlapping with logging concessions, or non-timber forest product concessions overlapping with protected areas. The few studies that have considered overlapping allocations primarily focused on overlap due to conflict between formal national land use allocations and traditional or customary land use areas (Fox et al., 2009; Lambin et al., 2014; Lestrelin et al., 2012). The objective of this study is to assess forest outcomes in overlapping formal national-level land use allocations.

We use the case of overlapping land use allocations in the Peruvian Amazon, where both accurate deforestation data and accurate land use allocation data are available (Fig. 1). Peru has the fourth largest tropical forest area globally, with 76 million ha of forest land (Asner et al., 2017). It is a high forest cover, low deforestation country, with a 0.22% annual rate of deforestation (Robiglio et al., 2014). Forest degradation has been estimated at 27% of anthropogenic forest cover loss (Asner

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<sup>1</sup> For the purposes of this research, we define land use allocation following FAO, as the process of specifically delineating an area of land to be used for an agreed purpose (FAO Land and Water Development Division, 1995). Land use allocation is in a strict definition a step that comes after land use zoning, which concerns the general allotment of land for various uses such as agriculture, protection, development, etc.

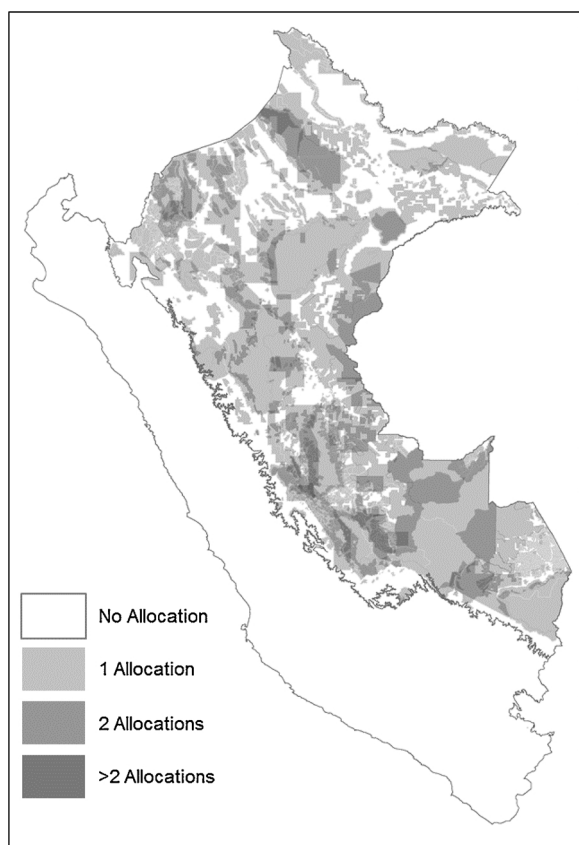


Fig. 1. Map of overlapping land use allocation in the Peruvian Amazon. Data Source: Dirección General de Ordenamiento Territorial, MINAM, Peru.

et al., 2010). Improved understanding of the relationship between land use allocation and deforestation patterns is of renewed importance as Peru has a national-level goal of conserving 54 million ha of forest and achieving zero net greenhouse gas emissions from land use change and forestry by 2021 (Ministry of Environment Peru, 2014). Recent research has documented the patterns associating deforestation with various land use allocations in Peru (Asner et al., 2014; Blackman et al., 2014; Gutiérrez-Vélez and DeFries, 2013; Miranda et al., 2014; Oliveira et al., 2007), including informal uses (Asner et al., 2013), but no analysis has investigated how overlapping land use allocations influence deforestation.

Cases of overlapping allocations in Peru are primarily assumed to be unintentional; different government bodies allocated the same land for different uses, likely due to a lack of coordination. In some cases, overlapping allocations may be intentional but presumed to cause no conflict; allocations such as oil extraction, which is considered a ‘sub-surface’ activity may conflict little with an allocation such as logging, which is considered a ‘surface’ activity.

Regardless of the government’s intention in creating overlapping allocations, the overlaps provide an opportunity to consider several

questions of land use policy and conservation including multiple use, conflict avoidance, and tenure security. The overlapping allocations might be viewed as cases of ‘multiple use’ of land, land tenure insecurity, or places that concession holders would avoid due to potential conflicts with the overlapping land user (Guariguata et al., 2012; Karsenty and Vermeulen, 2016; Robinson et al., 2013).

Traditionally, conservation is predicated on allocating land exclusively for conservation – e.g., in Peru, protected areas, wildlife management, and complementary protected areas. In addition to these clearly demarcated allocations, conservation goals may be met in lands that are allocated for other uses, such as logging, non-timber forest products, indigenous areas, oil concessions, or buffer zones. 72% of the Peruvian Amazon is allocated. Of all allocated lands that are forested, 25% is comprised of overlapping allocations, so it is important to examine the relationship between these land uses and conservation outcomes such as forest cover. In this study, we ask: What is the impact of overlapping land use allocations on forest cover? We find that overlapping land use allocations decrease deforestation. These results are relevant for informing multiple use management, land tenure security, and conflict avoidance.

## 2. Materials and methods

The study area is the lowland Peruvian Amazon. The data used include: 1) deforestation at 1-ha resolution derived by the Peruvian Ministry of Environment using remotely sensed Landsat data, and 2) land use concession polygon data from the Government of Peru. The two are used together to assess deforestation in overlapping land use allocations. The Landsat images were converted to a forest loss map using CLASlite (Asner et al., 2009), and data were scaled to 1 ha forest loss pixels for 2000–2005, 2005–2009, 2009–2010, 2010–2011, 2011–2013, and 2013–2014. This data set was produced following the methods of Oliveira et al. (2007) in partnership with the Ministry of Environment of Peru (MINAM) (Dirección General de Ordenamiento Territorial, 2011; Dirección General de Ordenamiento Territorial Peru Ministerio del Ambiente, 2015). The unit of analysis for this study is a 1-ha pixel with either no change or forest loss during the period of study.

The land use allocation polygons include maps of non-timber forest product concessions, timber concessions, indigenous communities, conservation areas, buffer zones, and oil blocks. A full list of allocation types is found in the Supplementary Material Table 1. For the purposes of matching, which requires pairwise comparison, land use allocations were grouped according to conservation allocations, commercial allocations, and sustainable land use allocations (Fig. 2). Sustainable land use allocations are those that are neither strictly conservation nor commercial but include elements of both in sustainable land use. Using a typology of the allocation types that are likely to interact allows for fewer pairwise comparisons than comparing across each of the 11 allocations. Select pairs of each specific land use allocation were also tested and provided consistent results, including for indigenous territories.

Analysis of deforestation in overlapping land use allocations was conducted using a quasi-experimental design, which approximates an

Table 1  
Matching results for multiple allocation as compared single allocation.

Overlap type <sup>†</sup>	conservation + sustainable	commercial + sustainable	conservation + commercial	commercial + commercial	sustainable + sustainable
Matching Estimate (Standard Error)	–0.00235** (.0012)	–0.0600*** (.0013)	–0.00921*** (.0010)	–0.0496*** (.0019)	–0.0398*** (.0020)
[N of matched pairs]	[148,213]	[370,602]	[177,807]	[146,594]	[112,811]

<sup>†</sup> Insufficient data for conservation + conservation; of 1,000,000 points, only 2 matches were identified.

\*\*\* P < 0.01.

\*\* P < 0.05.

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