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Protected Area Downgrading, Downsizing, and Degazettement (PADDD) in the Amazon

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ABSTRACT

Protected areas (PAs) are a cornerstone of biodiversity conservation. Brazil, home to one-third of the world's tropical forests and 12% of its PAs, is a global leader in PA creation and management. Despite this leadership, evidence suggests that Brazil is scaling back elements of its PA network through a process known as PA downgrading, downsizing and degazettement (PADDD). To examine PADDD in Brazil, we created a comprehensive spatial database and documented all enacted and proposed PADDD events since 1900. We identified 67 enacted PADDD events, which affected 112,477 km^2 and eliminated 6% of Brazil's total potential terrestrial PA estate. Hydropower (39%) and rural human settlements (20%) were associated with most of these enacted PADDD events, which have increased in frequency since 2005. Another 27 active PADDD proposals currently threaten to eliminate 60,555 km^2 of protected lands. We then compared short-term deforestation rates in Brazilian Amazon forests that experienced PADDD to deforestation rates in corresponding still-protected and never-protected forests. Contrary to previous research, we did not find a significant causal effect of enacted PADDD events on short-term deforestation rates; rather, short-term deforestation rates in PADDDed forests appear correlated with broader patterns of deforestation. These findings suggest the need for national policies governing PADDD that are analogous to policies governing the initial establishment of PAs, including transparency, technical studies, public consultation, and compensatory measures.

1. Introduction

National parks, nature reserves and other protected areas (PAs) are a cornerstone of global efforts to conserve the world's biodiversity. In tropical forests, PAs inhibit deforestation when compared to unprotected areas (Andam et al., 2008; Joppa and Pfaff, 2010). In the Brazilian Amazon, all categories of PAs have shown to reduce deforestation (Nepstad et al., 2006; Soares-Filho et al., 2010; Nolte et al., 2013); the probability of deforestation is 7 to 10 times lower in PAs than in surrounding areas (Ricketts et al., 2010).

Currently, more than 197,000 PAs cover 15.4% of Earth's terrestrial and inland water areas, and their global extent is increasing over time (Juffe-Bignoli et al., 2014). Recent evidence, however, shows that many PAs worldwide are losing legal protections through a process known as protected area downgrading, downsizing and degazettement (PADDD) (Mascia and Pailler, 2011; World Wildlife Fund, WWF, 2014). PADDD consists of legal changes that impact PAs by allowing more human activity within them (downgrading), reducing their spatial extent (downsizing), or eliminating their protected status entirely (degazettement; Mascia and Pailler, 2011). PADDD occurs on a global scale, affecting at least 503,500 km^2 of protected lands in 57 countries (Mascia et al., 2014). Although PADDD has been used in some cases to improve the overall effectiveness of a PA network, the proximate causes of most enacted PADDD events are generally associated with industrial-scale resource extraction and development, or local land pressures and land claims (Mascia et al., 2014). As such, PADDD events are correlated with land use change. In Peru and Malaysia, PADDDed lands experienced higher total deforestation and carbon loss than both protected and unprotected forests (Forrest et al., 2014). In Brazil, a report found that deforestation increased after legal changes in 10 PAs (Martins et al., 2014). Larger PAs appear to be at greater risk of PADDD than

Abbreviations: ARPA, Amazon Protected Areas Program; BACIP, before–after-control-impact-paired series research design; CBD, Convention on Biological Diversity; CU, Conservation Unit; PA, protected area; PADDD, protected area downgrading, downsizing, and degazettement; MMA, Ministério do Meio Ambiente; SNUC, Sistema Nacional de Unidades de Conservação; WDPA, World Database on Protected Areas.

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smaller PAs, perhaps due to greater opportunity costs associated with larger PAs (Symes et al., 2015).

PADDD is particularly relevant to countries with extensive PA estates, such as Brazil. Home to the world's largest PA network, Brazil governs approximately 2.2 million km^2 of PAs, which represents 12% of the global extent (IUCN and UNEP–WCMC, 2013). Excluding indigenous lands, *quilombola* territories (areas owned by descendants of slaves), and military areas, protected areas in Brazil are known as *unidades de conservação* (conservation units, hereafter CUs). Brazil's 887 federal, 761 state, and 180 municipal CUs cover nearly 1.5 million km^2, about 70% of its total protected land area (Ministério do Meio Ambiente, MMA, 2014). In the early 2000s, Brazil was a global leader in PA creation, responsible for establishing 74% of the total area protected globally from 2003 to 2009 (Jenkins and Joppa, 2009). From 2003 to 2006 alone – a time period which coincides with the Amazon Protected Areas Program (ARPA) – Brazil established 487,118 km^2 of CU land, which constituted 40% of all CUs existing in 2010 (Veríssimo et al., 2011). Through this expansion, the Brazilian government aimed to reduce illegal deforestation, regularize land tenure, and protect biodiversity (Veríssimo et al., 2011); evidence suggests that the expansion reduced total deforestation in the Amazon by 37% between 2004 and 2006 (Soares-Filho et al., 2010). Since 2009, however, PA creation has stagnated. Recent evidence suggests that the rate of PADDD is increasing (Bernard et al., 2014) due to a political and economic landscape that prioritizes resource use and development over PA creation and maintenance (Campos-Silva et al., 2015; Ferreira et al., 2014).

Previous research suggests widespread PADDD in Brazil, with substantive impacts on biodiversity (Bernard et al., 2014; de Marques and Peres, 2015; Martins et al., 2012). Bernard et al. (2014) documented 42 PADDD events enacted between 1981 and 2012, resulting in the loss of 51,785 km^2 of CU area across the country. De Marques and Peres (2015) focused on federal bills that affect CUs, documenting 23 proposed and 4 enacted PADDD events occurring between 2001 and 2013. Additionally, Martins et al. (2012) examined 10 proposed PADDD events in the Amazon, describing how an increase in illegal occupation and forest degradation in PAs has driven legal changes to CUs and indigenous territories. These studies highlight recent shifts in Brazilian policy that have fostered infrastructure projects and agricultural land conversion, even when these initiatives are in direct conflict with established CUs. Despite the potential for PADDD to affect biodiversity and ecosystem services, however, research to date has not comprehensively examined PADDD dynamics in Brazil nor rigorously explored PADDD impacts on Amazonian biodiversity.

To address this knowledge gap, we (1) document the extent, geographic patterns, temporal trends, and proximate causes of PADDD in Brazil from 1900 to 2014, and (2) document the impacts of PADDD on short-term deforestation rates, comparing rates in Amazonian CUs where PADDD was enacted to rates in corresponding protected and never-protected areas. Using forest change data, we demonstrate how forest cover changes in the short-term after a protected area is downgraded, downsized or degazetted, providing deeper insight of the implications of PADDD for tropical forests. Our research offers key insights for conservation science, policy, and practice in Brazil and beyond.

2. Materials and methods

2.1. PADDD data collection and preparation

We created a comprehensive database of enacted and proposed PADDD events in Brazil from 1900 to 2014, following research standards and methods described by Mascia and Pailler (2011), Mascia et al. (2014) and World Wildlife Fund, WWF (2014)). We do not consider upgrades, in which legal protections for a CU are increased (Bernard et al., 2014; de Marques and Peres, 2015). We examined PADDD in Brazilian Conservation Units (CUs) only, which are regulated by the Sistema Nacional de Unidades de Conservação (SNUC).

We reviewed the scientific literature, technical reports, legal documents, and popular media for reported instances of PADDD in Brazil. We conducted a comprehensive search in English and targeted searches in Portuguese on Web of Science, Google Scholar, and Google, using a combination of various keywords for "protected area" (e.g., park, nature reserve) and various keywords for downgrading, downsizing, and degazettement (e.g., delist, abolish). We searched for evidence of changes in PA legislation on multiple Brazilian government websites, including the Chamber of deputies (Camara dos Deputados) (2014), the Senate (Senado Federal) (2014), and the Brazilian CU database (Instituto Socioambiental, ISA, 2013). We examined and confirmed PADDD events reported in previous published literature (Martins et al., 2012; Bernard et al., 2014). To verify a PADDD event, we required one to three independent sources, including legal documentation, and screened all leads using established decision trees (Mascia et al., 2012).

The database includes all available information on enacted and proposed PADDD events. We attempted to collect data on 20 variables for each PADDD event, including its location, area affected (the legal spatial extent of PADDD event), PADDD type, year PADDD was enacted or proposed, proximate cause, and proposal status (Table A1). We defined a PADDD proposal as *active* if it could pass without needing a new bill to bring it forward, or as *inactive* if it had not experienced legislative movement since December 2012 and had not been officially archived. We uploaded all tabular data to PADDDtracker.org, an online, crowdsourced mapping tool designed to document, verify, and disseminate PADDD data globally (World Wildlife Fund, WWF, 2014).

2.2. Descriptive analysis

We examined the PADDD dataset as a whole and by biome, analyzing patterns in PADDD variables including event type, cause, and area affected by PADDD. We omitted events that were reversed within two years of enactment ($n = 1$). We also excluded potential PADDD events lacking sufficient legal documentation, thus excluding at least 76 probable incidences of PADDD caused by mining (Instituto Socioambiental, ISA, 2006). When calculating the total area affected by PADDD, if two or more events overlapped ($n = 5$), we omitted the area affected for all but the most recent event. We calculated the total area permanently removed ("lost") from the national CU estate by summing the area affected in all downsizing and degazettement events. We calculated the nation-wide, potential terrestrial PA estate as the sum of this area already "lost" and the current CU extent (Ministério do Meio Ambiente, MMA, 2014; Mascia et al., 2014).

We generated spatial data for the area affected ("PADDDed") by each PADDD event using two methods. For degazettements and downgrades, which affect the entire CU, we created polygons to match the CU boundaries in the year PADDD occurred. For downsizes, which affect only a portion of the CU, we either 1) manually digitized maps from government, NGO, and/or media reports, or 2) converted boundary coordinates into polygons of the area affected by PADDD, using minimum boundary geometry. We extracted these coordinates from text listed in the "Memorial Descritivo" section of legal documents, which describes either the new boundaries or the area affected by the legal change.

With the final dataset showing the spatial distribution of all PADDD in the Amazon, we calculated the proportion of PADDD events that overlapped spatially with areas designated as being extremely high priority for the conservation, sustainable use and benefit sharing of Brazilian biological diversity, as designated by the Brazilian Ministry of Environment (Ministério do Meio Ambiente, MMA, 2007). Additionally, we examined the distribution of PADDD events among IUCN categories, to explore PADDD frequency and area affected in strictly protected (IUCN categories I-III) and sustainable use (IUCN categories IV–VI) PAs (Table A2).