

1. Summary

Deforestation is a matter of pressing global concern, contributing to declining ecosystem services, biodiversity loss and growing carbon emissions. In particular the last century has seen an increase of deforestation in previously untouched ecosystems, with the prime example being the amazonian forest. Similarly, mangrove forests, which are inter-tidal forests occurring along tropical, subtropical, and some temperate coasts have been experiencing equal or greater rates of deforestation (Duke et al., 2007; Richards and Friess, 2016). Despite this fact, the issue of mangrove degradation and deforestation has received comparatively little attention (Friess et al., 2019).

Mangrove forests overlap with high and increasing densities of human populations. Therefore, mangroves provide key regulating, provisioning and cultural ecosystem services such as coastal protection, pollution control, food provision, and cultural values for hundreds of millions of people (Barbier et al., 2011). Mangroves' ability to provide relatively larger carbon sequestration when compared to other forests, as well as increased coastal resilience in the face of extreme weather patterns (Del Valle et al., 2020; Hochard et al., 2019), has placed them on the international climate change mitigation and adaptation agenda. Recent global commitments made during COP 26 highlight the critical importance of stopping deforestation. To achieve this, policymakers stressed the central role "[...] and value of knowledge and forest guardianship provided by Indigenous Peoples and local communities, calling for indigenous peoples to be empowered as such" (UNFCCC, 2021).

To curb deforestation numerous policies have been implemented with varying degrees of success. The promotion of property rights, through land titling, has been championed as a policy to reduce deforestation and to achieve development goals, with potential benefits ranging from poverty reduction to food security (Liscow, 2013; Miller et al., 2021). Moreover, transferring formal property rights to indigenous peoples and local communities addresses environmental justice and human rights issues concerning violence, expropriation and encroachment (BenYishay et al., 2017).

Property rights for indigenous and local communities also play a central, albeit, little recognized, role in the fight against climate change. Amazon indigenous territories alone cover nearly one-third of the region's land area across eight countries, and along with protected areas, protect over 52 percent of existing carbon stocks in the entirety of the Amazon forest (Walker et al., 2020). Theoretically, property rights could have ambiguous effects on deforestation depending on institutional and market settings (Busch and Ferretti-Gallon, 2017). Empirical evidence has found that land titling increased deforestation by small landholders in Brazil (Probst et al., 2020), and Nicaragua (Liscow, 2013), although both studies focus on private land holders. In contrast, recent evidence on communal/indigenous property rights¹ policies, finds mixed evidence on its effect on deforestation (Baragwanath and Bayi, 2020; BenYishay et al., 2017; Blackman et al., 2017; Buntaine et al., 2015). Rigorous analyses of titling campaigns are rare, with most studies not dealing with the non-random assignment of policy, therefore risking biased estimates of policy impact. Moreover, related theoretical and empirical research suggests that tenureship changes could either stem or spur forest damage impact (Miller et al., 2021; Busch and Ferretti-Gallon, 2017).

We identify several gaps in this broader literature, which mostly focuses on the effectiveness of interventions using panel methods, therefore not dealing with potential time-varying omitted

¹ Communal property rights are usually held in common ownership and may not be transferred or used as collateral (Probst et al., 2020).

variables that might bias estimates of interest (Blackman et al., 2017; Busch and Ferretti-Gallon, 2017; Miller et al., 2021). Furthermore, this body of work seldom presents empirical evidence of why or how these interventions work, nor do they reconcile observed effects with possible theoretical mechanisms behind said successes or failures (Deaton, 2010; Finer et al., 2018). We address these gaps in our study, and provide, to our knowledge, the first causal evaluation of a property rights based project targeting a previously understudied ecosystem, i.e. mangrove forests. Our aim is to contribute to the research on deforestation in the tropics and relevant climate and development policy, by first empirically examining the effects of formalizing land rights to “ancestral users” and its effectiveness on reducing mangrove deforestation in Ecuador. Secondly, we propose mechanisms that make said policy work, accounting for the role of international aid and NGO involvement in policy enrollment and outcomes. Specifically, we focus on the effect of local institutions by ancestral users, the presence of common-pool resources such as fisheries, and non-governmental organization involvement as the main mechanisms of policy success. To this end, we establish a simple stylized model to guide the empirical strategy and gain insights into conservation outcomes and policy adoption from communities. Our study is centred on the “Acuerdos de uso sustentable y custodia de manglar” (AUSCM) land titling policy, a pioneering land rights program across coastal Ecuador for mangrove conservation launched in the year 2000, and included in Ecuador’s national climate policy structure.

Our research contributes to three strands of literature. First we add to the literature on policy evaluation and causal methods in tropical deforestation (Sims, 2010; Ferraro et al., 2012; Liscow, 2013), specifically the effect of property rights granted to indigenous communities on mangrove deforestation, thereby expanding this literature to an important ecosystem. Second, this research aims to add to the body of work on common pool resources and endogenous institutions, in the framework of decentralized environmental and climate change policy (Dietz et al., 2003; Ostrom, 2010). Finally, we contribute to the growing body of literature on the role of the non-profit and non-governmental sector in influencing policy implementation, compliance, and policy relevant outcomes (Usmani et al., 2021; Grant and Grooms, 2017; Deaton, 2010).

The AUSCM policy was formulated in 1999 and implemented in 2000 in response to the rampant deforestation the country experienced during the 20th century which led to losses of over 40% of all mangrove coverage in Ecuador. This historical process was characterized by systematic encroachment and episodes of violence, leading to not only the loss of the ecosystems, but also to the loss of the traditional means of subsistence of ancestral communities, with adverse effects on development and food security (Beitl, 2014; Veuthey and Gerber, 2012). By 2020, 60 communities had property rights assigned, and 94 in total had been historically part of the policy. Communities voluntarily join the program, and over 30 percent of all remaining mangrove coverage in the country is covered by the policy.

Given that both policy and NGO presence are not assigned randomly, to achieve our stated goals presented above we develop an identification strategy that deals with the endogeneity of a) policy adoption by communities and b) NGO involvement. First, we evaluate the causal impact of the AUSCM policy on mangrove deforestation by employing an instrumental variable strategy, using the presence of aquatic organisms and relevant soil types as exogenous predictors of policy adoption. Second, by exploiting the variation in NGO involvement across time and communities, we investigate the causal impact of non-profit and non-governmental involvement on policy adoption and permanence. We employ a regression discontinuity design exploiting partisan voting behavior in the United States Congress as exogenous predictor of foreign aid disbursements and thus NGOs presence in policy uptake. We use this approach, since most of the NGOs who were working with

ancestral communities in the periods we study were at least partly funded by the United States Agency for International Development (USAID). As a robustness check, we employ an instrumental variable approach using international aid disbursements as an instrument.

Our results confirm that the adoption of communal property rights by ancestral communities reduces mangrove deforestation. This result is robust across different specifications, with the chosen instrumental variable being a strong predictor of policy adoption. This has positive implications for climate policy seeking to reduce emissions from deforestation, and north-south payments compensation mechanisms as part of the global climate mitigation strategies. We estimate that the policy prevented a total of 1.5 million tCO_2 emissions between 2010 and 2012. Valued at the social cost of carbon², this corresponds to almost 60 million $US\$$ of avoided damages.

Additionally, we find that devolution of property rights to ancestral communities provides more protection to mangrove forests against deforestation when compared to state-led protected areas, and that the presence of commercially important fisheries in mangrove forests is a strong predictor of property rights adoption by communities. These results therefore have positive implications for both development and food security benefits of the policy, notwithstanding the environmental justice component of devolution of rights to ancestral communities.

With regards to our second aim of assessing the effect of external actors' involvement on policy uptake, our results show that involvement of the non-profit and non-governmental (NGO) sector has a positive effect on the adoption and permanence of policy by ancestral communities. Our regression discontinuity design (RDD) relies on the partisan vote share margin in the US Congress as an exogenous predictor of foreign aid disbursements and hence the degree of NGO support. Both the RDD and the complementary instrumental variable approach yield similar results. Our instrument of choice, the amount of foreign aid disbursed at the state level, is a strong predictor of local NGO involvement. Our results suggest that NGO involvement affects policy adoption positively. We deduce that the mechanism for this is the reduction of transaction costs communities would otherwise have to bear to full fill the bureaucratic requirements of the policy. Likewise, our results highlight both the important role NGO involvement plays in environmental policymaking as well as that desired policy outcomes are at least partly dependent on the availability of international aid.

Our work highlights the role local and indigenous communities play for improved land stewardship, which is vital to achieve the climate change goals set forth in the Paris Agreement (Griscom et al., 2017). As mangrove deforestation is not only associated with increased carbon emissions, but also reduced future carbon uptake, our evaluation of property rights to local and indigenous communities supports its application as an effective climate change mitigation strategy. Our estimates show that the policy prevented additional emission of more than 1.55 million tCO_2 between 2000 and 2012 which is equivalent to almost 60 million $US\$$ of avoided damages resulting from climate change. This has positive implications for climate change related north-south transfers, specifically as this provides strong evidence of additionally avoided emissions.

² We used the estimate of 112.86 $US\$/tC$ by Wang et al. (2019).