



# The Impact of Rural Electric Access on Deforestation Rates

ANDREW M. TANNER and ALISON L. JOHNSTON\*

*Oregon State University, Corvallis, USA*

**Summary.** — Overpopulation and economic industrialization are two common explanations for deforestation. Political ecology, however, highlights that good governance and effective land management at the local level can offset the impact of population growth and development on environmental degradation. In this paper, we provide an innovative argument derived from political ecology to explain deforestation, but rather than pursuing a “bottom up” approach to governance, we take a “top down” approach. We argue that the state can ease deforestation rates by weaning rural populations off of the consumption of biomass for their energy needs by expanding rural electrification access. Using a panel analysis of 158 countries for the years 1990, 2000, and 2010, we find that not only does rural electrification cause deforestation rates to decrease, but also that it is more robust in explaining deforestation than population growth or development. Our study provides two innovations to political ecology: it highlights that the state can help, rather than hinder, local populations with managing their local environments in a more sustainable way by providing them with (public goods-based) energy alternatives, and; it supplements political ecology’s qualitative focus on environmental degradation with a generalized quantitative analysis of state-based initiatives on deforestation. Our results suggest that current global initiatives addressing deforestation—specifically the Reduction of Emissions from Deforestation and Forest Degradation (REDD+) agenda of the United Nations’ Framework Convention on Climate Change—should not only assist local land managers, but also work with the state to ensure universal access to electricity. © 2017 Elsevier Ltd. All rights reserved.

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## 1. INTRODUCTION

Overpopulation and economic development are two common explanations for global environmental problems such as pollution, climate change, and deforestation. However, even in combination, as with the “IPAT” formulation<sup>1</sup> and its variants, they cannot fully explain country by country variation in rates, levels, and forms of environmental damage. Political ecology provides an interdisciplinary-based governance approach to the study of environmental degradation, highlighting that developing economies with growing populations are not always destined to experience widespread environmental destruction if good governance promotes the sustainable management of natural resources, especially within rural areas. The original thrust of political ecology, pioneered by [Blaikie \(1985, 2008, 2011\)](#) and the East Anglia School, promoted the development of more effective environmental policy by focusing the structural, political-economic conditions that mediate interactions between people and their environment. These conditions are too often characterized by deep-rooted material and political inequality, which tends to both increase human impacts on the environment and reduce the effectiveness of policy measures taken to mitigate them. The role of the state in preserving or undermining (poor) rural populations’ ability to sustain their livelihoods is crucial in determining the degree to which these populations may be functionally forced into taking action that degrades their proximate environment.

In this paper, we provide a “top down” contribution to the political ecology literature, and argue that state can play a beneficent role in limiting rural populations’ need to engage in environmental degradation (which we measure by deforestation rates) for their livelihoods. Rural populations tend to be poorer and more marginalized than urban populations, and rely more heavily on their local environment to meet basic needs. Previous works in political ecology highlight that the state can be a detriment to rural communities’ use of natural resources, and that “bottom up” governance can enable rural

populations to serve as better stewards of their local environment ([Blaikie, 1985](#); [Hecht, 2011](#); [Peet & Watts, 2004](#); [Robbins, 2004](#); [Zimmerer, 1997](#)). In contrast, we argue that the state can also be an asset to rural communities’ sustainable use of their environment, via its provision of large-scale collective and public goods that reduce these communities’ need to pursue deforestation to meet basic energy needs. Specifically, the state’s pursuit of rural electrification not only enables rural populations to move up the “energy ladder” and shift their energy reliance away from the consumption of forest materials, but also demonstrates the state’s commitment to its citizens’ energy needs, because rural electrification involves significant sunk costs that are generally too high to be provided by rural populations (or markets). In turn, the provision of widespread rural electrification also can legitimize the state as a beneficial institution in the eyes of the populace.

We employ a panel analysis of World Bank data for 158 countries<sup>2</sup> for the years 1990, 2000, and 2010, to examine the relationship between countries’ levels of rural electricity access and their deforestation rates. We find that rural electrification is significantly correlated with declining deforestation rates, and that the significance of its predicted effects is more robust to alternative model specifications than population growth and economic development, which have dominated much of the deforestation literature. Our results are robust when we omit developed OECD economies (countries that are fully economically developed, have complete rural electrification and low rates of deforestation), and focus exclusively on the developed and developing world. Our findings indicate

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that deforestation studies which do not account for the intersection of governance, livelihood, and inequality lack a crucial explanatory factor.

The next section reviews two major literatures that seek to explain the causes of deforestation: economic development and population growth. We then transition into political ecology-derived insights into the causes of deforestation and present our “top down” state-based argument for how rural electrification reduces rural populations’ need to engage in deforestation to meet their energy demands. We then explain our quantitative methodological approach, which deviates from the more qualitative methodological nature of political ecology, present our results, and provide further support for our argument via illustrative cases. We conclude with a discussion of how rural electrification can be a crucial component of current global environmental initiatives, specifically the Reduction of Emissions from Deforestation and Forest Degradation (REDD) agenda of the United Nations’ Framework Convention on Climate Change.

## 2. CONSEQUENCES AND CAUSES OF DEFORESTATION

The rapid uptake and spread of industrial manufacturing, beginning in 18th century Europe, dramatically impacted Earth’s forests: It has been estimated that more than 70% of the earth’s original temperate forest cover area was destroyed by the start of the 21st century. Tropical forests now face the fastest rates of degradation and the bleakest future, with more than half anticipated to be gone by the mid-21st century. This ongoing degradation has significant social welfare implications. Millions of people around the world, disproportionately the poorest and most vulnerable, rely on access to forests to sustain their livelihoods (Angelsen et al., 2014; Wunder, Angelsen, & Belcher, 2014). Mere subsistence is the most pressing concern for the world’s poor, and for rural populations ready availability of biomass (often sourced from forests) is crucial to subsistence (Angelsen et al., 2014; Sapkota, Lu, Yang, & Wang, 2014; Taylor, Moran-Taylor, Castellanos, & Elias, 2011). For those higher on the ‘energy ladder’—usually, those with greater wealth (Davis, 1998)—forests may sustain a livelihood by serving as a source for building materials, crafting materials, and food (Angelsen et al., 2014). Deforestation threatens all these activities, and has historically been linked to the fortunes of entire civilizations.

Deforestation also has environmental importance. It is one of the largest contributors to greenhouse gas emission into the atmosphere. It is estimated that illegal logging alone may constitute up to 7–20% of the total anthropogenic greenhouse gas emissions each year (Burgess, Hansen, Olken, Potapov, & Sieber, 2012; Harris et al., 2012; Lynch, Maslin, Balzter, & Sweeting, 2013). This contribution to the global problem of climate change has resulted in the widespread push for the Reduction of Emissions from Deforestation and Forest Degradation (REDD) initiative, which seeks to promote development that does not require the destruction of native forests.

Deforestation’s causes have been widely examined in multiple disciplines, notably geography, forest studies, environmental economics, and cultural anthropology. Two of the most recurrent causal factors proposed are population growth and economic development. The former, as a development of Malthus, compellingly posits that humans have needs, which can only be satisfied by exploiting the environment, and the ten-

dency toward ever-growing populations leads to increasing environmental degradation, resulting in inevitable environmental collapse. In a gross sense this logic is irrefutable: only so much food can be produced on the planet so quickly, and if the need to sustain the human population outpaces food calorie production, natural resources will be exhausted with painful consequences (Hardin, 1968, Pimentel, 2009). The IPAT model and its derivatives are rooted in a modernized variant of Malthusian logic, and some of its originators were ardent Malthusians (Carson, 2010). Its impacts have been highly influential in developing the field of sustainability science, and many works emphasize the role of the inevitable pressures that human populations exert on resources, identifying this as the underlying culprit behind most deforestation (Harris et al., 2012; Ryan et al., 2012; Schaeffer et al., 2005). Several have singled out large and/or growing populations as a causal driver of deforestation (Celentano, Sills, Sales, & Verissimo, 2011; Tacconi, 2011), although others have added more nuance and flexibility to the original IPAT model, allowing for improved application to specific contexts (Waggoner & Ausubel, 2002).

Economic development theories about the causes of environmental degradation and deforestation more specifically relate to an environmental interpretation of the Kuznets curve.<sup>3</sup> The environmental Kuznets curve literature posits a hump-shaped relationship between development and environmental degradation more broadly. As poor countries undergo development via industrialization, pollution levels and deforestation rates increase. However, rising per capita incomes ultimately reach an apex for which citizens are wealthy enough to demand and pay for environmentally friendly policies and green technologies, which in turn, leads to less pollution and deforestation (Choumert, Motel, & Dakpo, 2013; Chowdhury & Moran, 2012; Culas, 2012). Significant attention is paid in empirical literature to identifying this “turning point” in terms of per capita income (Chowdhury & Moran, 2012; Culas, 2012). However, empirical results have been mixed, with studies conducted in more recent years tending not to find significant evidence supporting the quadratic relationship between income levels and environmental degradation (Choumert et al., 2013; Chowdhury & Moran, 2012). Others who focus on deforestation more narrowly have found that results are similarly mixed, with a tendency toward the failure to confirm the environmental Kuznets curve’s predictions (Choumert et al., 2013; Chowdhury & Moran, 2012; Culas, 2012).

Despite the mixed empirical evidence supporting an environmental Kuznets curve with respect to deforestation, several have found that social and economic processes related to development, particularly international trade, can exacerbate deforestation. International investment and the expansion of agriculture in a nation’s economic output have routinely been linked to deforestation, both through timber prices and the increasing demand for agricultural commodities, which promote deforestation in order to increase the stock of agricultural land available for productive use (Angelsen, 2009; Celentano et al., 2011). The problem of forest clearance in developing economies, often done in order to meet growing global demand for agricultural commodities, has been prominent in the deforestation literature in recent years (Ryan et al., 2012). Road construction and development is yet another factor strongly associated with deforestation, as roads lower the costs of accessing forest resources; deforestation in the Amazon has been noted for its rapid onset after a new stretch of highway is completed (Angelsen, 2009; Celentano et al., 2011).

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