



An upside to globalization: International outmigration drives reforestation in Nepal



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ABSTRACT

Halting and reversing global forest loss is a key priority for sustainable development pathways. Multiple countries in the Global South have recently transitioned from net forest loss to net forest gain. Understanding and explaining reforestation patterns is necessary to better understand land cover dynamics and create more effective sustainability policies. We show that international migration – a key feature of globalization in the 21st century – spurs a transition to greater forest cover in Nepal. Although some aspects of globalization - agricultural commodity production and trade in particular - have been identified as contributing to deforestation, the effects of international migration are less well understood. Using data from Nepal's national census (1.36 Million households) and from high-resolution forest cover change, we find that international outmigration is associated with substantial increases in local forest cover, even after controlling for multiple confounding factors. We find that areas with international outmigration levels above the median in 2001 were 44% more likely to experience net reforestation between 2000–2012. This effect of outmigration is mediated by changes in population density and in household agricultural activity. Effects of outmigration are higher in more agriculturally suitable areas, suggesting that migration-driven forest transitions are influenced by agricultural production systems. We provide new empirical evidence of forest transition driven by international migration and a generalizable analytical approach to the study of forest transitions using secondary global and national datasets. Our results suggest that actions to reach global sustainability, biodiversity targets, and reduced emissions can be better designed and targeted by taking into account the effects of international migration on natural resources and ecosystems.

1. Introduction

Forests are critical to sustainable development because of the extent and magnitude of their contribution to carbon sequestration, biodiversity conservation, watershed protection, and livelihood contributions among other societally valued benefits (UNFCCC, 2016; United Nations, 2015). Although deforestation continues to increase in many parts of the world, several countries in the Global South have transitioned from deforestation to reforestation during the past 15 years (Meyfroidt and Lambin, 2011; Rudel et al., 2005; Sloan and Sayer, 2015). Scholars have devoted substantial attention to elucidating the drivers of deforestation, yet the processes driving improvements in forest cover need to be better understood, particularly in the Global South.

The increased movement of labor is a key facet of globalization that

may affect natural resource use and requires more careful empirical study (de Haas, 2012; Kull et al., 2007). Global human migration flows alter local, regional and national socioeconomic processes through remittances, and changes in labor markets and population structures. In 2010, approximately 170 million international migrants contributed an estimated \$432 billion to the global economy (de Haas, 2012), with the vast majority of labor flows originating from countries in the Global South (Abel and Sander, 2014; IOM, 2014). Understanding the influence of these flows on natural resources and the environment is critical to design better strategies for natural resource protection.

Migration flows and remittances are considered key drivers of forest transitions and their effects on reforestation are thought to be driven by a series of overlapping mechanisms (Hecht et al., 2015; Hecht and Saatchi, 2007; Kull et al., 2007). Three key mechanisms that have been proposed to explain reforestation as a result of migration include: (i)

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remittances that are invested in financing the migration of entire households (Acharya and Leon-Gonzalez, 2016), leading to forest resurgence on abandoned agricultural areas (Aide et al., 2000); (ii) remittances that reduce recipient households' levels of poverty and dependence on agricultural production and/or forest products such as firewood or building materials (Manning and Taylor, 2014; Robson and Berkes, 2011); and (iii) reductions in the amount of agricultural labor available at the household level, leading to a reduction of agricultural production and a resurgence of forests on marginal lands (Manning and Taylor, 2014; Schmook and Radel, 2008).

However, the relationship between migration, labor shortages and agricultural production also appears to be highly context dependent (Davis et al., 2009). For example, outmigration may not change forest cover if migration is only seasonal and household members return to provide labor at key times or if remittances are used to replace lost labor through non-labor inputs (e.g., fertilizers, pesticides and herbicides, or small-scale mechanization) or by hiring in additional workers. Critically, outmigration can also lead to forest loss and increase agricultural activity if remittances are invested in more extensive agricultural production (e.g., through additional cattle ranching observed in several Latin American contexts) (Alix-Garcia et al., 2013; Davis and Lopez-Carr, 2014; Taylor et al., 2016; VanWey et al., 2012).

Our study tests for an overall relationship between international outmigration and forest cover, and for mechanisms that can explain the positive relationship we observe. Our results support theories that the magnitude of the effect of migration on reforestation depends on the type of migration and the type of agricultural production system. International migrants tend to send back higher remittances than national migrants and are often away for longer periods of time (VanWey et al., 2012), making it uneconomical for them to remain involved in household agricultural activities. If households reduce agricultural activities without changing production systems, it is thus a logical progression that international migration will lead to reforestation because less land is being used. At the same time, remittances may lead to changes in production systems, and in this case agricultural land suitability matters. Theory suggests that when land inputs are limited but of high quality, remittances are more likely to be invested in agricultural intensification through additional non-labor inputs (Angelsen, 2010). This process can lead to a potential contraction of agricultural production, even in the presence of high remittances, resulting in forest resurgence on abandoned lands and more intensive, non-labor input driven production on remaining agriculturally active lands. In contrast, when additional inputs or mechanization are more difficult to implement, labor losses would be more likely accommodated by a combination of additional inputs and additional land, or shifts in the time allocation of remaining household members to agricultural production; leading to less reforestation overall.

In Nepal, a key feature of agricultural suitability is slope: steeper slopes are difficult to intensify through capital inputs, while the flatter areas, which are limited in extent, tend to be more agriculturally productive, better connected to markets, and more amenable to the use of modern agricultural equipment and non-labor inputs (Marquardt et al., 2016). Nepal, therefore, provides an interesting case in which to test the hypothesis that high international migration combined with highly agricultural suitable lands that cannot be easily expanded or transformed into less intensive systems is likely to lead to forest regeneration.

Despite the magnitude and scale of international migration as a global phenomenon, its effects on ecosystem health and forest recovery remain a matter of discussion (Hecht et al., 2015). This is because most existing forest transition studies have either focused on small-n case studies to describe how outmigration and remittances influence land-use decisions in regions of origin, or have not measured outcomes in comparison to counterfactuals. Although small-n studies have identified the conditions under which migration can lead to forest regeneration, they have paid less attention to rigorously quantifying the impact of

outmigration and related pathways on improvements in forest cover, especially at larger regional or national scales (Bhagwat et al., 2014; Le et al., 2014). Although larger-n studies to date provide important information about relationships between factors (Hecht and Saatchi, 2007; Redo et al., 2012), they have not been able to account for many confounding elements of socioeconomic and environmental heterogeneity, including national level conservation and development initiatives (e.g. decentralized natural resource management policies) that might themselves act as forest transition pathways (Meyfroidt and Lambin, 2011; Nagendra, 2007).

Here, we move beyond small-n case studies by estimating the magnitude of the effect of international outmigration on forests in Nepal. To do so, we construct a comprehensive national-level dataset that includes longitudinal data at the sub-district level (2001, 2011) and high-resolution forest cover change data (2000–2012). We seek to disentangle the effects of migration from other factors by matching on and controlling for a suite of key biophysical, socioeconomic and institutional covariates. The pre-processing of data using statistical matching improves causal inference of regression analyses by ensuring that treated and comparison groups are similar with respect to key covariates that influence the relationship between treatment and outcomes (Ho et al., 2007; Stuart, 2010). To better test prior forest transition theories, we also analyze the significance of different effect mediators, including changes in population density, household poverty, and household agricultural activity, and test for heterogeneity in mediating effects of the agricultural suitability of land.

2. Methods

2.1. Country selection

Several factors make Nepal a useful setting to understand the effects of migration on forest cover. Nepal is important ecologically, with globally significant biodiversity assets (Myers et al., 2000) and substantial forest cover of 5.96 million hectares of forests or 40% of the country's surface area (Ministry of Forests and Soil Conservation, 2015). Furthermore, as is the case for many nations with remaining biodiversity, Nepal has a large rural population (83% of the total population) that relies predominantly on small-scale, labor-intensive subsistence agriculture - conducted in a variety of conditions including both irrigated flat plains, which are limited in extent but highly fertile, and steep mountain slopes where agriculture is predominantly practiced on terraces (Maharjan et al., 2013; Marquardt et al., 2016).

Levels of international outmigration in Nepal are substantial (but not exceptional across the globe) in both 2001 and 2011: 15% of households sampled in the census reporting one or more household members living abroad in 2001, a proportion that nearly doubled to 29% in 2011 (Central Bureau of Statistics, 2011; 2001). The major driver of international outmigration is the availability of higher wage opportunities for relatively low-skilled labor in other countries. This pull, predominantly from Gulf countries and Malaysia, as well as a free border agreement with India, has spurred substantial migration from rural areas (Kern and Müller-Böker, 2015). Most international migrants in Nepal are young, working-aged men that typically emigrate for several years (Table S12). Remittances are integral to Nepal's economy; in 2013 they accounted for approximately 25% of the country's Gross Domestic Product in the year 2013 (Ratha et al., 2016).

Given Nepal's ecological importance, large rural population and high levels of international outmigration, it is itself an important region in which to understand the effects of international migration on forest cover. Our study also potentially sheds light on reforestation and migration relationships in other countries undergoing similar processes by developing a generalizable methodology using public datasets that are legally available to the public. Thus in addition to novel results about Nepal, we illustrate an important analytical approach to the study of forest transition drivers that can and should be replicated in other

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