



Promoting women's leadership under environmental decentralization: The roles of domestic policy, foreign aid, and population change

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ABSTRACT

In recent decades, countries across Asia, Latin America, and Africa have adopted environmental decentralization reforms to encourage the community-based management of water, forests, fisheries, and other natural resources. While such reforms are meant to empower rural people to participate in environmental governance, experiences from recent decades suggest that these reforms often suffer from gendered inequalities in participation and leadership. We use the case of a forestry-sector decentralization reform in Nepal to test the importance of domestic policy, foreign aid, and population change for promoting women's leadership under environmental decentralization. Using data on local natural resource governance committees formed in villages across the country under the reform, we find that a non-binding government guideline encouraging committees to prioritize women's leadership resulted in an estimated increase of 7.5% points in the number of leadership seats held by women on these committees. We also show that locally-targeted, sector-specific foreign aid projects appear to have a strong impact, with rates of women's leadership that are estimated to be 24% points higher in committees formed in areas with projects, compared to rates in comparable committees formed in areas without such projects at the time of formation. Finally, we instrument for international male out-migration in rural Nepal, and find no apparent effect of international male out-migration on rates of women's leadership in local natural resource governance committees. The results highlight the importance of domestic policy, even without stringent enforcement, and targeted foreign aid projects for promoting women's leadership under environmental decentralization.

1. Introduction

Over the past several decades, decentralization of power to local, participatory, non-governmental bodies has been widespread across Asia, Africa, and Latin America (Freire and Stren, 2001; Mansuri and Rao, 2012).¹ In the natural resource sectors, this trend toward decentralization has meant that countries across the Global South have

transferred collective property rights over natural resources to local user groups—rural village councils for the governance and management of local natural resources such as water, forests, and fisheries. These venues for the participation of rural people in the governance of the local environment were meant to foster sustainable development,² not only by preventing the depletion of common-pool resources and promoting their restoration, but by democratizing environmental governance and

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¹ In this study, we focus on decentralization efforts that transfer authority over the governance and management of natural resources from governments to local communities. More specifically, we focus on community forestry as one model that exemplifies this type of decentralization. These programs differ from other styles of natural resource decentralization that devolve authority over natural resource governance and management from national governments to local governments (Wright et al., 2016).

² Here, we refer to the definition that conceptualizes sustainable development as comprised of three pillars: environmental quality, economic prosperity, and social wellbeing (United Nations Environment Programme, 2002).

ensuring that the rural poor and historically marginalized groups are able to derive important subsistence and commercial benefits from natural resources. However, evidence from the past few decades—in the environmental sectors and beyond—strongly suggests that elite capture³ and low rates of participation among historically marginalized groups are common in the local governance venues created by decentralization reforms across the world (Agarwal, 2016; Grillos, 2017; Lupien, 2018; Mansuri and Rao, 2012; McNulty, 2018; Warren and Visser, 2016). At the same time, there is mounting evidence that natural resource decentralization policies appear to have led to better environmental conservation and reduced poverty in some countries (Oldekop et al., 2019; Somanathan et al., 2009; Wood et al., 2019).⁴ If the current state of the knowledge is that decentralization can deliver substantial environmental and economic benefits, but that it allows problems of inequality to persist (or even exacerbates such problems), how should policymakers and the international community move forward with decentralization initiatives? In order to resolve this tension, more work must be done to understand the remedies to problems of inequality under these environmental governance arrangements.

While issues of inequality under decentralization are as varied as they are widespread, encompassing ethnic inequality, class disparities, and gender dynamics, one aspect of inequality is central to our study: Rates of women's participation in local decision-making structures are low in many contexts where decentralization has been attempted. Empirical evidence to date suggests that rates of women's participation in decentralized natural resource management processes are often lower than those of men, and that women are much less likely than men to exercise power when they do participate (Adhikari and Lovett, 2006; Agarwal, 2016; Coleman and Mwangi, 2013; F. Elias, 2017; M. Elias et al., 2020; Evans et al., 2017).

In this paper, we contribute to the literature on women's participation under environmental decentralization by asking the following question: What can improve rates of women's leadership in the local institutions of environmental decentralization? We situate our analysis within the context of decentralized forest governance in Nepal. We use the country's community forestry program as a test case for examining the importance of domestic policy, foreign aid, and male out-migration for predicting variation in rates of women's leadership—operationalized as the proportion of leadership positions held by women in more than 18,000 local Community Forest User Groups (CFUGs) formed across the country under the program in the years since the Forest Act established community forestry as the central forest governance model in Nepal in 1993. CFUGs are local, participatory councils with authority over the management and governance of collectively owned forests in rural villages, led by an executive committee of between 7 and 15 local citizens (Ministry of Forests and Soil Conservation, 2013). In a village that has received the program, the CFUG holds collective property rights over a patch of forest—a community forest—within or adjacent to the village, and the executive committee holds broad authority for rulemaking and management decisions related to the community forest.

As we explain in the following sections, decentralization in Nepal has been implemented in a changing context—a context characterized by gender-related policy directives from the national government, inflows of funding from international donor agencies seeking to promote equity-related goals, and high rates of international out-migration. Hence, the case of natural resource decentralization in Nepal presents an opportunity to assess the relationships between these factors and women's participation in local environmental decision-making. The statistical

results, generated from data on a census of CFUGs formed under the program from 1993 through 2015, suggest three findings. First, the Government of Nepal implemented a non-binding directive in 2009 stating that at least 50% of CFUG executive committee members should be women. The results suggest that, controlling for geographic fixed-effects, CFUGs formed after this directive had significantly more of their executive committee positions occupied by women, compared to CFUGs formed in the same local area before the directive. Second, results from a regression discontinuity analysis suggest that the presence of forestry-sector foreign aid projects at the time and place of CFUG formation is associated with higher rates of women's leadership in CFUGs, compared to rates of women's leadership in comparable CFUGs formed in the absence of such foreign aid projects. Third, using an instrumental variable estimation approach, we find no evidence of a strong or moderate-sized effect of local rates of international male out-migration on women's leadership in CFUGs, which runs contrary to the theory that male out-migration might boost women's leadership by creating new opportunities for women leaders.

We focus our analysis on these three independent variables—domestic policy, foreign aid, and male out-migration—based on previous theory and research related to gender norms. As we explain in Section 2, all of these variables have associated literatures suggesting that they may have an impact on women's leadership. Furthermore, domestic policy and foreign aid both relate to tangible policy actions that domestic and foreign actors can take in order to boost women's leadership, which means that our findings in relation to these two independent variables have direct policy implications that we discuss in Section 6.

Gender-based inequalities should be central to conversations around environmental decentralization, because not only is the disempowerment of women a policy failure in and of itself, but there is mounting evidence that women's participation in decision-making structures improves the effectiveness of local natural resource governance institutions, potentially leading to more equal benefit sharing (Cook et al., 2019), more effective conservation (Leisher et al., 2016), less resource-related conflict (Coleman and Mwangi, 2013), and conservation rules and practices that are more responsive to the subsistence needs of rural women (Agarwal, 2016). In diverse policy areas, both within and beyond the natural resource sectors, increased participation by women in formal decision-making processes is also believed to have a diverse array of positive impacts on the participants themselves, their households, and women in the broader community, such as by improving women's representation in policy decisions (Chattopadhyay and Duflo, 2004), weakening harmful gendered stereotypes and positively shaping aspirations for young girls (Beaman et al., 2009; Beaman et al., 2012), improving women's economic prospects (Ghani, Kerr, and O'Connell, 2014), and enhancing women's resilience to environmental shocks (Grillos, 2018).

The remainder of the paper proceeds as follows: in Section 2, we draw upon existing research on gender norms to generate three theoretical expectations regarding the effects of domestic policy, foreign aid, and male out-migration on women's leadership; Section 3 gives key background information on the community forestry program and the Nepalese case; Section 4 describes the data as well as the fixed effects, regression discontinuity, and instrumental variable estimation strategies used to test the hypotheses; Section 5 presents the statistical results; in Section 6, we discuss our empirical results in the context of previous research, and discuss the policy implications of our key findings—that domestic policy and foreign aid both appear to have positive impacts on women's leadership.

2. Theory and hypotheses

Existing social norms and practices can promote non-inclusive governance institutions (Agarwal, 2016). These include social norms that deprioritize or suppress women's participation, cultural norms that

³ Here, elite capture refers to the processes through which local elites—the wealthiest households, politically connected households, or members of traditionally advantaged ethnic groups—gain access to a disproportionate share of the resources, services, or goods managed under decentralization.

⁴ There are also some apparent counterexamples in the literature. See, for example, Coleman and Fleischman (2012) and Keane et al. (2020).

grant women little autonomy over their own time allocation and participation in governance activities, and men's customary claims over natural resource governance (Agarwal, 2016; Bhadwal et al., 2019; Meinzen-Dick and Zwarteeveen, 1998). Previous research suggests that these prevailing norms and practices that lead to exclusion of women from decision-making may be altered through deliberate policy action, and inadvertently through demographic changes. These deliberate actions to change norms and practices around women's participation and leadership can happen through either national or foreign governments. In the latter case, foreign governments use aid as a means to influence domestic gender norms. In the former, national governments can use policy directives to reshape gender norms and improve inclusivity. Finally, changes to demographic patterns can also inadvertently influence norms and lead to more inclusive institutions. For instance, as more men migrate to towns and cities in search of livelihoods, they leave behind women, who, now in the absence of men, may be more likely to participate in political life, thus altering the prevailing patriarchal norms. With this in mind, we formulate the following three theoretical expectations:

H1. : Non-binding government targets will increase women's leadership.

There is considerable evidence that binding policies, such as mandatory gender quotas, can lead to improved representation and participation of women in governance processes (Aili Mari and Kang, 2007; Chattopadhyay and Duflo, 2004; Clayton and Zetterberg, 2018). Such mandatory quotas are an example of the state assuming the role of a *guarantor* of equality (Franceschet and Piscopo, 2013). Building upon this existing evidence, our analysis focuses on the effects of non-binding state actions wherein the state assumes the role of a *promoter*—rather than a *guarantor*—of gender equality (Franceschet and Piscopo, 2013). In doing so, we examine the Government of Nepal's 2009 policy directive that set a non-binding target to have at least 50% of executive committee seats occupied by women in each CFUG. This directive was adopted by the government's Community Forestry Program as part of the second revision to the program's guidelines on CFUG formation. As local people work together to craft new institutions under decentralization (such as CFUGs in the case of Nepal), non-binding government guidelines can act as a heuristic or social reference point, and help alter perceptions around prevailing social norms. Furthermore, although the logic of environmental decentralization hinges on the idea that local actors should be given some level of autonomy, this autonomy is not absolute because the actions and decisions of these local actors are constrained and influenced by governments. For instance, in Nepal, qualitative evidence has shown that the district-level forest bureaucracy influences the content of CFUGs' formal written bylaws so that they are often written in accordance with central government directives, as we explain further in the following section (Basnyat et al., 2018; Bienen et al., 1990). It is for these reasons that non-binding government targets aimed at increasing women's leadership—such as the 2009 policy directive in Nepal—should have an impact on women's leadership.

H2. : Localities receiving targeted foreign aid projects will have higher rates of women's leadership.

Foreign aid is a vehicle for the international diffusion of norms, due in part to the fact that donors use aid as an instrument to influence public policy, social norms, and values in Global South countries (Edgell, 2017; Elgström, 2000; Huang and Pascual, 2017; Resnick, 2018). This process should also influence local rates of women's leadership under environmental decentralization. Donor agencies prioritize issues related to gender equity (Dreher et al., 2015; Elgström, 2000), and attempt to advance these priorities through the developmental programs they fund. For example, in Nepal, international donors spent approximately 30 times more than the Government of Nepal supporting the establishment of community forestry during the first three decades of the Community Forestry Program (Ministry of Forests and Soil Conservation, 2013).

Donor-funded projects and international non-governmental organizations in the forestry sector reportedly promoted the inclusion of more women on CFUG executive committees through activities such as leadership trainings for local women, or even by providing funds and facilitation for the formation of new CFUGs formed with women on the executive committees (Buchy and Rai, 2008). In other words, when donors have supported environmental decentralization efforts like the one in Nepal, they have increasingly done so with goals in mind that extend beyond the narrow area of environmental conservation, and have used projects as a means to achieve these aims. These goals are motivated by the sustainable development paradigm, and include social equity considerations such as gender equality alongside goals related to environmental conservation and poverty alleviation. For these reasons, environmental decentralization should involve more women leaders in areas where there is sector-specific support from foreign aid projects.

H3. : Male out-migration will increase women's leadership.

With a high proportion of men migrating out of rural areas in search of economic opportunities, many women are left behind. Quantitative and qualitative evidence suggest that this can result in various forms of empowerment for women, and changes in the activities in which women participate (Doss et al., 2022; Fakir and Abedin, 2020; Maharjan et al., 2012). Male out-migration can also significantly increase household incomes through remittances and hence reduce women's workloads, enabling them to participate in new activities (Robson and Berkes, 2011). Qualitative research suggests that male out-migration may leave a "window of opportunity" for women's participation (Giri and Darnhofer, 2010b), and women may therefore play a larger role in local governance institutions (Robson and Berkes, 2011). Based on this previous research, we theorize that such patterns may also apply to women's participation in local leadership. Specifically, higher rates of male out-migration may give women the opportunity to take part in formal decision-making venues for the governance of local natural resources, and would therefore be associated with higher rates of women's leadership. Nepal, where male out-migration has been widespread in rural areas in recent decades (International Organization for Migration, 2019), represents an ideal test case for this hypothesis.

3. Background: the case of community forestry in Nepal

CFUGs, which have been formed in villages across the country in the years since the Forest Act was adopted, are local, participatory councils with authority over the management and governance of collectively owned forests in rural villages (Ministry of Forests and Soil Conservation, 2013). Over 1.2 million hectares of community forests had been established from the inception of the program until 2013, covering roughly 23% of the country's forested land, with CFUGs claiming roughly one third of the country's rural population among their members (Ministry of Forests and Soil Conservation, 2013). By 2017, the average community forest in Nepal covered roughly 87 ha, and the average CFUG claimed about 125 member-households (Ministry of Forests and Soil Conservation, 2017). Member-households are eligible to collect various products from the community forest for their own consumptive use (such as firewood and fodder). Some also collect certain forest products that can be sold or fashioned into finished goods. In return for these benefits, members participate in a variety of activities, such as forest monitoring, thinning and pruning, fire mitigation, and attending general assembly meetings of the CFUG (Ministry of Forests and Soil Conservation, 2013; Ojha et al., 2009; Rai et al., 2016).

CFUGs are formed through a process in which government forestry officials visit the village and work with local people to map the forest patch and identify the households that use the forest. Forest users, often in collaboration with government forestry officials, prepare a written Operational Plan that codifies rules regarding how the community forest is to be governed and managed. Qualitative evidence suggests that it can take roughly a month for a government forestry official undertaking this

process to approve an Operational Plan once it has been prepared (Paudel et al., 2008). Subsequent contact between government forestry officials and CFUGs varies, and often occurs when mandatory for specific bureaucratic tasks, such as when a CFUG decides to revise its Operational Plan. Each CFUG is governed by an executive committee that is either elected or (more often) selected through consensus by the members. CFUGs typically generate a large share of their budget through the sale of certain forest products, with smaller shares generated through fines for rule-breaking, membership fees, or entrance fees for non-members. Donor support has also been an important source of funding for CFUGs (Ministry of Forests and Soil Conservation, 2013).

A series of large-scale shifts in Nepalese forest governance led to the creation of the community forestry program in the early 1990s. In 1957, the Government of Nepal nationalized all forests through legislation. The post-nationalization turn toward community-based forestry began with new designations in the late 1970s that allowed village committees to manage some highly degraded forests (though scholars argue that this early effort was largely unsuccessful), and culminated with the creation of community forestry under the Forest Act (Gautam et al., 2004).

Public policy in Nepal has recognized, and attempted to address, long-standing economic and social disparities between women and men that are evident in a variety of indicators (Bennett et al., 2006). The impacts of the community forestry program on women have been the subject of academic debate. Women appear to face various social norms that discourage their participation in CFUGs and executive committees (Agarwal, 2016). Other research, however, suggests that women in Nepal have been active in widening their scope of influence in CFUGs, and have used CFUG participation as a means to exercise greater influence over local governance (Giri and Darnhofer, 2010a).

4. Methods

To test the hypotheses, we collected records on all CFUGs formed under the Community Forestry Program until August 2015 (18,960 CFUGs), provided by the Government of Nepal. CFUGs vary in the sizes of their executive committees, with the vast majority of CFUGs having an executive committee of between 7 and 15 people. We measured women's leadership in each CFUG as the percentage of CFUG executive committee members who were women when the CFUG was formed.⁵ In other words, our dependent variable captures the gender composition of a CFUG's first executive committee. To generate this variable, we used columns in the database containing (1) the size of the executive committee when the CFUG was formed and (2) the number of those executive committee members who were women. Of the 18,960 CFUGs in the database, roughly 8.5% have missing data on either or both of those two variables, and are therefore omitted from the analysis. Section A of *Supplementary Information* gives additional details on the data source and the measurement of the dependent variable.

Our analytic approach uses three different research designs to examine the roles of central government directives, foreign aid projects, and international male out-migration in shaping the gender composition of CFUG executive committees. All three of our research designs rely upon locational data on CFUGs in the database. We gathered these locational data by identifying the Village Development Committee (VDC) or *nagarpalika*—referred to simply as the 'municipality' throughout this paper—in which the CFUG was located based on the record in the database. Before the restructuring of Nepal's administrative boundaries in 2017, VDCs and *nagarpalika* were local administrative areas, the counterpart to towns or municipalities in other country

⁵ While some of these executive committee members have special assigned roles such as Chairperson, Vice-Chairperson, Secretary, and Treasurer (Ministry of Forests and Soil Conservation, 2013), the database only contains data on the overall gender breakdown of the committee, not on individual roles within the committee.

contexts. There were nearly 4000 VDCs/*nagarpalika* nested within Nepal's 75 districts.

4.1. Non-binding government targets (H1)

Our analysis assumes that the 2009 directive is non-binding and that compliance will therefore vary among CFUGs, an assumption that is corroborated by qualitative research (Agarwal, 2010, 2016). While naive comparisons show that the executive committee of an average CFUG formed after 2009 had more women members than the executive committee of an average CFUG formed before 2009 (see Section 5.1), the difference in executive committee gender composition before and after the 2009 guidelines is likely confounded by systematic differences between local areas that received the program early in the implementation of the community forestry program and those that received the program later. To account for this, we adopt a fixed effects approach that controls for systematic differences in municipalities receiving the reform later and those receiving it earlier by only comparing CFUGs formed within five years after the 2009 directive (in years 2010 through 2014, $N = 1476$) to those formed in the same municipality in the five years before the directive (in years 2005 through 2009, $N = 2458$).

To calculate the fixed effects estimates, we use a linear regression model that predicts the dependent variable as a function of a vector of municipality fixed effects and a vector of year dummies, the latter of which are coded based on the year in which the CFUG was formed. We use average predictive comparisons (Gelman and Pardoe, 2007) to generate the estimated quantity of interest reported in Section 5.1: the average within-municipality difference in women's leadership between CFUGs formed after the directive compared to those formed before. Because this is a within-municipality estimation, it controls for all observed and unobservable time-invariant characteristics of the municipality in which the CFUG is located. Section B of *Supplementary Information* gives further details on the estimation of this model and the calculation of quantities of interest from the model.

This estimation approach is akin to an interrupted time series with unit-level fixed-effects. While municipality-level fixed-effects control for time-invariant differences at the municipality level (differences which, as we explain above, may be correlated with the timing of CFUG formation), one potential drawback of this approach is that the effect of the directive is not identified separately from the effect of time. To interpret these results as causal, we must assume that there is no time-varying confounder biasing the estimates. While we cannot completely rule this possibility, our additional analysis and discussion in Section B of the *Supplementary Information* makes such a confounder appear unlikely.

4.2. Foreign aid projects (H2)

To test H2, we collected data on forestry-sector foreign aid projects⁶ that were targeted at the municipal or sub-municipal levels as our policy treatment of interest, using records from the Nepal AIMS Geocoded Research Release, Version 1.4.1, provided by AidData (AidData, 2016). This dataset covers the years from 1997 to 2017, and contains geocoded data on 475 projects across 20,952 locations in Nepal, compiled using information from Nepal's Aid Management Platform. Section C of *Supplementary Information* gives further details on the projects in the sample.

Because the assignment of foreign aid projects is non-random, local areas with aid projects likely differ from other areas based on pre-existing social and geographic characteristics, making CFUGs formed in the two groups incomparable. We therefore adopt a regression discontinuity design to test H2. The logic of the regression discontinuity

⁶ We identified projects as specific to the forestry sector if, under AidData's coding scheme, any subcategory of 'forestry' was listed as the sector for the project.

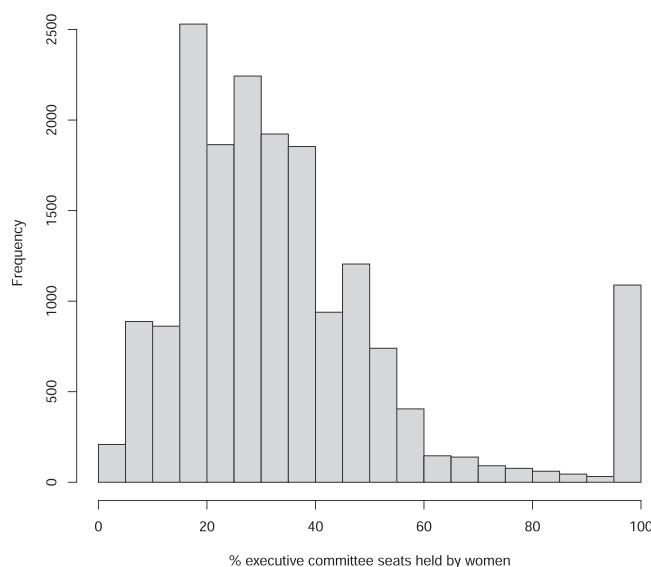


Fig. 1. Percentage of CFUG executive committee members who were women at the time of formation. For a given CFUG, the dependent variable measures the percentage of executive committee members who were women when the CFUG was formed, generated from a census of CFUGs formed from the beginning of Nepal's Community Forestry Program in the early 1990s until 2015. See Section 4 for further details on the sample and measurement of the variable.

design is that by comparing CFUGs formed *shortly after* the initiation of an aid project in their local area to those formed *shortly before*, we are comparing two groups of CFUGs that should be generally similar to one another on all characteristics (geographic, social, etc.) other than those related to the aid projects themselves, especially when controlling for time effects and conditioning on the observable characteristics of the local area in which the CFUG was formed.

We adopt a running variable representing, for a given CFUG in a given municipality, the number of days between the implementation of the first project in the municipality and the date the CFUG was formed. For example, if a CFUG was formed 15 days after the first aid project in the CFUG's municipality, the variable would be coded as "15." For CFUGs formed before the initiation of the first project in their municipality, the running variable takes a negative value. CFUGs formed on the first day of the first project get a zero value, and we use zero as the cutoff between 'treated' and 'untreated' CFUGs in our regression discontinuity design.⁷ We use an automated, data-dependent algorithm to select the optimal bandwidth around the cut-point in which to estimate the effect of project presence on the dependent variable (Calonico et al., 2014). The optimal bandwidth is estimated to be from 492 days before the initiation of the first project in the local area in which a CFUG was formed to 492 days after, producing an analytic sample of 95 CFUGs—38 'treated' CFUGs that were formed after an aid project had already begun in their local area, and 57 CFUGs that were formed before.

The regression discontinuity estimates reported in Section 5.2, which represent our best estimates of the effect of projects on women's leadership, were estimated using a local polynomial regression approach that discards observations outside the bandwidth and uses a triangular kernel to weigh the remaining observations higher if they are closer to the cutoff point relative to other observations within the bandwidth (Calonico et al., 2014). To improve the precision of the estimates, the model controls for time dummies and a number of municipality-level

covariates that are explained in Section A of [Supplementary Information](#). Confidence intervals from the model (reported in Section 5.2) are biased-corrected (Calonico et al., 2014), and account for clustering on the running variable.

Following previous work that uses regression discontinuity designs (Caughey and Sekhon, 2017), Section C of [Supplementary Information](#) analyzes pre-treatment balance immediately around the cut-point of the running variable in the regression discontinuity design. One possible drawback of the regression discontinuity design is that there may be a certain minimum level of project saturation needed before some of the impacts of aid projects are realized, which we discuss further in Section C of [Supplementary Information](#).

4.3. Male out-migration (H3)

To test H3, we exploit local-level variation in international male out-migration in 2011, measured through the national population census ([Central Bureau of Statistics, 2011](#)). For the CFUGs in the dataset, we calculate the average number of male household members living internationally in 2011, per household, in the municipality in which the CFUG was formed. While the data presented in Section 5.3 suggest that out-migration in the municipality and women's leadership are correlated, this apparent relationship may be due in part to systematic differences between local areas with high and low levels of out-migration.⁸

We therefore use an instrumental variable approach (Imbens and Angrist, 1994) to estimate the causal effect of international male out-migration on women's leadership. Previous research shows that rainfall shocks are a strong driver of subsequent patterns of international out-migration from rural villages in Nepal (Shrestha, 2017). Crucially for our study, this instrument should specifically drive differences in men's out-migration. In Nepalese society, rural men typically migrate away from their home village to seek economic opportunities (often abroad or in urban areas in Nepal), whereas women tend to out-migrate due to family reasons (typically, moving into the husband's household after marriage). These stark gender differences in reasons for migration from rural villages in Nepal help to explain why the widespread out-migration from villages in rural Nepal in recent decades has been driven primarily by men (Giri and Darnhofer, 2010b; Meinzen-Dick et al., 2022), who comprised 95% of labor migrants from Nepal between 2008 and 2015 ([Government of Nepal, 2016](#)). Furthermore, the theorized mechanism linking rainfall shocks to out-migration should only be strong for male migrants. Rainfall shocks in agricultural areas in Nepal temporarily increase farm incomes, which makes international migration from rural areas for employment more likely by making such migration more affordable to households (Shrestha, 2017). Because this type of migration is predominantly done by men, positive rainfall shocks should specifically increase rates of men's out-migration.

This enables us to use rainfall shocks in 2010 as an instrumental variable to capture plausibly exogenous variation in international male out-migration in 2011, and estimate the effect of the rate of international male out-migration in the municipality in 2011 on rates of women's leadership among CFUGs that were formed in the municipality shortly thereafter (Imbens and Angrist, 1994). We used satellite imagery data to construct a rainfall shock index which takes negative values for municipalities in which the amount of monsoon rainfall in 2010 was

⁷ None of the CFUGs in our analytic sample were treated with more than one such aid project by the time of their formation.

⁸ One potential example of such a confounding variable is exposure to the Maoist insurgency in the municipality in which a CFUG is formed. Some have argued that localized exposure to the Maoist insurgency may have boosted women's empowerment (Valente, 2014), and there is also evidence that the insurgency acted as a "push" factor for out-migrating households (Shrestha, 2017). The Maoist insurgency, then, is potentially correlated with both out-migration and women's leadership, which would mean that the apparent correlation between male out-migration and women's leadership could not be treated as evidence of causation.

below the local 30-year historical average, and positive values for municipalities in which the amount in 2010 was higher than the local historical average (see Section A of [Supplementary Information](#)). With rainfall shocks as an instrument for out-migration, we use a two-stage least-squares (2SLS) regression model to estimate the effect of the local rate of such out-migration in a given municipality in 2011 on women's leadership in CFUGs formed within two years after the 2011 census date ($N = 407$). The model controls for several pre-treatment municipal-level covariates: the proportion of land under forest cover and rate of change in the proportion of land covered by forest in the municipality, region dummies, population size, the presence of a major road, average slope and elevation in the municipality, the proportion of land in the municipality that was used for agriculture in the year 2000, and the historical monsoon rainfall average in the municipality from 1970 to 2000. Section A of [Supplementary Information](#) explains and justifies these covariates in greater detail. The model includes year dummies coded based on the year in which the CFUG was formed. Standard errors from the model (reported in [Supplementary Table 1](#)) are adjusted to account for clustering at the municipality level. Section D of [Supplementary Information](#) provides additional details on the instrumental variable estimation.

5. Results

[Fig. 1](#) shows that there is substantial variation in women's leadership among the 18,960 CFUGs in the sample. While it is not uncommon for CFUGs to have more than 50% women members on the executive committee (with a notable subset of CFUG executive committees being all-women), only about 30% of executive committee members are women in the median CFUG in the sample. In short, data on CFUGs across the country from the early 1990s–2015 show that gender parity in CFUG leadership has not been the norm. In the following sections, we present the results of our three empirical analyses designed to test the effects of non-binding government targets, foreign aid projects, and male out-migration on rates of women's leadership in CFUGs.

5.1. The non-binding government directive increased women's leadership by approximately 7.5% points

Rates of women's leadership appear to have increased after the government implemented the non-binding directive in 2009 stating that at least 50% of CFUG executive committee members should be women. [Fig. 2](#) shows that CFUGs established after the directive were indeed more likely to meet or exceed gender parity on the executive committee—operationalized as having at least half of a CFUG's executive committee seats occupied by women at the time of formation—compared to CFUGs established before. Nearly all of the pre-directive years had fewer than 20% of CFUGs meeting or exceeding gender parity, whereas the number was close to or greater than 30% in most of the post-directive years. It is therefore not surprising that aggregate levels of women's leadership were higher in CFUGs formed after the directive compared to those formed before. In the years after the directive, the average newly formed CFUG had 44% women members on the executive committee, compared to only 33% in the years before the directive.

As we discuss in [Section 4.1](#), this presentation of the data does not account for confounding factors at the local level. We therefore present an estimate from a fixed-effects modeling approach as our best estimate of the effect of the directive on women's leadership, and our formal test of H1 (see [Section 4.1](#) for details on the approach). Consistent with H1, this estimate suggests that the proportion of women on the executive committee of the average CFUG formed after the directive was 7.5% points higher than that of the average CFUG formed in the same municipality before the directive (95% CI = 4.686, 10.211). This effect estimate corresponds to a difference of roughly one third of one standard deviation. Put in different terms, the effect estimate equates to slightly

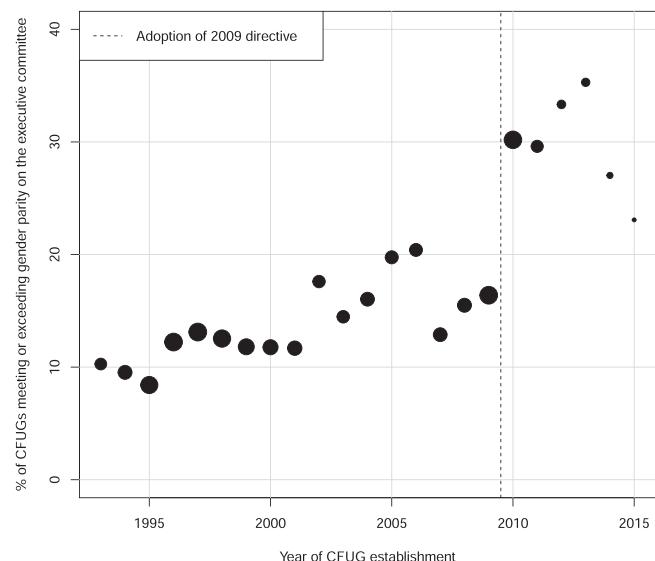


Fig. 2. Percentage of CFUGs meeting or exceeding gender parity on the executive committee, by year of establishment. After the 2009 directive, the percentage of newly formed CFUGs meeting or exceeding gender parity increased. Horizontal axis shows the year of CFUG formation. Vertical axis shows the percentage of CFUGs that had at least half of their executive committee seats occupied by women at the time of formation, for CFUGs formed in each year. Point sizes are scaled according to the number of observations in each year. Data generated from a census of CFUGs formed from the beginning of Nepal's Community Forestry Program in the early 1990s until 2015. See [Section 4](#) for further details on measurement.

less than a + 1 difference in the number of seats held by women on an 11-member executive committee.⁹

One alternative explanation for the results of the fixed-effects analysis is that the apparent effect is due to a gradual increase in rates of women's leadership over time that began before the directive, and is therefore not a result of the directive itself. We explore this possibility in [Section B of Supplementary Information](#), and find that the data show a clear discontinuity at the year of the directive rather than a gradual increase over time, which is supportive of the idea that the pattern is attributable to the directive itself.

5.2. Foreign aid projects increased women's leadership by approximately 24% points

[Fig. 3](#) shows, descriptively, the distribution of women's leadership in two groups of CFUGs formed from 2001 to 2014: those formed in municipalities that had received at least one locally targeted foreign aid project in the forestry sector by the time the CFUG was formed, and those formed in municipalities that had not received such a project by the time of CFUG formation. While CFUGs formed in municipalities that had received a project had noticeably more women on their executive committees than CFUGs formed in municipalities that had not received such a project, this descriptive analysis does not account for potential unmeasured confounders.

We therefore present estimates from a regression discontinuity design described in [Section 4.2](#) as our best estimate of the effect of foreign aid projects on women's leadership, and our formal test of H2. Estimates from the regression discontinuity analysis of locally targeted, forestry-sector foreign aid projects suggest that CFUGs formed immediately after the implementation of such an aid project in their municipality had significantly more women on their executive committees

⁹ The median CFUG in the dataset has an executive committee of 11 members in total.

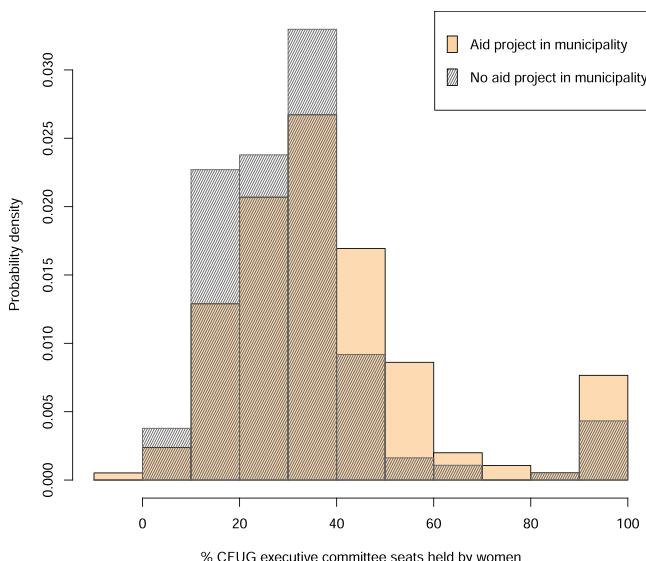


Fig. 3. Percentage of CFUG executive committee seats occupied by women, in municipalities that had and had not received aid projects by the time of CFUG formation. CFUGs had higher rates of women's leadership if they were formed during or following a locally-targeted, forestry sector aid project in their municipality. Aid projects are targeted at the municipality or sub-municipality level. CFUGs formed from 2001 to 2014 are classified into two groups: those formed in municipalities that had received at least one locally targeted foreign aid project in the forestry sector by the time the CFUG was formed, and those formed in municipalities that had not received such a project by the time of CFUG formation. Horizontal axis shows the percentage of CFUG executive committee members who were women at the time of CFUG formation. Vertical axis shows the probability density. See Section 4.2 for further details on aid projects, and Section 4 for details on the sample and measurement of the dependent variable.

than those formed immediately before an aid project in their municipality—equivalent to a predicted difference of 24% points (Table 1).

This effect estimate is substantively large, corresponding to a difference of greater than one standard deviation. This effect estimate equates to slightly less than a +3 difference in the number of seats held by women on an 11-member executive committee. Even the 95% lower bound estimate shown in Table 1 is substantially larger than the estimated difference before and after the central government directive, as presented in Section 5.1. Fig. 4 shows binned averages of the dependent variable across the range of the running variable with polynomial fits on either side of the cutoff. A discontinuity is clearly visible at the cutoff.¹⁰

5.3. No evidence of a strong effect of male out-migration on women's leadership

Fig. 5 shows the association between women's leadership and municipality-level male out-migration in the analytic sample. While the association appears suggestive of a positive relationship at first glance, we find no evidence for a strong causal effect. Using our instrumental variable approach to estimate the causal effect of international male out-migration on women's leadership, we fail to reject the null hypothesis of

¹⁰ We do not have a theoretical explanation for the sharp downward trend in the smoother at the extreme lower limit of the graph. However, estimates in this range of the smoother are based on a small amount of information, since only one observation in our dataset had a value of the running variable than was lower than -3000. We therefore attribute this anomaly to random variation in a small number of outlying observations—observations that fall outside the optimal bandwidth of observations used to estimate the regression discontinuity estimate reported in this paper.

Table 1

Regression discontinuity estimate of the effect of foreign aid projects on women's leadership. Dependent variable is the percentage of CFUG executive committee members who were women at the time of CFUG formation. See Section 4.2 for details on the estimation, and Section 4 for details on the sample and measurement of the dependent variable.

RD estimate	24.134
95% C.I.	[15.187, 40.592]
Z	4.303
p	< 0.001

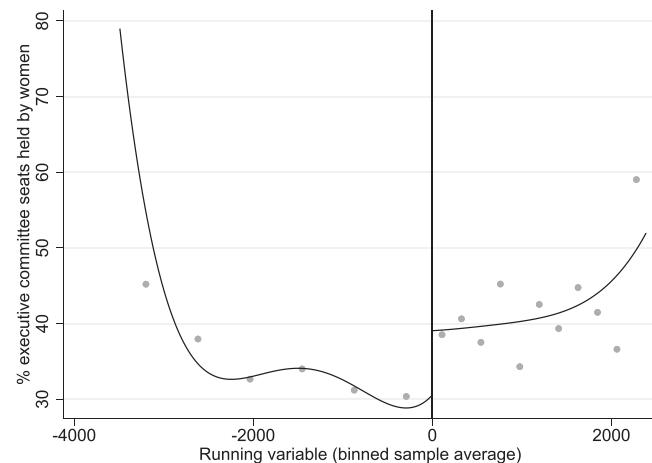


Fig. 4. Average rates of women's leadership across range of foreign aid running variable. Observations are binned and polynomial fits estimated using the data-driven method from Calonico et al. (2017). Vertical axis shows the percentage of executive committee seats held by women at the time of formation, for CFUGs in the regression discontinuity analytic sample. Running variable for the regression discontinuity design on the horizontal axis. See Section 4.2 for details on the coding of the running variable, and Section 4 for details on the sample and measurement of the dependent variable.

no effect using the two-stage least-squares regression model presented in Table 2. The effect estimate of international male out-migration on women's leadership does not reach statistical significance at conventional levels ($p = 0.296$). We therefore cannot reject the null hypothesis of no effect, and find no support for H3.

The null finding is unlikely to be the result of a weak instrument. While weak instruments exacerbate bias (Andrews et al., 2019), the rainfall shock index for 2010 appears to be a strong instrument for international male out-migration in 2011. The coefficient on the instrument in the first stage is positive and statistically significant, and corresponds to an increase of roughly one-half standard deviation in out-migration for each standard deviation increase in the rainfall shock index. A robust partial F-test of instrument strength, correcting for heteroskedasticity and clustering at the municipality level, surpasses established instrument strength thresholds.¹¹

The confidence intervals on the effect estimate are also telling. The 95-percent upper bound of the estimate corresponds to an increase of 0.14 standard deviations in women's leadership in the CFUG predicted by a standard deviation increase in international male out-migration in the municipality, which is less than one third of the estimated effect of the directive and less than one tenth of the estimated effect of foreign aid projects. Put another way, at the upper bound of the estimate, a standard

¹¹ $F_{Eff} = 29.992$, threshold value = 23; $\tau = 10\%$, $\alpha = 5\%$; (Olea and Pflueger, 2013).

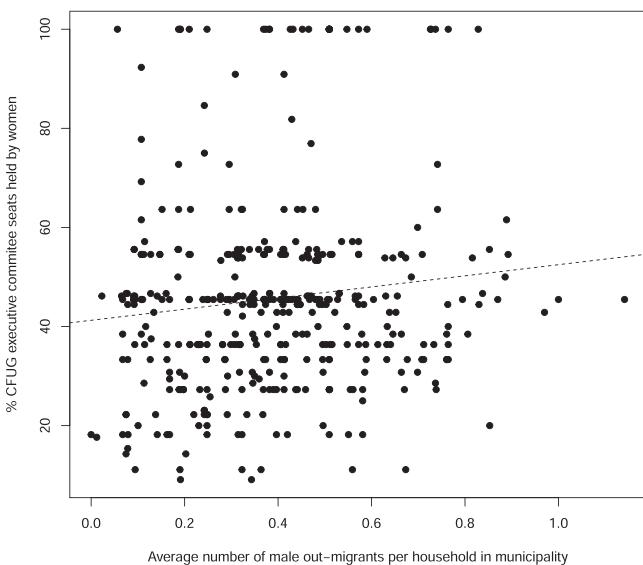


Fig. 5. Linear association between women's leadership and international male out-migration. Includes CFUGs from the analytic dataset used in the analysis described in Section 4.3. These data show an apparent positive relationship between women's leadership in a CFUG and male out-migration in the municipality in which the CFUG is located. For a given CFUG, the vertical axis shows the percentage of CFUG executive committee members who were women at the time of formation. The horizontal axis shows the average number of male household members living internationally per household in the municipality in which the CFUG was formed, based on data from the 2011 population census. Trend line generated using bivariate OLS regression. Slope = 11.225; Intercept = 41.256; $R^2 = 0.013$.

deviation increase in international male out-migration would equate to a roughly +2%-point change in the proportion of executive committee members who are women. Such an impact would be substantively small.

Taken together, these results suggest that while moderately sized confidence intervals on the estimated effect of male out-migration do not allow us to completely rule out a causal relationship between male out-migration and women's leadership, our data make a positive effect of any considerable magnitude appear unlikely.

6. Discussion and conclusion

While it seems increasingly clear that decentralization can be a tool for balancing poverty alleviation and environmental protection, deeply entrenched gender inequalities undermine the promise of decentralization as a path toward sustainability. What can be done to promote women's leadership under environmental decentralization? This study suggests at least two mechanisms through which the international community can seek to alleviate gendered inequalities in local leadership under decentralization. Domestic policies, such as the policy enacted by the government of Nepal stipulating that at least 50% of local leaders should be women, appear to have a positive effect. We estimate that this policy directive increased women's leadership by nearly 8% points. We also find substantial evidence suggesting that international donors can play a role in promoting local leadership under decentralization. We estimate that foreign aid projects increased rates of women's leadership by approximately 24% points. This is consistent with the broader literature suggesting that some types of targeted aid may improve norms related to women's participation (Baliamoune-Lutz, 2016). In other words, both domestic and foreign actors appear to have roles to play in promoting gender equity under environmental decentralization.

While these results suggest a substantial effect from foreign aid projects, foreign influence and domestic policy should not necessarily be

Table 2

Two-stage least squares estimation of the effect of international male out-migration on women's leadership. The rainfall shock index for the municipality in 2010 is used to instrument for international male out-migration in the municipality in 2011, controlling for covariates at the municipality level (see Section 4.3). Male out-migration is measured as the average number of male out-migrants to foreign countries reported per household during the 2011 census, in the municipality in which the CFUG was formed. Second-stage dependent variable is the percentage of CFUG executive committee members who were women at the time of CFUG formation. Estimated effect of male out-migration on women's leadership is given in bold. Standard errors corrected for clustering at the municipality level. Dummy variables included for the year of CFUG formation (not shown). $N = 407$.

	First stage (Dependent variable: Out-migration)	Second stage (Dependent variable: Women's leadership)
Male out-migration in 2011 (instrumented)	-11.318 (10.827)	p = 0.296
Rainfall shock index (2010)	0.318 (0.058) $p < 0.001$	
Terai region	-0.132 (0.055) $p = 0.018$	-8.797 (3.756) $p = 0.277$
Mountain region	-0.009 (0.047) $p = 0.836$	-3.639 (4.872) $p = 0.455$
Major road in municipality	-0.039 (0.026) $p = 0.133$	-3.663 (2.204) $p = 0.057$
Municipality population	0.000005 (0.000003) $p = 0.058$	0.0001 (0.0002) $p = 0.560$
Average monsoon rainfall (1970 – 2000)	0.0003 (0.00007) $p < 0.001$	-0.001 (0.005) $p = 0.798$
Proportion of land in municipality used for agriculture (2000)	-0.054 (0.133) $p = 0.684$	1.825 (10.039) $p = 0.856$
Proportion of municipality covered by forest (2000)	-0.072 (0.125) $p = 0.565$	28.295 (9.532) $p = 0.003$
Change in proportion of municipality covered by forest (1990 – 2000)	-1.761 (0.409) $p < 0.001$	-52.719 (37.947) $p = 0.165$
Average slope in municipality	0.002 (0.004) $p = 0.645$	-0.727 (0.240) $p = 0.002$
Average elevation in municipality	-0.00006 (0.00003) $p = 0.094$	-0.003 (0.003) $p = 0.286$
Constant	0.017 (0.168) $p = 0.919$	54.531 (11.571) $p < 0.001$

compared against one another as competing, mutually exclusive policy prescriptions, especially since both can work in tandem to promote women's leadership. Likewise, for at least two reasons, our results should not be interpreted as evidence that foreign aid is necessarily preferable to domestic policy. First, the implementation and monitoring costs associated with issuing a non-binding policy directive are far lower than those for many foreign aid projects. Second, it is likely that foreign aid and domestic policy can potentially interact with one another, working in combination to promote gender-related goals. For example, local user groups might be more likely to implement equity-related changes recommended by non-binding government directives when such user groups receive donor support. Such potential interactive effects, which warrant further study, would also suggest that foreign aid and domestic policy should not be treated as competing, mutually exclusive tools for promoting women's leadership under environmental

decentralization.

While it might be tempting to assume that male out-migration creates an environment in which women are more likely to participate in leadership positions, we find no evidence of a strong effect of international male out-migration on the likelihood of women's leadership, counter to the theoretical expectations that underpin H3. This negative result is consistent with findings from qualitative case studies (Giri and Darnhofer, 2010b) suggesting that male out-migration may not facilitate women's leadership at the local level, especially where rural women with migrant husbands must contend with time poverty and restrictive social norms, and with other qualitative research from the Himalayan region which highlight that male out-migration has increased women's workloads, leading to time poverty (Bhadwal et al., 2019; Udas et al., 2019). Women living in joint families often experience little autonomy when men migrate because in-laws and relatives still make household decisions (Datta and Mishra, 2011), and women with migrant husbands are often overworked while simultaneously facing social pressures to avoid engaging in public spaces (Lei and Desai, 2021). In other words, social norms may explain why women appear no more likely to participate in leadership positions in areas with high rates of male out-migration.

It is important to note that the results from this study merely supply evidence that domestic policy and foreign aid can expand women's presence in leadership positions under environmental decentralization. The significance of women's presence, however, has been critiqued heavily (Agarwal, 2016; Lau et al., 2021). Women often face discrimination, exclusion, and harmful stereotypes even when they do serve as leaders (Agarwal, 2016). Their substantive participation in decision-making is often therefore hindered by gender dynamics. Furthermore, policy efforts to promote women's presence in local decision-making can lead to unintended consequences when they burden women with greater workloads or cause a 'backlash,' and often incorrectly treat women as a single, monolithic group, thereby failing to address inequalities and power disparities by ethnicity, caste, and class (Lau et al., 2021).

Previous research on gender norms in local governance, therefore, provides several important lessons that help contextualize our results, including the lesson that the presence of women in leadership positions will not automatically translate into large changes in women's empowerment (Lau et al., 2021), especially in the absence of changes in gender norms within the household and in public life. Therefore, more work must be done to understand what actions can be taken to enhance the quality of women's participation in leadership (Cronkleton et al., 2021). Furthermore, women's leadership should be seen as only one factor, likely among several that work in combination, to promote women's empowerment under decentralized governance. Nonetheless, as we discussed earlier in this paper, not only is women's leadership potentially a piece of this puzzle, but there is mounting evidence that women's participation and presence in leadership positions is related to an array of benefits, both to the participants themselves and to the broader community. There is also a growing body of evidence suggesting that improvements in women's numerical representation in leadership positions can, at least in many cases, lead to policy decisions and outcomes that are more consistent with the priorities of women leaders (Clayton and Zetterberg, 2018; Funk et al., 2022; Mendelberg et al., 2014).

CRediT authorship contribution statement

Nathan Cook: Conceptualization, Methodology, Formal analysis, Writing – original draft, Writing – review & editing, Visualization, Supervision, Project administration, Funding acquisition. **Michelle Benendum:** Methodology, Formal analysis, Writing – original draft, Writing – review & editing. **Ganesh Gorti:** Conceptualization, Writing – original draft, Writing – review & editing. **Sitashma Thapa:** Conceptualization, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.envsci.2022.11.007.

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