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# Large-scale land investments, household displacement, and the effect on land degradation in semiarid agro-pastoral areas of Ethiopia

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## Abstract

Agro-pastoral areas in Ethiopia have been targeted by large-scale land investments, particularly for the establishment of sugar plantations, since the 1970s. This has led to the displacement of local communities. We investigate the impact of this displacement due to large-scale land investment on land degradation in semiarid agro-pastoral areas in Ethiopia. We conducted a survey of 866 households in two agro-pastoral sites in Ethiopia in 2019, where extensive large-scale land investment was implemented. We use an endogenous (switching) treatment model to assess the effect of the displacement of households on land degradation. The result shows that 75% of the surveyed households experienced moderate–severe land degradation. Forestlands and grasslands are ranked as the most degraded areas. About 43.7% of the households face a reduction in herd size and 55.8% lost land due to large-scale land investment, while 86% of the households show a substantial decline in crops and livestock productivity due to land degradation. The results also reveal that the displacement of households leads to a significant increase in land degradation. Household exposure to drought and conflict, the number of livestock, overgrazing, and sharecropping are other drivers of land degradation. Market access, extension services, household income, and mobility, on the other hand, limit the occurrence of land degradation. We conclude that the shifts in property rights from common land used by pastoralists to private land in large-scale plantations aggravate land degradation in semiarid drylands.

**KEYWORDS**
displacement, drylands, grazing, land use, pastoralism, sugar plantation

## 1 | INTRODUCTION

Land is an essential resource for human existence, and the degradation of land brings severe challenges to the welfare of people. Land degradation is the reduction or loss of biological, economic productivity, and ecosystem services of land resources (Hugo, 2006; Sombroek & Sene, 1993; United Nations Convention to Combat Desertification [UNCCD], 1994). It is a negative trend in the land condition caused by direct or indirect human-induced processes (Intergovernmental Panel on Climate Change [IPPC], 2019). In dryland areas, land degradation includes deterioration in the quantity, quality, and persistence of native pastures, associated with a loss of plant cover and invasion by shrubs of low pastoral value (Sombroek & Sene, 1993). Land degradation is the most serious problem in drylands and a major threat to the world's ability to achieve zero hunger (Nigussie et al., 2017; Waswa, 2012). It is severe in developing countries and particularly in Africa, where the economy is driven by land-based activities such as agriculture and pastoralism (Tilahun et al., 2015).

Approximately, 30% of the global land area and 40% of land in developing countries is degraded, affecting 3.2 billion people globally (Global Environmental Facility [GEF], 2019; Nkonya, Mirzabaev, & von Braun, 2016). In drylands, 73% of the rangelands are affected by degradation (Sombroek & Sene, 1993). Globally, $6.3 trillion worth of ecosystem services per year is lost due to land degradation (Sutton, Anderson, Costanza, & Kubiszewski, 2016). The annual global cost of losses in milk and meat production due to grassland degradation is about US$7 billion (Nkonya et al., 2016). About 65% of Africa's agricultural land and one million square kilometres of land in Sub-Saharan Africa are degraded, while 43% is extreme deserts (Ioras, Bandara, & Kemp, 2014; Kapalanga, 2008; Nana-Sinkam, 1995; Vlek, Le, & Tamene, 2010). Land degradation is a serious global problem affecting livelihoods and sustainable development and has received attention globally. The Rio Summit in 1992 (United Nations Department of Economic and Social Affairs [UNDESA], 1992) and the United Nations Convention to Combat Desertification in 1994 (UNCCD, 1994) set policies for combating land degradation. The UN Sustainable Development Goal (SDG) 15 emphasizes achieving a land degradation natural world by 2030 (GEF, 2019).

Land degradation is an acute problem in Ethiopia (Bielli, Berhanu, Isaias, & Orasi, 2001); 23% of the land area in Ethiopia is degraded and 17.7% severely degraded (Gebreselassie, Kirui, & Mirzabaev, 2016; Sutton et al., 2016). Land degradation is of much concern as 85% of Ethiopians primarily depend on land (agriculture and pastoralism) for their livelihoods (Alemu, Oosthuizen, & van Schalkwyk, 2002) and a quarter of the population lives below the national poverty line (World Development Indicators, 2019).

Land degradation in drylands is, to a large extent, a natural process. However, land-use changes by humans, and especially agricultural activities, aggravate land degradation (IPPC, 2019). Land-use changes by industrial sugar plantations, which we refer to as large-scale land investments (LSLI) in this study, can modify natural habitats and land conditions by intensive use of water, agrochemicals discharge, runoff of polluted effluent, and air pollution (World Wildlife Foundation, 2005). Moreover, in dryland pastoral areas, LSLIs have been primarily located on fertile and water-abundant lands leading to pasture scarcity and aggravation of land degradation.

The Ethiopian government initiated LSLIs in the 1970s. With the goal of development, the state captured large tracts of land, often with minimal consultation and compensation to the pastoral communities that resided on the land (Rettberg, 2010). This has led to the displacement of several pastoral communities. For instance, in the Afar pastoral region, over 400,000 ha of land were taken in the last five decades for LSLIs, parks, and wildlife reserves (Mousseau & Martin-Prével, 2016). Since 2010, the Karrayyu and Afar agro-pastoralists in Fentale and Dubti have lost over 80,000 ha of pasture land due to sugar plantations (Rettberg, 2010). The LSLIs control fertile lands and large rivers that pass through the dryland regions. As a result, pastoralists have lost access to highly productive commons (pastures, water, and forests) that they have been using for centuries. This further increases the pressure on land resources.

Some reports claim that the introduction of LSLIs in the agro-pastoral areas of Ethiopia has harmed pastoral welfare and livestock productivity (Ibrahim, 2016; Mekuyie, Jordaan, & Melka, 2018; Mousseau & Martin-Prével, 2016). However, these reports are mainly qualitative and largely ignore the potential land degradation effects of LSLIs. The majority of the existing studies in Ethiopia focus on land-use and environmental changes (Berihun et al., 2019; Meaza et al., 2019; Nyssen et al., 2014; Tsegaye, Moe, Vedeld, & Aynekulu, 2010), land management (Chesterman et al., 2019; Shiferaw & Holden, 1998), and land tenure (Nega, Adinew, & Gebresillase, 2003; Taddese, 2001). Furthermore, these studies have mainly been conducted in highland, non-pastoral areas. No studies have quantitatively investigated the impact of LSLI-induced displacement on land degradation in the agro-pastoral context. Moreover, the use of local pastoral knowledge in assessing land degradation has seen little application by scientists. Therefore, this paper investigates the effect of LSLI-induced displacement on land degradation from a community and household perspective. The study addresses the following specific research questions: (a) What is the impact of household displacement due to large-scale land investments on land degradation? (b)What is the extent of land degradation among households that have been displaced by large-scale land investments? (c) What are the drivers of land degradation in agro-pastoral areas in Ethiopia that have been affected by large-scale land investments?

## 2 | MATERIAL AND METHODS

### 2.1 | Data and sampling

In 2019, we conducted a household survey in Fentale and Dubti agro-pastoral *woredas*[1] located in Oromia and Afar States of Ethiopia. These *woredas* host the Metehara and Tendaho sugar plantations (Figure 1). The Metehara sugar plantation was established on 10,000 ha in the early 1970s and expanded by 20,000 ha, leading to the establishment of the new Kesem sugar plantation in 2010. The Tendaho sugar plantation was established on 60,000 ha in 2014. Both LSLIs have displaced people and restricted access to dry season grazing.

We applied a two-stage stratified random sampling method in which we first selected the two *woredas* purposively for the presence of LSLI, and then we identified four *kebeles*,[2] two adjacent *kebeles*, and two distant (out of five-kilometre radius to the LSLI). The sample was taken from the 2018 population of Fentale (113,902) and Dubti (102,936) (Central Statistical Agency, 2013), by Yamane's formula (Yamane, 1973) at a 95% confidence level, ±5% precision, and 8% contingency. A sample of 440 households from Fentale and

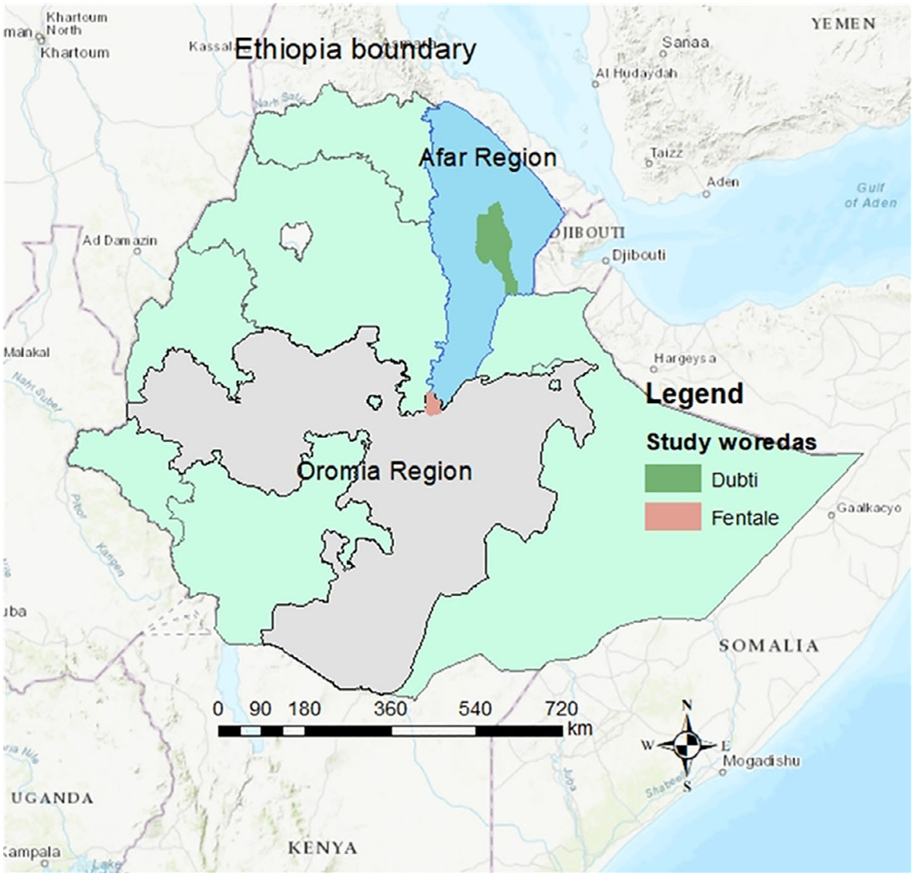



**FIGURE 1** Map of the study *woredas* [Colour figure can be viewed at wileyonlinelibrary.com]

430 households from Dubti were interviewed. After data screening, 866 households were included in the analysis.

We adopted the methodology for the local-level assessment of land degradation in drylands developed by the Food and Agriculture Organization of the United Nations (FAO) (Nachtergaele & Licona-Manzur, 2008). Following this methodology, we first conducted community focus group discussions (FGDs) before the formal survey. A total of 43 male and 16 female elders participated in eight FGDs. We conducted the FGDs to identify the major land-use types, livelihood activities, and indicators, causes and trends of land degradation over the last 30 years. We follow Nachtergaele and Licona-Manzur (2008) to rank indicators of the severity of land degradation as none, light, moderate, and severe. Based on Willemen et al. (2018), we identified 15 indicators of land degradation common to all kebeles of the study areas. Insights from the FGDs were used to develop the household survey. Apart from the indicators of land degradation, the questionnaire consists of household characteristics, socioeconomic, institutional, and environmental factors.

## 2.2 | A conceptual model of the study

Large-scale land investments have led to the displacement of pastoral communities, limiting their access to common property resources (grazing, forests, and water) from which the community previously derived their livelihood (Rettberg, 2010). They deprive the customary land rights of the pastoral communities who used the areas as dry season grazing (Ibrahim, 2016). Displaced communities may end up landless or lose entitlements to dry season grazing.

Hence the loss of access to common property resources by displaced people increases pressure on forest lands, rivers, and grasslands, negatively affecting their ecological resilience (Terminski, 2013). While pastoral production systems require mobility for access to grazing and water, LSLIs restrict access to dry season grazing by blocking paths to water and pasture (Mousseau & Martin-Prével, 2016). As a result, livestock overgrazes sparse grazing land leading to more land degradation (Mousseau & Martin-Prével, 2016). The denial of grazing land forces the displaced people to destroy natural resources for survival (charcoal and firewood selling) and over-exploitation of the remaining grazing areas (Fernandes, 2001; Terminski, 2013). Thus, displacement leads to natural resources degradation. Figure 2 illustrates how land degradation is caused by displacement[3] via loss of access to common resources and overgrazing. Other factors, such as household and farm characteristics, socioeconomic, institutional, and environmental factors also influence land degradation (Berry, 2003; Kertész, 2009; Young, 1994).

## 2.3 | Econometric model

In observational studies where there is no baseline information available, quasi-experimental designs such as matching techniques,

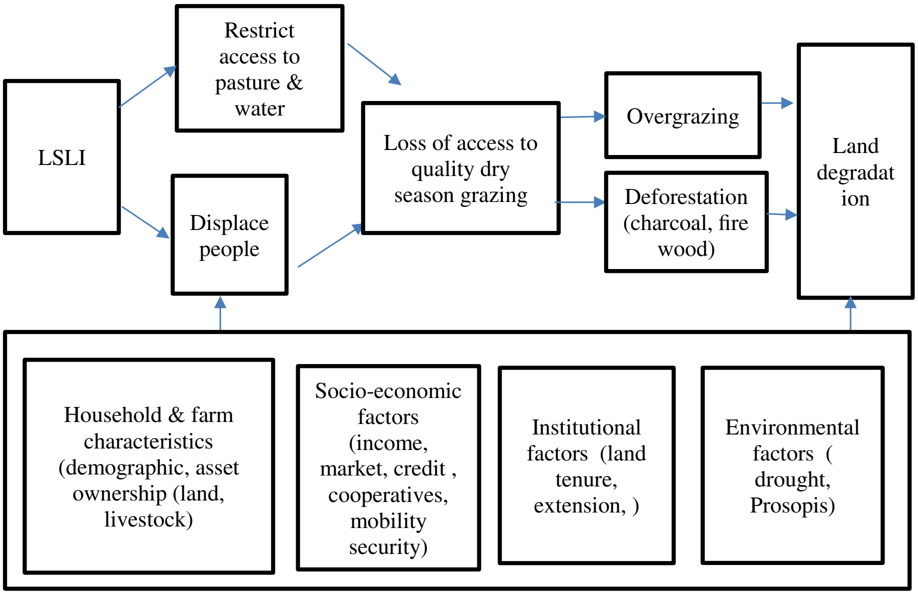



**FIGURE 2** Conceptual model of the study. Source: Authors' design [Colour figure can be viewed at wileyonlinelibrary.com]

instrumental variables, endogenous (switching) treatment, and inverse probability weighting methods can be applied (Baker, 2000). The appropriate method depends on the nature of the selection process. In our case, the displacement of households is non-random, and not all agro-pastoralists are exposed to the treatment of displacement leading to selection bias. Those households living in areas with good soil and water are likely to be more vulnerable to displacement because LSLIs have been located on good quality land (Lay, Nolte, & Sipangule, 2018). As a result, unobserved factors that drive LSLIs and hence displacement may also affect land degradation (simultaneity) and, therefore, displacement is considered to be endogenous. To address this endogeneity problem, we adopt an endogenous (switching) treatment regression models (Maddala, 1983). The endogenous treatment regression model (ETRM) uses a linear model for the outcome and a constrained normal distribution to model the deviation from the conditional independence assumption imposed. The endogenous switching regression model (ESRM) accounts for observed and unobserved bias by estimating a simultaneous equation model (Lokshin & Sajaia, 2004). The ETRM is nested in ESRM and is widely applied in the analysis of the welfare impact of policies and technology adoption (Adebayo, Bolarin, Oyewale, & Kehinde, 2018; Adego, Simane, & Woldie, 2019; Adela & Aurbacher, 2018; Heckman, Tobias, & Vytlacil, 2003; Mekonnen, 2017). Other relevant studies have applied ESRM to analyse the effect of land-use changes on water quality (Abildtrup, Garcia, & Kere, 2015), the effect of a large dam on agricultural production (Chen, Hsu, & Wang, 2018), the effect of climate exposure on afforestation (Oyekale & Oyekale, 2019), and the effect of forced displacement on income (Do Yun & Waldorf, 2016).

The specification[4] of the endogenous switching regression model is as follows (Lokshin & Sajaia, 2004):

$$T_i = 1 \text{ if } \gamma Z_i + u_i > 0,$$

$$T_i = 0 \text{ if } \gamma Z_i + u_i \le 0,$$

$$Y_{1i} = X_i\beta_1 + \varepsilon_{1i}, \tag{1}$$

$$Y_{2i} = X_i\beta_2 + \varepsilon_{2i}, \tag{2}$$

$T_i$ is the treatment of the $i$th household, 1, if displaced and 0 otherwise.

$Y_{ji}$ is the land degradation index for household $i$ in treatment $j$.

$Z_i$ is a vector of factors that influence the probability of the treatment.[5]

$X_i$ is a vector of factors that influence the level of land degradation.

$\beta_1$ , $\beta_2$, and $\gamma$ are vectors of parameters, and $\varepsilon_1, \varepsilon_2$, and $u_i$ are the error terms (a trivariate normal distribution with mean vector zero and non-singular covariance matrix).

The average treatment effect of the treated (ATT) and the average treatment effect on controls (ATC) in a counterfactual framework can be defined as follows:

$$\text{ATT} = E(Y_{1i} - Y_{0i} | T_i = 1), \tag{3}$$

$$\text{ATC} = E(Y_{1i} - Y_{0i} | T_i = 0). \tag{4}$$

## 2.4 | Dependent variable

Land degradation is complex, and there is no widely accepted measurement of land degradation (Dubovyk, 2017; IPPC, 2019). Generally, the use of multiple indicators for land degradation assessment is advised (Walpole, 1992). Following Walpole (1992) and Willemen et al. (2018) and the results of the FGDs in each kebele, we identify 15 local indicators of potential loss in land quality, namely soil loss (erosion), gullies, soil pollution, water pollution, salinity, loss of wildlife, forest loss, depletion of soil nutrients, landslides, dried up water bodies, lost wetlands, weed invasions (*Prosopis*[6]), pollution of the land, and loss of soil dry matter. The majority of the indicators of land degradation that were identified by the community in our study were also reported in research in the Ethiopian Rift Valley areas (Meaza et al., 2017; Nyssen et al., 2014). In the survey, households rated each indicator as not visible, light, moderate, and severe on a 1–4 scale (see Appendix 1). We then constructed a land degradation index (LDI) for each household, which is the average value of the 15 indicators, and used this as the dependent variable in the model.

$$\mathrm{LDI}_i = \sum_{j=1}^{n} (I_j)/n, \tag{5}$$

I is the value of each land degradation indicator, *i* is a household, *j* is the type of indicator, and *n* is the total number of indicators.

## 2.5 | Independent variables

The main independent variable of interest is the displacement caused by LSLI. This variable measures whether a household was displaced from their land due to LSLI in the last 30 years or not. About 24.5% of the sample households were displaced because of LSLI in the last three decades. Large-scale land investment locations are determined by land quality, water availability, and infrastructure (Lay et al., 2018). Thus, distance from LSLI (LSLI_km) and the number of family members employed in the formal sector (N_employed), which drive displacement, were used as exclusion criteria.[7]

Table 1 displays all the independent variables with their descriptive statistics. The drivers of land degradation are derived from the literature (Berry, 2003; Kertész, 2009; Nyssen et al., 2014; Tsegaye et al., 2010; Vu, Le, Frossard, & Vlek, 2014; Waswa, 2012; Young, 1994). Resource access in developing countries is affected by household characteristics. Women play an important role in land conservation (Jolejole-Foreman, Baylis, & Lipper, 2012). Education

**TABLE 1** Independent variables and descriptive statistics

| | Variables | Variable definition | Control | Treatment[a] | Total | Sign[b] |
|---|---|---|---|---|---|---|
| Treatment outcome | DISPLACE | If the household has been displaced in the last 30 years 1, 0 otherwise | 75.5 | 24.48 | 100 | + |
| | LDI | Land degradation index | 1.8 | 2.1 | 1.9 | |
| Household and farm characteristics | AGE | Age of head (years) | 42.4 | 41.0 | 42.1 | +/– |
| | GEND | Gender of head (1 if male, 0 otherwise) | 83.0 | 87.3 | 84.1 | |
| | HH_size | Number of family members | 7.8 | 8.0 | 7.84 | + |
| | EDU | Years of education of head | 1.3 | 1.4 | 1.3 | |
| | TLU | Livestock number owned (TLU[c]) | 13.0 | 19.5 | 14.5 | +/– |
| | LAND_own | Quantity of land owned (ha) | 0.8 | 0.9 | 0.9 | – |
| | OVGRAZ | If high intensity overgrazing 1, 0 otherwise | 26.3 | 40.7 | 28.8 | |
| | SHARECROP | Participate in sharecropping (1 yes, 0 no) | 43.4 | 55.1 | 46.3 | – |
| Socioeconomic factors | LOGINC | Total household income in ETB | 32,307.8 | 39,234.0 | 34,003.3 | – |
| | CREDIT | Households credit use (1 = yes, 0, no) | 11.8 | 11.8 | 11.8 | – |
| | MARKET_km | Distance to market (km) | 14.1 | 16.4 | 14.6 | +/– |
| | COOPER | Membership of cooperatives (1 yes, 0 otherwise) | 16.8 | 17.9 | 17.1 | – |
| | CONFLICT | Household exposure to conflict (1 yes, 0 otherwise) | 14.1 | 31.1 | 18.2 | + |
| | MOBILITY | If the household practices mobility (1 yes, 0 no) | 50.3 | 42.5 | 48.4 | – |
| Institutions | LAND_tenure | If the household has a land certificate (1, yes, 0 no) | 32.1 | 35.8 | 33.0 | +/– |
| | EXTENSION | Access to agricultural extension (1 if yes, 0 otherwise) | 40.5 | 35.4 | 39.4 | +/– |
| Environmental | DROUGHT | Household exposure to drought (1 yes, 0 otherwise) | 56.4 | 70.3 | 59.8 | + |

*Note:* The descriptive values show averages for continuous variables and % for binary variables. Source: Authors' survey (2019).
[a]Treatment refers to the group of households that have been displaced in the last 30 years; Control refers to the households that have not been displaced.
[b]The sign stands for the expected effect on land degradation, where '+' indicates that the variable is expected to increase land degradation and '–' to decrease land degradation.
[c]TLU refers to tropical livestock units using conversion factors by Storck and Doppler (1991). TLU was calculated by multiplying the count of each species by their respective units; sheep and goats (0.1), cow (1.0), ox (1.1), donkey (0.5), horse (0.8), poultry (0.01), and camels (1.2) (Storck & Doppler, 1991).

increases farmers' ability to conserve land (Mango, Makate, Tamene, Mponela, & Ndengu, 2017). Age of the household head and household size has been found to improve the adoption of land conservation practices and limit the occurrence of land degradation (Kirui & Mirzabaev, 2015). Population density leads to more land degradation in highland Ethiopia (Nyssen et al., 2014). Farm characteristics also influence land degradation (Kirui & Mirzabaev, 2015; Kosmas et al., 2016). The number of livestock may increase land degradation through the effect of overgrazing (Jolejole-Foreman et al., 2012). Cooperative membership helps households to share knowledge, labour, and skills and helps to acquire inputs to combat land degradation (Nkonya et al., 2016). Proximity to the market decreases the adoption of sustainable land management (Kirui & Mirzabaev, 2015). A higher income may help to invest in the sustainable use of land and the conservation of land. Thus, credit access can also contribute to reducing land degradation (Kirui & Mirzabaev, 2015). Mobility is a strategy for the efficient use of scarce pastures (Davies et al., 2016). Extension services can include training on the sustainable use of natural resources (Mango et al., 2017). Farmland tenure helps to combat land degradation (Kirui & Mirzabaev, 2015) because the security of land ownership provides incentives for sustainable land use (Nkonya et al., 2016). Finally, climate factors, such as rainfall and temperature, may also affect the extent of land degradation (Meaza et al., 2017; Meaza et al., 2018). To capture the effect of climate change, we include households' drought exposure. Drought indicates long dry seasons with the absence of rainfall and very high temperatures. Drought shocks are expected to lead to more land degradation (Ariti, van Vliet, & Verburg, 2018; Davies et al., 2016; Demeke, Guta, & Ferede, 2006). Pastorals live in conflict-prone areas because of the nature of mobility, and conflict exposure is expected to increase land degradation.

## 3 | RESULTS

### 3.1 | Perceived impacts of large-scale land investments

Table 2 compares the perceived impacts of LSLIs by displaced and control households. Over the last 30 years, 55.8% of households have lost, on average, 2.5 ha of private land due to an LSLI. The average area lost by the control households was 2.44 ha and 3.01 ha for displaced households. Particularly, over 90% of the displaced households report loss of access to grazing land, displacement of their close relatives during the same period, and deterioration of their livelihoods, while these shares were between 60 and 80% for the non-displaced group. Moreover, 57.5% of displaced and 43.7% of non-displaced respondents report an increasing trend of land-use conflict and a reduction in herd size associated with an LSLI. Regarding the positive impacts of the LSLIs, we assess employment, training, and infrastructure development. The FGDs revealed that there are no efforts made by LSLIs to benefit the community. Consequently, we observe very low responses. 4.62% of the respondents report infrastructure development (roads, schools, and clinics), 2.32% on training, and 6.8% on employment opportunities (as security guards). The average wage per day for daily labourers ranges between 37.5 and 50 Ethiopian Birr, which was approximately 1.33–1.78 US$[8] per day, this wage rate was below the absolute poverty line of 1.9 US$ set by the World Bank. Only less than 1% of the employees in the LSLI are from pastoral communities.

**TABLE 2** Perceived negative impacts of large-scale land investment

| | Household category | | |
|---|---|---|---|
| | Control | Displaced | Total |
| Land lost (per household) (ha) | 2.4 | 3.0 | 2.5 |
| Yes (%) | | | |
| Lost private land | 30.7 | 69.34 | 55.8 |
| Poverty increases | 71.9 | 87.3 | 75.6 |
| Lost grazing land | 78.0 | 93.9 | 81.9 |
| Conflict increases | 52.8 | 72.2 | 57.5 |
| Natural resources lost | 81.5 | 91.5 | 84.0 |
| Parents & relatives displaced | 57.6 | 95.3 | 66.9 |
| Deterioration of livelihoods | 61.5 | 93.4 | 69.3 |
| Reduction in herd size | 41.3 | 50.9 | 43.7 |

Source: Authors' survey (2019).

### 3.2 | Level and causes of land degradation

We asked respondents to rate the extent of land degradation for each land-use type. About 89.8% of households have indicated light–severe levels of land degradation (aggregate average for all land uses). Out of this, 75.3% estimated a moderate–severe level of land degradation, while 14.5, and 10.2% report light or no degradation. Overall, 86.2 and 65.5% of the displaced and control households have reported moderate–severe land degradation, respectively (Table 3). Forestlands and grasslands were rated as the most severely degraded land use, followed by grazing land (areas grazed by livestock including grasslands and shrublands) and water resources. A higher proportion of the displaced households was affected by moderate/severe land degradation compared to the control households.

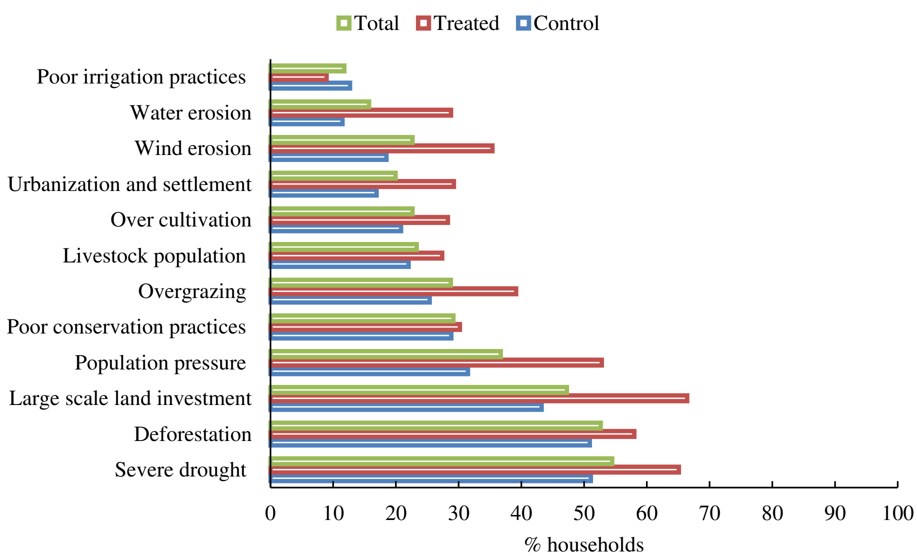
Figure 3 shows pastoralists' perspectives on the causes of severe land degradation in the study areas. The proportion of households for each of the control, treated, and total households was determined. Households identified severe drought (54.2%), deforestation (52.7%), and LSLI (47.3%) as the main causes of severe land degradation. In Ethiopia, the incidence and length of severe drought periods have been increasing (Beyene, 2016). Drought is related to declining rainfall and rising temperatures. The average annual precipitation over the last 35 years declined by 17.7% in Fentale and 35.9% in Dubti, while the maximum temperature in Fentale rose by 1.85°C and in Dubti by 5.5°C (Appendix 2 and 3). Similar observations have been made for the Rift Valley areas of Ethiopia, with declining and erratic rainfalls (Meaza et al., 2017; Meaza et al., 2018).

**TABLE 3** The extent of land degradation by land-use type (%)

| | Level of degradation | Control | Displaced | Total |
|---|---|---|---|---|
| Farm land | Invisible | 15.2 | 12.7 | 14.8 |
| | Light | 23.9 | 11.3 | 21.7 |
| | Moderate–severe | 60.9 | 76 | 63.5 |
| Grazing land | Invisible | 10.6 | 14 | 11.2 |
| | Light | 11.2 | 4 | 9.9 |
| | Moderate–severe | 78.2 | 82 | 78.9 |
| Forest land | Invisible | 6.0 | 1.33 | 5.2 |
| | Light | 8.2 | 8 | 8.2 |
| | Moderate–severe | 85.8 | 90.7 | 86.6 |
| Grassland | Invisible | 7.4 | 7.3 | 7.4 |
| | Light | 10.8 | 3.3 | 9.5 |
| | Moderate–severe | 81.8 | 89.3 | 83.1 |
| Water bodies | Invisible | 12.8 | 11.5 | 12.6 |
| | Light | 23.8 | 19.6 | 23.1 |
| | Moderate–severe | 63.4 | 68.9 | 64.4 |
| Aggregate | Invisible | 13.2 | 5.3 | 10.2 |
| | Light | 21.3 | 8.4 | 14.5 |
| | Moderate–severe | 65.5 | 86.2 | 75.3 |

Source: Authors' survey (2019).

**FIGURE 3** Perceived causes of severe land degradation; Authors' survey (2019) [Colour figure can be viewed at wileyonlinelibrary.com]




Next to droughts, deforestation is seen as a major cause of land degradation. In this respect, the respondents indicate LSLI (83%), charcoal (57%), and firewood collection (54%) as the main drivers of deforestation. Charcoal production was introduced to the area by the highland labour migrants that were attracted by the LSLIs. Furthermore, LSLIs cleared natural vegetation and forests that had existed on the land before their establishment (Ibrahim, 2016).

Over a quarter of the respondents believe that population growth (human and livestock) drives land degradation. The human and livestock population grew rapidly in the region, by 3.2 and 1.5% per annum, respectively, while pastureland availability declined. The population of the study areas increased from approximately 54,056 in 1973 to 113,902 in 2018 and by 65.4% in Fentale and 90.4% in Dubti, respectively. From 1995 to 2013, the cattle population grew by 41.2%, of sheep by 49.8%, and of goats by 58.6%. As was found in other studies, population pressure is harming natural resources (Abate, Ebro, & Nigatu, 2010; Berry, 2003; Bielli et al., 2001; Nkonya et al., 2016; Nyssen et al., 2014) and negatively affecting the conservation practices in Ethiopia (Demeke et al., 2006; Shiferaw & Holden, 1998).

About 28.64% of households point to high-intensity overgrazing, contributing to land degradation. Less than 25% of households report the causes of severe land degradation to be wind and water erosion, over-cultivation, settlement, and poor irrigation practices. On average, displaced households give a higher weight to the different causes of land degradation than control households, except in the case of poor irrigation practices.

Figure 4 illustrates the perceived effects of land degradation on people's livelihoods by control, treated, and total household categories. More than 86% of the respondents associate land degradation with lower crop and livestock productivity. Moreover, 71.6% of households associate land degradation with increased death of livestock and 48.9% with crop failure. FGD participants explain this by the loss of access to common resources and the poor quality of the soil since LSLI establishment. For instance, maize yield declined from 1.5 metric tt $ha^{-1}$ to 0.7 metric t $ha^{-1}$ in Dubti after the establishment of the plantation (Planel & Labzaé, 2016). In the survey year, a household, on average, reported the death of 10 goats, six sheep, three cows, five oxen, four camels, two poultry, and two donkeys. This is in line with studies that show increasing livestock mortality in the region (Ariti et al., 2018; Ibrahim, 2016; Ioras et al., 2014). Similarly, milk production has been declining in the past 30 years for camels from 15 L to less than 2 L per day, for cows from 10 L to 1 L per day, and for goats from 5 L to less than 1 L per day. As a result, there is no or only a little surplus of milk to be marketed. 97.8% of the respondents claim that desertification has been rising.

## 3.3 | Empirical model results

Tables 4 and 5 show the ETRM model results and the average treatment effects of being displaced, and Appendix 4 reports the ESRM regression results. The full information maximum likelihood jointly estimates the selection and treatment equations efficiently (Lokshin & Sajaia, 2004). For both ETRM and ESRM models, the Wald tests show that the regression models fit the data well. The likelihood-ratio test for independence of the treatment and outcome equations also suggests the rejection of the null hypothesis of no correlation between the treatment and outcome errors, indicating an endogeneity problem that should be solved. In ETRM, the correlation coefficients between the error terms of the displacement and land degradation equations are negative and significant. The significance and negative correlation between error terms, respectively, show the presence of a selection bias and unobservables that raise LDI while lowering displacement. In ESRM, the correlation coefficients between the treatment and outcome equation are both negative, but significant only for the correlation between the treatment and the control equations (Appendix 4), suggesting that non-displaced households have higher LDI than they would have if displaced.

The exclusion variables show a significant effect on the probability of treatment in ETRM, but not in ESRM. Accordingly, the number of employed family members (N_employed) significantly reduces the likelihood of being displaced. Whereas distance from LSLI_km increases the likelihood of displacement. The ESRM result shows that the likelihood of displacement increases with the size of livestock, household income, distance from market, conflict, farmland tenure, and intensity of overgrazing. Conversely, extension access, herd mobility, head age, and conflict significantly reduce the likelihood of displacement. It should be noted that households with farmland tenure did not escape displacement.

The results show that displacement significantly increases the level of land degradation after controlling for unobserved factors. The estimated average treatment effect (ATE)[9] of being displaced is 0.56 and 0.91 in ETRM and ESRM, respectively. This means that being displaced, on average, increases LDI by approximately 0.56–0.91 units per household. Moreover, control households would have a 0.47 higher LDI if they had been displaced. The heterogeneity effect is related to unobservable differences that could explain land

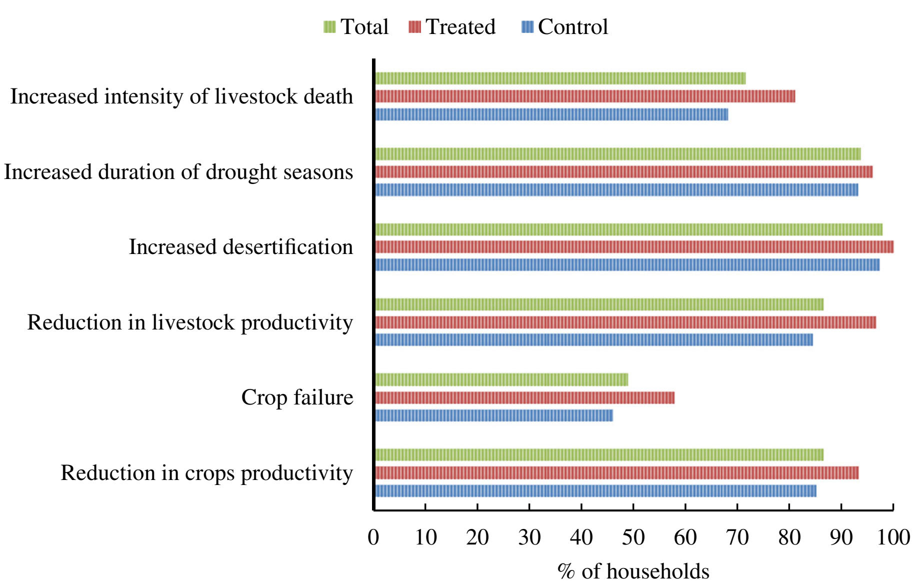



**FIGURE 4** Perceived effects of land degradation on livelihoods of agro-pastoralists; Authors' survey (2019) [Colour figure can be viewed at wileyonlinelibrary.com]

**TABLE 4** Endogenous treatment effect of displacement on land degradation

| | | Coef. | Std. err. |
|---|---|---|---|
| | TREATMENT | 0.564*** | 0.108 |
| Household and farm characteristics | AGE | −0.001 | 0.001 |
| | GENDER | −0.030 | 0.037 |
| | HH_size | 0.004 | 0.004 |
| | EDU | 0.010* | 0.005 |
| | TLU | 0.003*** | 0.001 |
| | LAND_own | −0.019 | 0.018 |
| Socioeconomic factors | LOGINC | −0.065*** | 0.012 |
| | CREDIT | −0.057 | 0.041 |
| | MARKET_km | −0.009*** | 0.002 |
| | COOPER | −0.076** | 0.035 |
| | OVGRAZ | 0.163*** | 0.030 |
| | SHARCROP | 0.405*** | 0.031 |
| | CONFLICT | 0.325*** | 0.037 |
| | MOBILITY | −0.075*** | 0.027 |
| Institutional | LAND_tenure | −0.120*** | 0.029 |
| | EXTENSION | −0.037** | 0.018 |
| Environmental | DROUGHT | 0.287*** | 0.033 |
| | _cons | 2.224*** | 0.127 |
| TREATMENT | | | |
| Drivers of treatment | MARKET_km | 0.017*** | 0.006 |
| | N_employed | −0.367*** | 0.109 |
| | LSLI_km | 0.017*** | 0.008 |
| | _cons | −1.051*** | 0.118 |
| | /athrho | −0.584*** | 0.179 |
| | /lnsigma | −0.896*** | 0.049 |
| | Rho | −0.526 | 0.130 |
| | Sigma | 0.408 | 0.020 |
| | Lambda | −0.215 | 0.062 |
| | Wald chi2(18) | 1,090.03*** | |
| | Log likelihood | −851.701 | |
| | Observations | 863 | |
| | LR test of indep. eqns. (rho = 0): chi2(1) = 4.4** | | |

*Note:* TREATMENT (1 displaced, 0 Control), ***, **, * respectively show the 1, 5, and 10% significance levels. '+' signs of the coefficients show the variables that worsen land degradation, "−" signs of the variables that reduce land degradation. Source: Authors' survey (2019).

**TABLE 5** Treatment effects of displacement on land degradation (ESRM)

| Treatment effects | Treated (1) | Control (0) | Heterogeneity effect |
|---|---|---|---|
| Treated (1) | 2.13(0.52) | 2.25(0.45) | −0.12 |
| Control (0) | 1.22 (0.37) | 1.78 (0.33) | −0.56 |
| ATT (ATC) | 0.91*** | 0.47*** | 0.44 |

*Note:* *** indicates $p < .01$, Standard deviations (in parentheses), ATT is the average treatment effect on treated, and ATC is the average treatment effect on the control.

degradation. The heterogeneity effect is negative, implying that the displacement effect is smaller for the displaced households compared to the control.

There are slight differences in terms of significant variables between ETRM and ESRM results. The ESRM provides significant variables separately for treated and control households. Accordingly, household income and market access reduce land degradation for both treated and control groups. For the treated households, the age of household head, size of land owned, access to credit, and market distance lower the degree of land degradation. Albeit, for the control households, cooperative membership, mobility, and land tenure lower the degree of land degradation. Whereas for both treated and control, sharecropping, conflict, and drought worsen land degradation. For treated households, the intensity of overgrazing worsens land degradation. For control households, the level of education of the household head (which is very low on average) does not help in reducing land degradation. Age and land size in ESRM, but not in ETRM, affect land degradation; households with older household heads and larger land sizes have lower land degradation.

In ETRM, apart from the household characteristics, several of the control variables have good statistical power. Livestock size (TLU) significantly has a worsening but small influence on land degradation, implying that the larger the livestock population, the more land degradation. Household income and distance to the market have a small effect but lead to significantly lower levels of land degradation. We find that cooperative membership leads to a lower level of land degradation. High-intensity overgrazing and sharecropping are associated with more land degradation. Farmland tenure security reduces land degradation. However, in practice, pastoralists are herders who move from place to place to optimize grazing availability. Thus, offering them a certificate for a plot is not compatible with their means of livelihoods. Access to extension and mobility leads to a lower degree of land degradation. Exposure to drought and conflicts significantly increase land degradation. Moreover, a connection exists between the two. The burning of forests, crops, and grasslands occurs during severe conflicts. For example, the conflict of Afar and Issa contributed to the deterioration of the pasturelands (Said, 1994), as did the conflicts between the Karrayu and Argoba communities.

## 4 | DISCUSSION

Overall, we find evidence that displacement due to LSLI increases the intensity of land degradation, causing the deterioration of livelihoods. The finding is in line with the observation that displacement is causing environmental degradation in Africa (Mohamed, 2016). Over 75% of the respondents have encountered a moderate–severe level of land degradation. Displaced households, on average, have 0.56–0.91 units higher levels of land degradation compared to non-displaced households. Drought, deforestation, and LSLI were seen by community members as the key drivers of land degradation. LSLI-induced displacement was also identified as a significant driver of land degradation in the econometric analysis.

Our findings of the drivers of land degradation are to a large extent in line with other studies on this topic. The main factors that we have identified to decrease land degradation are market access (Berry, 2003; Nkonya et al., 2016); household income (Bunning, McDonagh, Rioux, & Woodfine, 2011), cooperative memberships (Kirui & Mirzabaev, 2015), access to extension services (Qasim, Shrestha, Shivakoti, & Tripathi, 2011), livestock mobility (Butt, 2010; Said, 1994; Sonneveld et al., 2010), and farmland tenure security (Ariti et al., 2018; Kirui & Mirzabaev, 2015). Some of our findings contradict other studies' results. For instance, market access may lead to more exploitation of natural resources (Douglas, 2006; Mirzabaev, Nkonya, Goedecke, Johnson, & Anderson, 2016). Factors that are found to increase land degradation are livestock population and overgrazing (Jolejole-Foreman et al., 2012), sharecropping (Coughlan, Nelson, Lonneman, & Block, 2017), drought (Bielli et al., 2001; Said, 1994), and conflict (Said, 1994). In relation to LSLIs and displacements, lack of tenure rights for commons and restriction of mobility were the key drivers of land degradation.

There have been two general debates in the academic literature regarding the causes of land degradation, Hardin's tragedy of the commons (Hardin, 1968) and Ostrom's counter-argument to the tragedy of commons (Ostrom, Burger, Field, Norgaard, & Policansky, 1999). The “tragedy of the commons” hypothesis argues that the communal ownership of resources leads to their degradation and recommends privatizing property rights (Hardin 1968). In contrast, Ostrom argues that communities can manage their collective resources sustainably and private ownership of land may well lead to resource depletion as individuals want to maximize their private benefits from the land. However, neither of these two debates acknowledges the tragedy that may result when powerful external groups take control of resources to gain personal advantage without consultation or compensation of local communities.[10] The latter is exactly what was found in the current research: LSLIs restrict pastoralists' access to grasslands and water, leading to increased scarcity of dry season grazing and pressure on pasture lands.

Moreover, as LSLI capture the most productive land that has been used for dry season grazing, the overall productivity of the grazing land declines (Abbink et al., 2014) and, for instance, in Afar, the appropriation of land for LSLI has increased the incidence of overgrazing (Sonneveld et al., 2010). In contrast to the "tragedy of the commons" concept, overgrazing in the study area is not the result of the accumulation of livestock and the free-rider problem (Cox, 1985; Hardin, 1968). Instead, it is due to the denial of access to grazing land that disrupted the mobility pattern of pastoralists and their livestock (Beza & Assen, 2017) (Beza & Assen, 2017; Cox, 1985; Said, 1994). Two observations support our claim for the absence of the tragedy of commons. First, pastoralists elsewhere in Ethiopia survived for centuries based on the traditional governance of the commons and in harmony with their environment (Dell'Angelo, D'Odorico, Rulli, & Marchand, 2017; Federal Democratic Republic of Ethiopia [FDRE], 2019). Second, in Ethiopia, pasture land governance has well-defined user rights, access conditions, set rules and norms (Beyene, 2016), and exclusion criteria to prevent outsiders from exploiting the resource (Beyene, 2006).

As the state owns all the land in Ethiopia, pastoralists can easily be removed from their ancestral land and the result for the effect of farmland tenure on land degradation should be interpreted with caution. On the one hand, we do find that land tenure security reduces land degradation and ensures sustainability (Ariti et al., 2018; Kirui &

Mirzabaev, 2015). However, the notion of land certification poorly fits with pastoral livelihoods. Considering the transhumance nature of pastoralist systems, what matters for pastoralists is access to pastures rather than a specific piece of land (Dell'Angelo et al., 2017). Loss of access to the commons undermines pastoralist livelihoods unless there is compensation with a land of equivalent or superior quality (Vanclay, 2017). Therefore, the recognition of collective tenure rights to the commons and mobility is a cornerstone of sustainable development and optimizing scarce pastures (Butt, 2010; Davies et al., 2016).

According to Dwivedi (2002), there are two arguments regarding development-induced displacement (such as LSLIs). The first argument is that development-induced displacement is inevitable and minimizing the effect of displacement is necessary. The second view sees displacement as a disruption in peoples' existing ways of life and the denial of property rights. Without taking either side of these views, this study suggests that LSLIs have displaced indigenous pastoralists in favour of industrial plantations and disturbed their way of life. Thus, revisiting the possibilities of ensuring pastoralists' access to common resources will mitigate land degradation. However, if the displacement in the future is inevitable, it should be implemented with community consultation and adequate land improvement strategies.

## 5 | CONCLUSIONS AND POLICY RECOMMENDATIONS

This study provides evidence on the effect of LSLI-induced displacement on land degradation in agro-pastoral areas of Ethiopia. The results reveal that LSLI areas expand by displacing households and restricting access to pastures and other resources in the study area. This aggravates the scarcity of pasture lands and hence leads to land degradation.

LSLI aggravated land degradation directly by destroying common resources (clearing of vegetation and grass) in favour of plantation production and by dispossessing grazing land and exacerbating overgrazing. Significant proportions of the households in our study perceive that poverty and conflicts have been increasing while herd size has shown a declining trend as a result.

LSLI-induced displacement significantly worsens land degradation. There is strong evidence that the land of the displaced households has suffered significantly more degradation than that of the control households. Loss of access to productive dry season pasture and dispossession of former pasture is a major driver of overgrazing. This is also related to the absence of property rights for the commons. We conclude that displacement increased the severity of land degradation. However, also non-displaced households may face negative externalities from LSLI, such as the discharge of polluted water and a decline in ecosystem services (loss of native vegetation and forest products).

Among the confounding variables, access to markets and extension services, membership in cooperatives, farmland tenure, and livestock mobility reduce land degradation. While drought, the number of livestock, and sharecropping aggravate land degradation.

Actions to be taken to halt and minimize land degradation and increase livestock productivity include, creating market integration, allowing mobility, and developing pastoral extension systems. The extension should integrate conservation practices to those highly degraded areas. Evidence from Ethiopia shows that intensive rehabilitation activities have helped to combat land degradation in dryland areas (Nyssen et al., 2014). Thus, effective soil and water management practices could enhance pasture availability. Future LSLIs should engage the local communities in the planning process and recognize the rights of pastoral people. If displacement is inevitable, prior informed consent, compensation, and shared access to communal resources is advisable. A corrective measure is also necessary to help displaced pastoralists gain access to common pool resources. A stricter implementation of responsible agricultural practices on LSLIs, ensuring pastoralists' access to pasture lands and allowing mobility can possibly mitigate land degradation.

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## CONFLICT OF INTEREST

The authors declare no conflicts of interest.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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## ENDNOTES

[1] *Woreda* is the fourth administrative level in Ethiopia (Federal-Regional-Zonal-***Woreda***).

[2] *Kebele* is the fifth administrative level in Ethiopia (Federal-Regional-Zonal-Woreda-***Kebele***).

[3] The concept of displacement is adopted from Bartolome, De Wet, Mander, and Nagraj (2000) and refers to the alienation of the individual and community customary rights and permanent dislocation of the social and economic organization. The displacement is induced by policy (in our case, LSLIs). The dislocation of people from their homeland territory without social support in the new place of residence is a violation of the most fundamental human rights (Terminski, 2013).

[4] Without loss of generality, we specify the models based on treatment effect literature, and we adopt a single equation for the ETRM and ESRM models (Heckman et al., 2003; Lokshin & Sajaia, 2004). The ETRM simultaneously estimates the treatment and outcome equation (Equation [1] with bivariate endogeneity error terms correlations), while the ESRM estimate (Equation [1] and [2]) such as the treatment equation, the outcome equations on treated and the untreated with trivariate endogeneity error terms correlations.

[5] We include in the vector $Z_i$ some variables that do not belong to the vector $X_i$ to make the estimation more robust and improve identification. We recognize that some of the important determinants of the treatment are exogenous factors (policy decisions) and are difficult to obtain. Hence we use as exclusion restrictions, LSLI_km, ROAD_km, N_employed that affect the selection variable but not the outcome variables.

[6] Prosopis was introduced into Ethiopia in the 1970s as a soil conservation measure, with high drought tolerance. In Afar region, the plant is now covering over 1.2 million hectares (FDRE, 2017).

[7] Exclusion criteria for treatment in ESRM are not strictly required for identification as the non-linearity assumption of the error term. We include them for a more robust estimation of the regression.

[8] During the survey year 2019 for January on average 1 USD equals 28.11 Ethiopian Birr.

[9] We use *etregress* for ETRM and *movestay* for ESRM. Both models capture the treatment with high predictive power. The ATT in ETRM is lower than ESRM. This may be because the treatment effects from ETRM are constrained in the absence of interaction between treatment variable and covariates of the outcome variables (except for MARKET_km).

[10] In Dubti-Afar study sites, the FGD participants reported that the government negotiated with clan leaders about taking the land for sugar plantation. The actual people affected by the Tendaho plantation did not receive compensations; however, a few traditional leaders and elites received money and forced the community to relocate as the government's development plan for sugar plantation is compulsory.

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## SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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