

Groth, Juliane; Seppelt, Ralf; Sakdapolrak, Patrick; Senbeta, Feyera; Hermans, Kathleen

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Research

# Why smallholders stop engaging in forest activities: the role of in-migration in livelihood transitions in forested landscapes of southwestern Ethiopia

Juliane Groth<sup>1</sup> , Ralf Seppelt<sup>1</sup> , Patrick Sakdapolrak<sup>2,3</sup> , Feyera Senbeta<sup>4,5</sup> and Kathleen Hermans<sup>6,7</sup>

**ABSTRACT.** Forest decline and degradation are particularly high in the tropics and pose a risk to those who depend on forest resources. The in-migration of smallholders to forest frontiers can fuel transitions of livelihoods and land and resource use. However, the conditions under which in-migration contributes to such transitions remain poorly understood. With this study, we aim to investigate the influence of in-migration, together with other non-demographic factors, on the livelihoods of local and migrant communities. As a case study, we chose the Guraferda district, a hotspot of rural in-migration and forest loss in southwest Ethiopia, where the forest-based local population experienced a rapid transition to agriculture-based livelihoods. We used 224 household surveys in three different kebeles (smallest administrative unit in Ethiopia) and applied descriptive and analytical statistics to understand how and why the forest activities of local and migrant groups have changed since a major resettlement program was launched in 2003. The findings were contextualized by local expert knowledge to assess forest loss and the role of in-migration in livelihood transitions and deforestation. Forest cover in Guraferda declined partially because of the in-migration of smallholders from agricultural-based systems, and insecure land tenure, but also considerably because of the expansion of commercial agriculture. With the decline in forest, the local population adopted migrants' agricultural practices, a trend further encouraged by agricultural policies and barriers to participation in forest management for locals. Our study challenges simplified assumptions in in-migration–deforestation debates by showing that governmental policies, land tenure, and natural-resource access are mediating the impact of migration on livelihood transitions and deforestation. We conclude that securing land tenure and equal access to natural resources for frontier residents and promoting a mix of agricultural and forest livelihood activities can reduce adverse impacts in in-migration areas.

**Key Words:** *Africa; in-migration; livelihood transition; natural-resource degradation; random-forest regression*

## INTRODUCTION

Every year, approximately 13 million ha of forests are lost worldwide, with the highest forest-loss rates in the tropical regions of Latin America, Southeast Asia, and Africa (FAO 2020). Forest decline and degradation pose a risk to those who depend on forest resources. In the tropics, the rural poor heavily rely on forest resources such as wood, medicine, or food to meet their subsistence needs (Angelsen et al. 2014, Wunder et al. 2014). Migration-induced population growth is often considered an important underlying cause of tropical deforestation and degradation, primarily because a growing population increases the demand for fuelwood, timber, and agricultural land (e.g., López-Carr and Burgdorfer 2013).

Research on in-migration–environment linkages is mainly concerned with the question of whether migrants are “agricultural colonists,” or under what circumstances migrants become “exceptional resource degraders” (e.g., Codjoe 2006, Codjoe and Bilsborrow 2012). An increasing number of studies show that the impacts of in-migration on the environment are highly context-dependent, findings that therefore do not directly support simplified explanations of the linkages between in-migration and environmental effects (Zommers and MacDonald 2012, Jones et al. 2018). Non-demographic factors at various spatial scales, such as socioeconomic household characteristics or institutional settings (e.g., resource-access mechanisms or land-tenure security), are supposed to be crucial in mediating the influence of in-migration on natural resources (e.g., Unruh et al. 2005, Caviglia-Harris et al. 2013, Hermans-Neumann et al. 2016,

Tadesse et al. 2016). Further, there is evidence that the level of migrant integration, and the migrants' knowledge of the local contexts and interaction with the receiving (host) communities influence their use of natural resources (Cassels et al. 2005, Codjoe and Bilsborrow 2012, Hartter et al. 2015). Yet, detailed empirical insights into the influence of in-migration on traditional livelihood practices of receiving communities at tropical forest frontiers and the interaction between locals and migrants, e.g., the exchange of livelihood practices and local knowledge, are lacking. Besides population dynamics, macroeconomic forces such as large-scale land acquisition (LSLA) are considered a major non-demographic driver of deforestation (e.g., Rudel et al. 2009, Magliocca et al. 2020) and can add substantial pressure on the local natural resource base and consequently on natural resource-dependent livelihoods at forest frontiers (Cotula 2012, Carter et al. 2017). Moreover, it has been shown that LSLA affects the land use of surrounding smallholders and thus indirectly contributes to deforestation, for which migrants are often blamed (Zaehringer et al. 2021).

Consequently, this paper intends to broaden the current scope of in-migration–environment analysis by assessing the linkages between in-migration, resource use, and the livelihoods of receiving communities. We focus on rural in-migration of land-seeking smallholders to tropical forest frontiers because this migration type increases the demands for agricultural land potentially at the expense of forest, and thus likely influences forest-dependent livelihoods. Therewith, we acknowledge smallholder in-migration as a contributing factor to livelihood

<sup>1</sup>Department of Computational Landscape Ecology, Helmholtz Centre for Environmental Research - UFZ, Germany, <sup>2</sup>University of Vienna, Department of Geography and Regional Research, <sup>3</sup>Wittgenstein Centre for Demography and Global Human Capital (IIASA, OeAW, University of Vienna), Austria, <sup>4</sup>Department of Biological Sciences, Faculty of Sciences, Botswana University of Agriculture and Natural Resources, Gaborone, Botswana, <sup>5</sup>College of Development Studies, Addis Ababa University, Ethiopia, <sup>6</sup>Department of External Environment for Agriculture and Policy Analysis (Agricultural Policy), Leibniz Institute of Agricultural Development in Transition Economies (IAMO), <sup>7</sup>UFZ - Department of Computational Landscape Ecology, Helmholtz Centre for Environmental Research, Germany

and related resource-use transitions in in-migration areas, yet we seek to better understand under what conditions in-migration leads to negative environmental effects.

We chose Ethiopia's southwest transitional and lowland tropical forest, in particular the Guraferda district in the Bench Maji Zone of the Southern Nations, Nationalities, and Peoples' Region (SNNPR; Fig. 1), as a study region because it is known for its richness in biodiversity, range of ethnicities, and in-migration history. The region is one of the last highly forested areas in Ethiopia where wild coffee still grows (Wood et al. 2019). Favorable climatic conditions and an abundance of land perceived as unused in this region were the major reasons for various inflows of smallholders from the drought-prone, degraded, and densely populated parts of the country throughout Ethiopian history (Hammond 2008). In-migration in the more recent past has been associated with a transition from forest-based to agriculture-based livelihoods and an associated increase in deforestation and forest degradation (Kassa et al. 2017a, Getahun et al. 2017). However, the conditions under which these in-migration flows actually contributed to livelihood and land-use transitions remain unclear. Thus, in this study, we aim to understand how in-migration, together with non-migration-related factors, influences livelihood transitions and deforestation in Guraferda.

## IN-MIGRATION, RURAL LIVELIHOODS, AND INSTITUTIONAL CHANGES IN GURAFERDA BETWEEN 2003 AND 2018

Guraferda has experienced rapid social-ecological changes over the past 20 years, including swift population growth, expansion of cropland and agricultural livelihoods, forest loss, and changes in forest management and land-tenure policies.

### Population development

Between 2003 and 2018, the population of Guraferda grew from approximately 30,000 to 50,000 people, mainly through in-migration from the degraded and densely populated Ethiopian highlands (CSA 2007, Hammond 2008; Guraferda Land Administration 2019, *unpublished data*). Beginning in 2001, an unknown number of "northern migrants" from the northern Ethiopian highlands (mainly Amhara but also from Tigray and Oromo ethnic groups) came to Guraferda without any government or institutional support (Debonne 2015, Kassa et al. 2018). In addition, at least 8000 "southern migrants" (mainly Welayta, Sidama, and Kambaata ethnic groups) from the southern highlands resettled to Guraferda as part of a large intra-regional resettlement program beginning in 2003 (Lemenih et al. 2014; Guraferda Land Administration 2019, *unpublished data*).

### Land tenure

Officially, land is state-owned in Ethiopia, and upon arrival in 2003, the planned southern migrants received 2.1 ha of land from local state authorities under the umbrella of the resettlement program for their own disposal (Belay 2004), which equals a total of approximately 16,000 ha. In contrast, northern migrants did not receive formalized, state-recognized land-use rights. Instead, they obtained land by making their own arrangements with the resident local (receiving) communities because large parts of Guraferda were under the traditional forest tenure, the so-called *kobbo* system (see Appendix 1 for detailed information), which is still recognized by the local communities (Kassa et al. 2017a). Kobbo owners transferred portions of their forestland to the

newly arrived migrants from the north in exchange for rent or a share of the harvest (Kassa et al. 2017a). However, these land transfers were not state-recognized (Debonne 2015). In other cases, northern migrants cleared or simply used unclaimed land, which was possible because of the land abundance in 2003 and the absence of formalized rules regarding forest use (Debonne 2015, Kassa et al. 2017a). Unclaimed land was perceived as de facto open-access (Stellmacher and Eguavoen 2011).

### In-migration

The arrival of diverse settlers has greatly increased the cultural, linguistic, and ethnic diversity of the Guraferda population, including the livelihood systems. On arrival, both migrant groups depended on sedentary farming and plantation systems, cultivating cash crops such as coffee and pepper (FEWS NET 2006). In contrast, the resident local groups, the Dizi, Sheko, and Menit, practiced shifting cultivation of mainly maize and relied heavily on non-timber forest products (NTFPs; FEWS NET 2006) such as honey or wild coffee collected in the forest. Unlike the locals, migrants used the forest mainly as a source of timber and fuelwood (Fig. 2). In the last two decades, Guraferda's rural communities lost approximately 26,000 ha of forest (Guraferda Land Administration 2019, *unpublished data*) and transitioned from a forest-based to an agricultural system (FEWS NET 2006, Kassa et al. 2017a; Fig. 2). Kassa et al. (2017a) have shown that locals engage less in forest activities and instead increasingly focus on agriculture, a shift that is *inter alia* influenced by in-migration, although details of this link remain unclear.

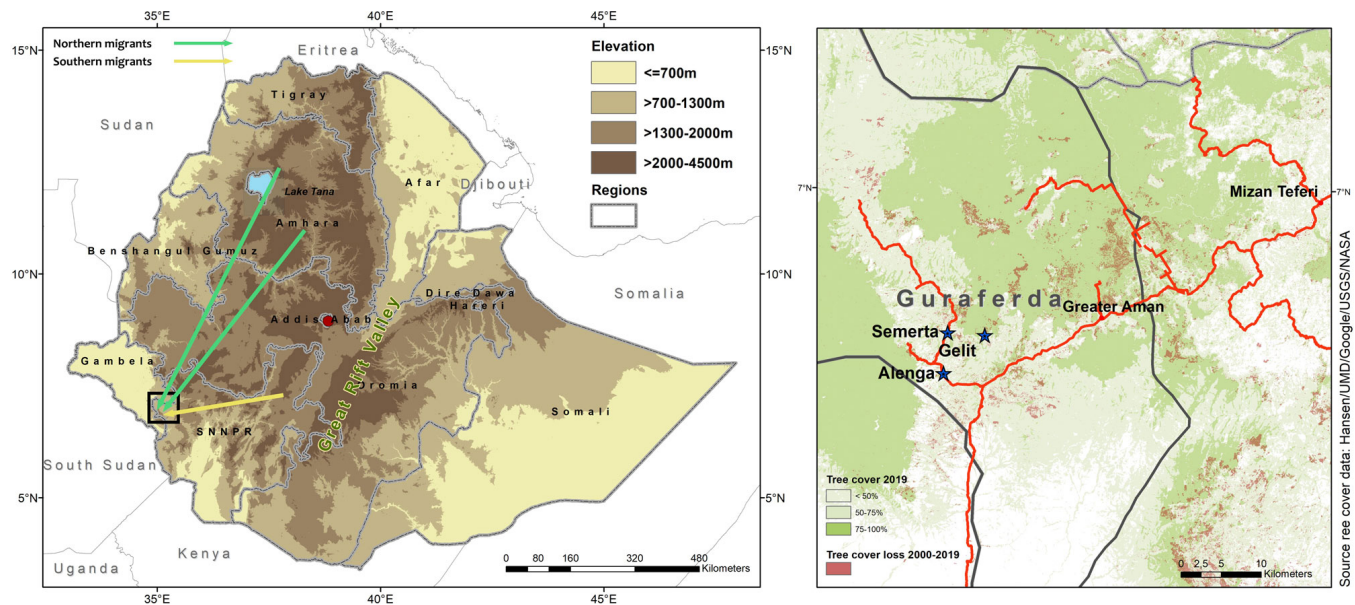
### Commercial agriculture and land reforms

In the same period, large-scale commercial agricultural projects expanded and an additional area of 22,000 ha was allotted to private investors (Bench Maji Zonal Statistics 2019, *unpublished data*). Furthermore, there have been policy and institutional changes in Guraferda. In 2010, a land reform secured land for migrants and limited the maximum land area to 2.1 ha for all migrant households (Debonne 2015; Guraferda Land Administration 2019, *unpublished data*). This overruled the agreement that northern migrants had with local people (and therewith the traditional *kobbo* system) and officially allocated the land claimed by northern migrants to them, thereby reducing the land held by locals and resulting in a plurality of tenure arrangements. In addition, in 2005 the state released a land proclamation that allowed it to confiscate land or transfer it to private investors for public benefits (Proclamation No. 455/2005 and No. 456/2005).

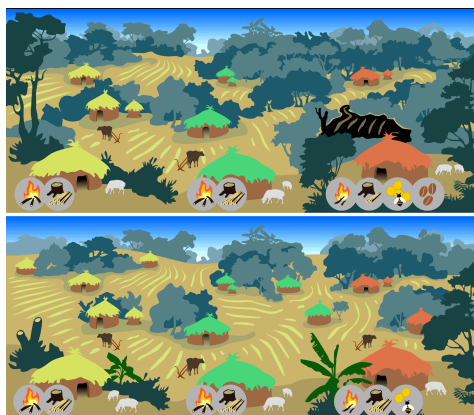
### Forest management

Participatory forest management (PFM) schemes were introduced in the area to protect the remaining forest, starting around 2010 (SWFLG 2014). Forest-use rights and responsibility for sustainable management of the forest were transferred to the communities, now made up of a mix of migrants and local people, to so-called forest user groups (FUGs) under the umbrella of PFM (SWFLG 2014). Restrictions on the use of forest products (e.g., permission required for collecting NTFPs) were introduced under the FUG domain, and also applied to all remaining trees and forests on the farmers' land (for details see Appendix 1). However, this contradicts the customary user rights of the locals under the *kobbo* system (Kassa et al. 2017a).

**Fig. 1.** Left: Map showing Ethiopia's administrative regions and the location of the case study area (black rectangle) based on elevation data obtained from the Shuttle Radar Topography Mission (SRTM) at 250 m resolution (Farr et al. 2007). The three arrows showing the area of origin of the northern migrants (green) and southern migrants (yellow). Right: Map showing the study area, the Guraferda district, with the locations of the three kebeles (blue stars) studied during the empirical fieldwork, the two major cities of Mizan Teferi and Greater Aman and the main roads (red). In green, the tree cover in 2019 and in red, the tree cover loss between 2000 and 2019 is illustrated based on data obtained from a time-series analysis of Landsat images at a 30 m resolution (Hansen et al. 2013).



**Fig. 2.** Transition of livelihoods and use of forest products from 2003 (upper figure) to 2018 (lower figure) of southern migrants (left, yellow), northern migrants (middle, green), and local households (rights, red). The southern and northern migrants focus on intensive farming and use the forest mainly as a source for timber and fuelwood, both in 2003 and 2018. In contrast, the livelihoods of the locals changed considerably from shifting cultivation (black spot) with hand tools and a focus on collection of non-timber forest products (NTFPs) to sedentary, intensive agriculture. The forest cover considerably declined between 2003 and 2018.



Against this background, we hypothesize (i) that the engagement in forest activities and the use of forest products has declined from 2003 to 2018 for all three groups; and (ii) that reduced forest cover, which is mainly caused by clearing activities of migrants and the expansion of smallholder cropland, drives this decline in engagement in forest activities within households.

## METHODS

### Selection of research sites and data collection

During a preparatory visit in February 2018, we interviewed district and kebele officials to gather qualitative information on land-use change and in-migration for several districts and kebeles in the Bench Maji zone. Based on this information, we selected three kebeles, Alenga, Semerta, and Gelit, in Guraferda district for in-depth research, which differed considerably regarding in-migration and resulting population composition, remoteness, institutional settings, and forest availability and loss, so as to increase our sample variation.

Between January and March 2019, we conducted in-depth fieldwork, supported by five local enumerators who received training prior to the fieldwork. The data collection was mainly conducted in Amharic, but a few interviews required additional translation into the local languages. In addition we accompanied the enumerators to ensure consistency during data collection. In each kebele, our data collection started with one group discussion with four to five local officials and leaders (see Appendix 6) to obtain a consensus overview of the specifics of rural livelihoods, kebele infrastructure, population dynamics, land cover, forest



**Table 1.** Characteristics of the three research sites in 2018. Data were obtained during focus group discussions and from statistical records of the kebeles and Guraferda land administration office.

Kebele	Total population (households) <sup>†</sup>	Locals (surveyed households; share)	Northern (surveyed households; share)	Southern (surveyed households; share)	Year-round road	Distance to local market	PFM	Loss of forest area <sup>‡</sup> 2003–2018	Forest area <sup>‡</sup> in 2018
Alenga	4695 (891)	5% (23; 51%)	70% (26; 4%)	25% (24; 11%)	Yes	7 km	Since 2017	1191 ha (68.4%)	549 ha
Semerta	2444 (611)	7% (26; 60%)	25% (26; 17%)	68% (27; 6%)	None	17 km	Since 2011	425 ha (22.5%)	1468 ha
Gelit	1522 (317)	25% (23; 29%)	50% (26; 16%)	25% (23; 29%)	None	20 km	None	1316 ha (100%)	0 ha

<sup>†</sup> Based on official kebele records. Note: spontaneously in-migrated households might not be fully covered.

<sup>‡</sup> Forest that is accessible for kebele community (excludes forest with restricted access for kebele community, e.g., forest transferred to private investors).

product use, and forest institutions (see Table 1). In addition, the discussions were crucial to build trust and gain access to the communities under study.

After the group discussions, we conducted household surveys, which were adjusted after a pilot period prior to the survey campaign, in all three kebeles. Adjustments made to the survey were mainly related to the forest products, i.e., for the quantification we focused on wild coffee, honey, timber, and firewood. These forest products were ranked as the four most important ones throughout all studied kebeles during the group discussions and test surveys. Further, we added the land-use category “shared land” to account for land used but not owned or rented by households. We selected our respondents (household heads or their spouses) based on a stratified sample. The household survey equally comprises all three population groups (locals, southern migrants, and northern migrants). Given the lack of a complete official household list (because spontaneously in-migrated households are often insufficiently covered) for respondent selection, we visited the respective settlement areas of each population group and chose households from every geographic direction to ensure a sufficiently broad and unbiased sample by utilizing a sufficient geographic spread in each community. Translation into a language other than Amharic was required only for the subsample of the local group. We collected mainly quantitative data on socioeconomic household characteristics (including assets and savings, education level, ethnic group, involvement in conflicts), the share of forest and other livelihood activities, household land use and holdings, use and availability of forest products, knowledge and enforcement of the rule on forest products and participation in local forest-user groups. We employed a partially retrospective survey by collecting information not only about the household in the recent year (2018) but also about the situation of the household around the start of the resettlement program (2003). Hence, households that were formed or arrived after 2003 were excluded from the survey. To facilitate recall, we choose 2003 as a particularly significant year in the recent history of Guraferda because this was the year that the major resettlement program was launched and a significant number of people in-migrated. This not only changed the situation for the migrants, who started a new life in Guraferda, but also changed the daily life of the locals tremendously. Such life-changing and remarkable anchor points facilitate recall of other activities or conditions in the same period (Herting 1993).

In sum, we conducted three group discussions at the kebele level and 230 surveys at the household level. In addition, we conducted three semi-structured expert interviews with representatives from local NGOs and the zonal government, and nine semi-structured key informant interviews at the kebele level (see Appendix 6 for further details on the interviewed experts and informants). For the latter, we interviewed three key informants (e.g., the religious leaders) from each kebele, one from each of the local, northern migrant, and southern migrant groups, respectively, who had not taken part in earlier interviews or discussions. The field notes taken during these interviews merely served to provide additional context to our largely quantitative analysis and were not analyzed systematically.

#### Data analysis

For the data analysis, we used 224 out of the 230 surveys (73 in Alenga, 79 in Semerta and 72 in Gelit; see Table 2); six surveys were excluded because of missing response variables (for details on the data preparation, see Appendix 2). Related to our first hypothesis, we used our household survey data to investigate how the engagement in forest activities and the use of the four major forest products, honey, wild coffee, fuelwood, and timber, changed from 2003 to 2018 for each of the three population groups. Subsequently, and related to the second hypothesis, we used a set of variables related to household characteristics, forest availability, forest institutions, social capital, forest products, household assets, and land use from our survey data (see Table 2) and used a random-forest regression-tree procedure (Breiman et al. 2001) to explain what drives the share of forest activities in households in both 2003 and 2018. In addition, we used rank-sum test to explore group-specific impacts on forest clearing.

Related to our second hypothesis, we analyzed three aspects: first, we used regression analysis to examine the influence of the variables “available forest area” and “NTFP use,” which are highly correlated with forest availability, as drivers for the share of forest activities. Second, we performed a Kruskal-Wallis rank-sum test (for non-normally distributed data) and a post hoc pairwise Wilcoxon rank-sum test to test whether there were differences between the two migrant groups and the local group regarding forest clearing activities, and therefore a migrant-specific impact on forest availability, in 2003. Third, we used the regression analysis to examine the influence of the variables “seasonal cropland” and “perennial cropland” used by a household to understand whether smallholder cropland expansion drives the engagement in forest activities. Finally, we used additional information from the key-informant and expert interviews to

**Table 2.** Definitions, mean values, frequencies, standard deviation, range of the response variables, and predictors for 2003 and 2018 included in the statistical analysis.

Variable name	Definition	Mean (SD) /	Min;	Mean (SD)	Min;
		Frequency	Max	/ Frequency	Max
		2003		2018	
Response					
Forest activities [%]	Percentage of household livelihood provided by forest activities; refers to time spent gathering the four main forest products: wild coffee, honey, fuelwood and harvesting timber	23 (20)	0; 100	16 (11)	0; 50
Predictors					
Household characteristics					
Sex household head [female, male]	Sex of the household head	F = 22 M = 202		F = 22 M = 202	
Formal education of household head [completed years]	Completed years of formal education of the household head	2 (3)	0; 10	2 (3)	0; 10
Local [y,n]	Household is a member of the local population	Yes = 72 No = 152		Yes = 72 No = 152	
Northern [y,n]	Household is a member of the northern-migrant population	Yes = 78 No = 146		Yes = 78 No = 146	
Southern [y,n]	Household is a member of the southern-population	Yes = 74 No = 150		Yes = 74 No = 150	
Alenga [y,n]	Household is located in Alenga	Yes = 73 No = 151		Yes = 73 No = 151	
Semerta [y,n]	Household is located in Semerta	Yes = 79 No = 145		Yes = 79 No = 145	
Gelit [y,n]	Household is located in Gelit	Yes = 72 No = 152		Yes = 72 No = 152	
Savings [ETB]	Household savings	549 (8018)	0; 120k	10k (40k)	0; 430k
Forest availability					
Available forest <sup>†</sup> [ha]	Area of state, community or own forest area, which can be used by the household	293 (1705)	0; 25k	250 (540)	0; 3000
Forest institutions					
Member in forest-user group [y,n]	Household is member of the kebele forest-user group (PFM)	<i>FUGs did not exist in 2003</i>		Yes = 80 No = 144	
Enforcement of timber permission [y,n]	Household respects the customary/governmental rules for timber harvest	no = 161 yes = 46		no = 45 yes = 167	
Knowledge of rules on timber use [y,n]	Household knows about the customary /governmental rules for the use and harvest of timber	Yes = 52 No = 167		Yes = 191 No = 23	
Knowledge of rules on fuelwood use [y,n]	Household knows about the customary/governmental rules for the use of fuelwood	<i>No rules existed in 2003</i>		Yes = 21 No = 202	
Social capital					
Majority [y,n]	Household population group belongs to the majority in the kebele	Yes = 75 No = 149		Yes = 75 No = 149	
Conflicts [y,n]	Household was involved in a conflict (personal, over natural resources, over assets) with another household or group up to 4 years after arrival or in the last 4 years	Yes = 1 No = 223		Yes = 22 No = 202	
Walking distance to kebele center [min]	Walking minutes from the homestead to the kebele center	23 (17)	1; 120	23 (17)	1; 120
Forest products					
Forest product gross value [%]	Percentage of gross value generated by collecting and harvesting forest products contributing to all forest and agriculture products collected, produced or harvested	31 (26)	0; 100	14 (11)	0; 57
Timber use <sup>‡</sup> [pieces]	Pieces of timber from native tree species harvested by household	83 (81)	0; 580	106 (106)	0; 700
Fuelwood use [loads]	Loads of fuelwood from native tree species collected by household	107 (54)	0; 364	123 (49)	0; 364
Honey and wild coffee use [kg]	Amount of honey and wild coffee collected by household	46 (194)	0; 2560	17 (61)	0; 750
Household assets and land use					
Land owned <sup>‡</sup> [ha]	Area of land (forest, seasonal and perennial cropland, others) owned by household	3 (3)	0; 25	3 (2)	0; 18
Shared land <sup>‡</sup> [ha]	Area of own land the household shares with another household	0 (0)	0; 5	1 (1)	0; 6
Tin roof [y,n]	Household has a tin roof	Yes = 31 No = 193		Yes = 116 No = 108	
TLU					
Seasonal cropland <sup>‡</sup> [ha]	Tropical livestock unit owned by household	2 (2)	0; 16	2 (2)	0; 7
Perennial cropland <sup>‡</sup> [ha]	Area of cropland used to cultivate seasonal crops owned by household	2 (2)	0; 12	2 (1)	0; 9
Others	Area of cropland used to cultivate perennial crops owned by household	0 (0)	0; 3	1 (1)	0; 3
Eucalyptus used as timber [pieces]	Pieces of timber from eucalyptus trees harvested by household	0 (4)	0; 50	61 (255)	0; 3000
Eucalyptus used for fuelwood [load]	Loads of fuelwood from eucalyptus trees collected by household	0 (1)	0; 20	6 (20)	0; 156
Tree plant [y,n]	Household planted trees on own land within the last 4 years	Yes = 64 No = 160		Yes = 91 No = 133	
Forest clearing <sup>‡</sup> [ha]	Area of forest cleared by household	0 (1)	0; 5	0 (0)	0; 2

<sup>†</sup> High data uncertainty (available forest area 2003 and forest clearing 2018).

<sup>‡</sup> Medium data uncertainty.

contextualize the results from the statistical analysis and to discuss whether changes in forest access and land tenure mediated the influence in-migration had on engagement in forest activities and deforestation in Guraferda.

To analyze the influence of in-migration on forest activities we applied random-forest regression trees, which are particularly strong in addressing multiple correlated drivers (Breiman et al. 2001) and thus are well suited to understanding multicausal, non-linear phenomena in social-ecological systems (Archibald et al. 2009, Hermans-Neumann et al. 2016). We first grew 500 regression trees using a random subset of 12 independent continuous and categorical variables at each split, using two-thirds of our total data (cf. Archibald et al. 2009, Hermans-Neumann et al. 2016). The remaining one-third was used for testing. We built two random regression models, one with the data for 2003 and one for 2018, to explore the differences between the two periods. Furthermore, we used the mean-squared error (MSE) to evaluate the importance of each predictor for the model. The percentage of increase in the MSE (% IncMSE) indicates how much the predictive power of the model is reduced when a predictor is randomly permuted. Consequently, the higher % IncMSE is, the higher the importance of the predictor for the model. The random-forest model results indicate the average over all 500 trees grown, and thus the model does not allow the exploration of any split conditions.

Therefore, we employed a second step, in which we grew two single regression trees, one for 2003 and one for 2018, and pruned them where a split does not increase the model quality based on a complexity parameter. We further added the criterion that the final nodes have at least 10 observations to allow meaningful interpretation of the model results. As a result, we obtained two stable trees, each indicating a combination of predictors explaining low to high shares of forest activities within our observed households. The statistical analysis was implemented using R software (<https://cran.r-project.org>) and by applying the “randomForest” package (Liaw and Wiener 2002) and the “rpart” package (Therneau et al. 2015).

## RESULTS

### Changes in forest activities and forest-product use between 2003 and 2018

In both years 2003 and 2018, forest activities were more important for local households than for the two migrant groups (Fig. 3). Yet, from 2003 to 2018, there was a sharp decline in mean forest activities from 37% to 24% in the local group, while in the other two migrant groups, mean forest activities declined from approximately 16% to approximately 12%. This reduced importance of forest activities is also reflected in the maximum share of forest activities per household across all three groups. In 2003, the maximum share of forest activities reached 100%, while it was halved in 2018, indicating that no single surveyed household depended solely on forest activities. Further, we found that there was little change in product use between 2003 and 2018 among migrants; however, among the local group, the use of honey and wild coffee decreased significantly, while the use of timber increased. Thus, we conclude that the decline in forest activities among local households is primarily due to a decline in the use

of the main NTFPs, honey and wild coffee. In addition, we found that in 2018, local households were rarely part of the local forest-user groups (only 22 out of 72 surveyed local households; see Appendix 3.4 variable “FUG”).

### Changes in drivers of forest activities between 2003 and 2018

#### *Changes in driver importance between 2003 and 2018*

The most important driver of forest activities in both years was the percentage of gross value produced by forest products, which increased the MSE by 31% in 2003 and 17% in 2018. In both years, this was followed by membership in the local group (13% increase in MSE in 2003 and 15% in 2018) and the use of NTFPs (10% increase in MSE in 2003 and 15% in 2018). In the 2003 model, the use of timber increased the MSE by 9%, followed by the membership in the southern migrant group and the forest area available for a household (both 8% increase in MSE). In contrast, in 2018 timber use and forest area available were less important (both below 5% increase in MSE), but southern group membership for 2018 was similarly high (7% increase in MSE). The kebele Alenga was important in explaining the share of forest activity in a household in 2018 (8% increase in MSE), yet in 2003 it had a lower importance (below 5% increase in MSE).

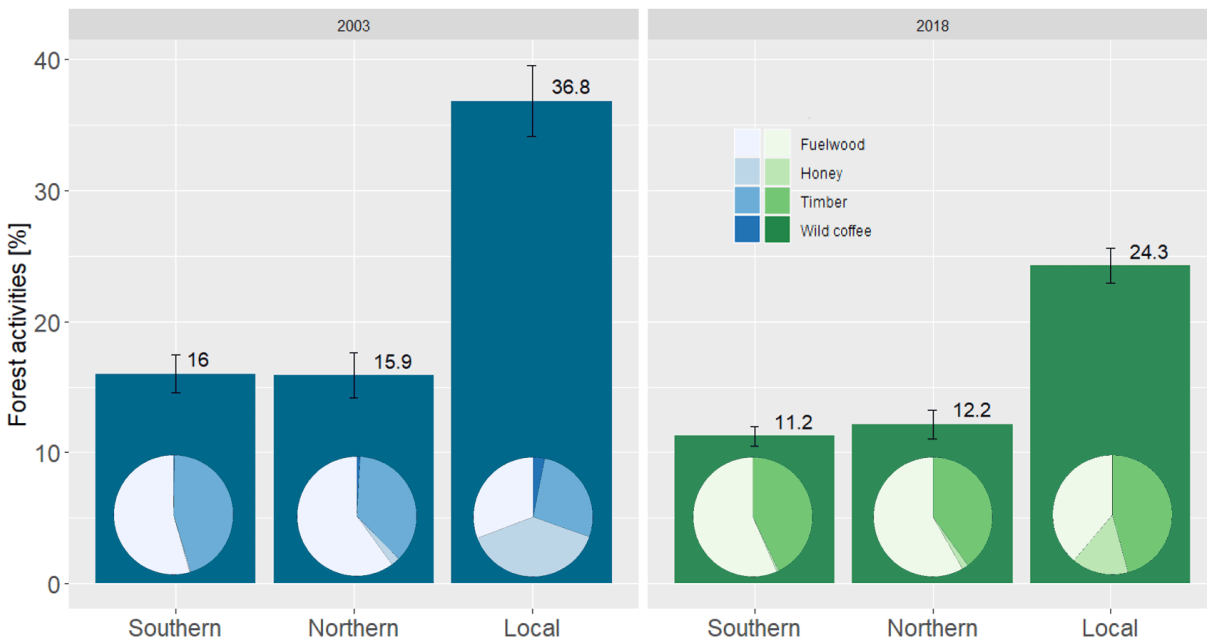
Interestingly, seasonal or perennial cropland increased the MSE by less than 5% in 2003 and thus had a very low relative importance, whereas in 2018 the area of seasonal cropland used by a household was more important with a 10% increase in MSE. From descriptive statistics, we know that cropping activities increased from 2003 to 2018 (see Appendix 3). The random-forest regression models explain 41% of the variance in our data in 2003 (Fig. 4 left) and 39% in 2018 (Fig. 5 left).

#### *Driver interactions that explain forest activities in 2003 and 2018*

In the next step, we identified split conditions using single regression trees, which allows the identification of pathways that explain low to high shares of forest activity and the directional influence of predictors in 2003 (Fig. 4 right) and in 2018 (Fig. 5 right). Overall, both single trees have a somewhat lower predictive power compared to the random-forest regression models, with an  $r^2 = 0.31$  in 2003 and an  $r^2 = 0.34$  in 2018. The 2003 model's predictions are more confident for lower shares of forest activity, but stay the same for the 2018 model (see Appendix 4 for detailed model uncertainties). Compared to 2003, the single regression tree for 2018 is rather small, which can be mainly attributed to the overall lower importance of forest activities in 2018 (cf. Fig. 3).

In 2003, the households with the lowest share of forest activities (below 15% for 108 of the 224 total households) are explained by a gross value of less than 24% produced by forest products. In other words, for almost half of the households, forest activities were a minor activity in 2003, and consequently, the gross value generated by these households through the collection or harvesting of forest products was small. For the other half of our sampled households, which spent approximately 32% of their total livelihood activities engaging in forest-related activities, the most important split condition was their population-group membership. While migrant households have an average share of 22% in forest activities, local households devoted twice as much of their livelihood activities to forests (45%).

**Fig. 3.** Mean shares of forest activities and forest products used by southern migrants, northern migrants, and locals in 2003 and 2018.



For migrant households in 2003, those located in Alenga had a lower share of forest activities (13%) than the other two kebeles (at least 22%). Another branch of the regression tree divides the local households into 41 households harvesting more than 35 pieces of timber per year and showing a mean share of 39% in forest activities, and 12 households harvesting less than 35 pieces of timber per year but showing the highest share of forest activities in our sample (63%). These local households with the highest share of forest activities only engaged a little in timber harvesting (the average number of timber pieces collected in the entire sample in 2003 is 83 pieces) and instead spent a great deal of time on time-intensive collection of mostly non-timber forest products. Local households, which collected more than 35 pieces of timber per year, were further subdivided into two groups. Those with more than 65 ha of forestland available (including forestland exclusively used by a household and forest area that can be used by all community members) had, on average, only a 30% share in forest activities, and households with less than 65 ha of forestland available had a comparatively high 51% share in forest activities.

In 2018, the most important split condition was population-group membership, similar to 2003. Migrant households had an average share of forest activities of 12%, while local households had an average share of double that, at 24%, yet to a lower extent compared to 2003. Local households can be further divided into 53 households (the majority of local households) that achieved an average share of forest activities of 21%, and only 19 local households that achieved the highest average share of forest activities of 33%.

#### Engagement in forest clearing

The Kruskal-Wallis test showed that the amount of forest clearing in 2003 differed significantly between population groups ( $p = 0.04$ ). The post hoc pairwise Wilcoxon test revealed a significant difference between the forest-clearing activities of northern migrants and locals ( $p = 0.04$ ; see Appendix 5). In 2003, the average area of forest cleared by local households was 0.14 ha, that cleared by southern households was 0.15 ha, and that cleared by northern households was 0.32 ha. In contrast, for 2018 households reported almost no clearing activities (see Appendix 3.3).

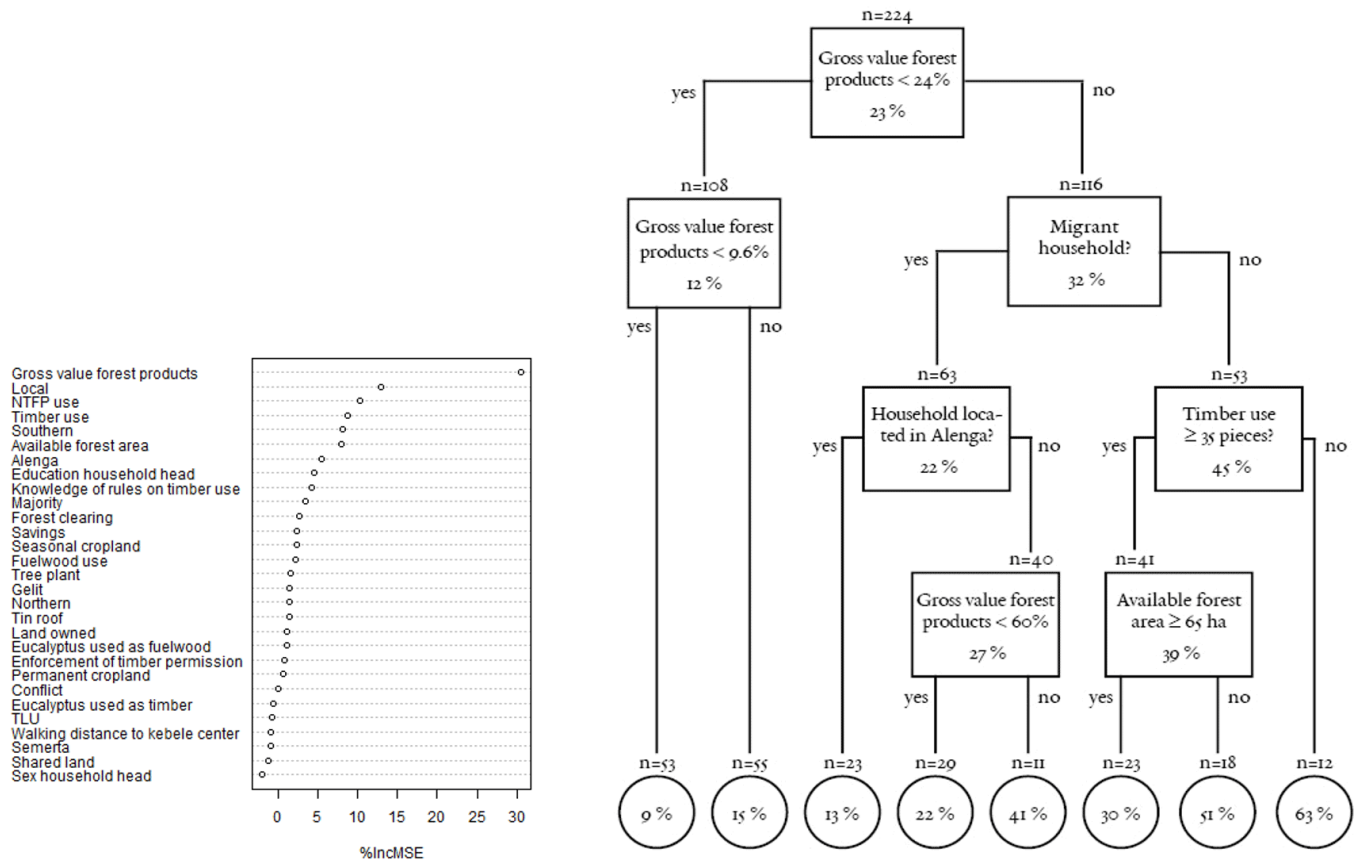
#### DISCUSSION

##### In-migration and expansion of commercial agriculture contributed to forest-cover decline, hampering the collection of NTFPs for locals

We examined NTFP use, which greatly depends on access to large and ecologically intact forest areas, to investigate the influence of forest availability. As shown in Figures 4 and 5, NTFP use was among the most important drivers of forest activity in 2003 and 2018. Therefore, high levels of forest dependence are associated with greater reliance on NTFPs. Reasons reported during the interviews for the declining forest cover and increasing forest degradation—the main obstacles to the collection of NTFPs—suggest that in-migration is not the only nor the main driver. Besides changes in farming practices, which fueled forest degradation and the expansion of smallholder cropland, commercial cropland increased tremendously in Guraferda, by 22,000 ha (allotted to private investors), between 2003 and 2018 (Bench Maji Zonal Statistics 2019, *unpublished data*). This rapid



**Fig. 4.** Left: Relative importance of the predictors for explaining the share of forest activities in households in 2003 expressed as an increase in mean squared error (% IncMSE). Right: Pruned regression tree for 2003. Each split indicates the split condition, the mean share of forest activities, and the number of households (observations) used in each split. The final nodes indicate the mean share of forest activities and the number of households.



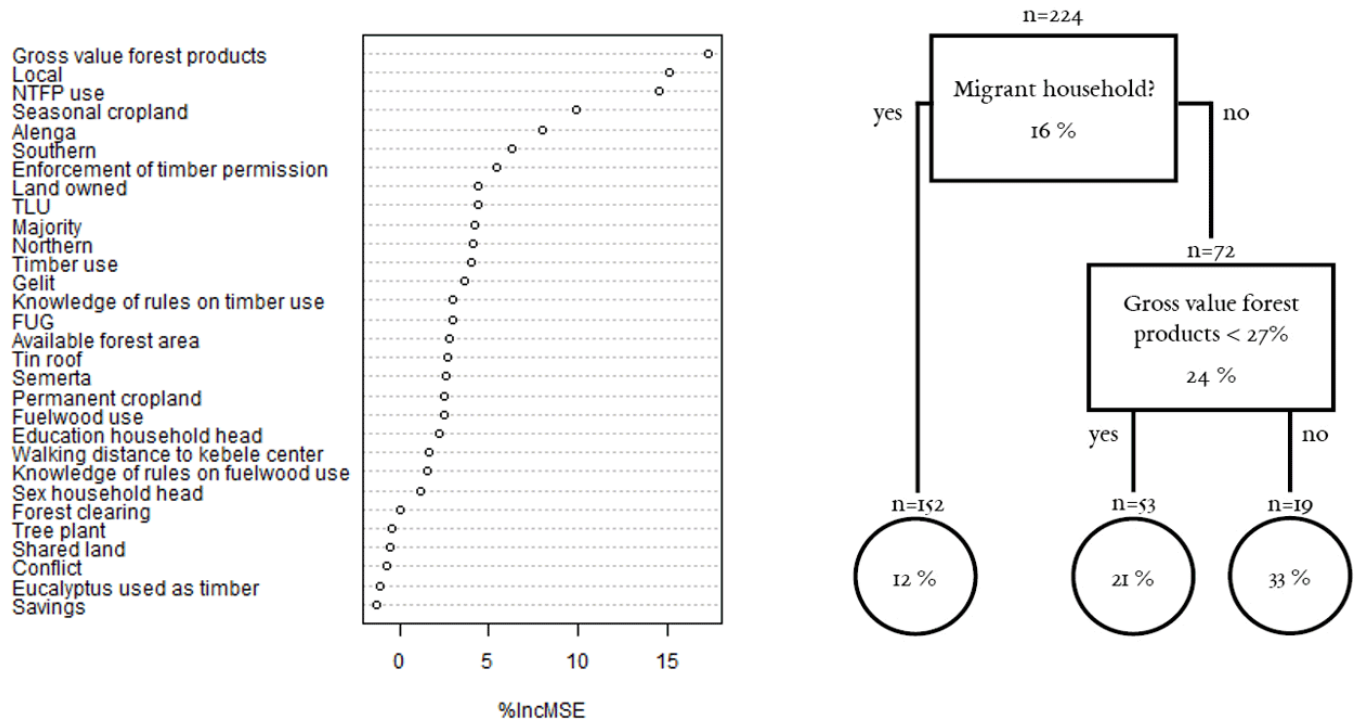
expansion can be explained by the enactment of the land proclamation in 2005 (Proclamation No. 455/2005 and No. 456/2005) that privileged land transfers to private investors. Consequently, the expansion of large- and small-scale agriculture has contributed immensely to the decline of forest cover in Guraferda, with the in-migration of land-seeking smallholders being only one contributing factor. Overall, the shrinking forest area in Guraferda hindered forest activities, especially NTFP collection by local households. This is critical because NTFPs are vital to the livelihoods of forest-dependent people (Pandey et al. 2016, Rasmussen et al. 2017).

The results for 2003 show that a local household with comparably little available forest area has a higher share of forest activities than a local household with more forest available, therewith contradicting our interpretation above. However, this finding may also suggest that the relationship between forest activity and forest size is non-linear and that there is a minimum area threshold that enables people to collect NTFP. Yet, estimating the size of available forestland was difficult for respondents, especially in 2003 (see uncertainty marked in Table 2), because common land, such as forests, was not yet demarcated and was partially perceived as de facto open-access. Thus, these specific results need to be treated with caution.

#### Changes in forest access mechanisms hindered engagement in forest activities

In addition to forest availability, forest management changed in Guraferda. With the introduction of PFM schemes and related FUGs at two of our research sites (Alenga and Semerta), the communities took over forest management, yet, NTFP use declined in all kebeles and it seems that the PFM had little influence on the revival of forest activities. A study by Wood et al. (2019) in the neighboring Sheko District shows that PFM has the potential to reduce forest loss and maintain biodiversity. However, the authors identified strong links between the forest and village communities as a crucial factor for PFM success. In the studied kebeles that implemented PFM schemes (Alenga and Semerta), locals became the minority after in-migration in the early 2000s, and are rarely part of the FUGs (see Appendix 3.4 variable “FUG” and result section). This is mainly due to reported language barriers; FUG meetings are held in Amharic, which is spoken fluently by most migrants but not necessarily by locals. Such language-related group-specific barriers to accessing the forest might have further contributed to the declining forest activities of local households, and presumably hinder the effectiveness of PFM schemes in Guraferda. Our results suggest that in-migration has altered population composition and social

**Fig. 5.** Left: Relative importance of the predictors for explaining the share of forest activities in households in 2018 expressed as an increase in mean squared error (% IncMSE). Right: Pruned regression tree for 2018. Each split indicates the split condition, the mean share of forest activities, and the number of households (observations) used in each split. The final nodes indicate the mean share of forest activities and the number of households.



structures and, in combination with institutional changes, may have changed resource-access mechanisms (Ribot and Peluso 2003). However, an in-depth analysis of the influence of PFM on forest activities was beyond the scope of our study.

#### **Lack of formal land-use rights fueled forest clearing by migrants, reducing opportunities to engage in forest activities for locals**

We revealed a significant difference between the clearing activities of northern and local households in 2003. The average area of forest cleared by northern households in 2003 was twice as large as either the area cleared by local households and southern households, respectively. Unruh et al. (2005) showed for southern Zambia how clearing activities were used to consolidate land claims under insecure tenure in areas of abundant land availability (as in Guraferda in 2003). In Guraferda, northern migrants, unlike southern migrants, faced a lack of formal land-use rights upon arrival around 2003 (Kassa et al. 2017a), and key informants reported that informal land transfers from the locals to northern migrants or clearing of unclaimed forestland by northern migrants was a common practice back then. We argue that northern migrants, in their comparatively volatile situation and given the de facto open forest access, used forest clearing as an important strategy to claim land they needed for their agricultural livelihoods in the new settlement area. This accelerated reduction in forest cover, in turn, limited NTFP collection for locals in particular.

Since 2014, forest clearing has been officially prohibited. This makes it a particularly sensitive issue and likely explains the mismatch of reported clearing activities for 2018 between our

survey and our observations of freshly cleared forest plots during the fieldwork. In addition, we observed that northern migrants are increasingly blamed for clearing activities, and in recent years, there have been reports of violent conflicts over land-use rights between locals and northern migrants (Debonne 2015). The recently observed land clearing activities and reported conflicts between local and northern migrants might be a result of tenure plurality, created by the land reform in 2010, and the shrinking land availability caused by population increase and the expansion of commercial agriculture (Unruh et al. 2005, Stellmacher and Eguavoen 2011, Robinson et al. 2014).

#### **In-migration of cereal-based smallholders and agricultural policies fueled the uptake of seasonal cropping activities, substituting forest activities**

Seasonal cropland shows a sharp increase in relative importance, from low in 2003 to the fourth-most-important variable in 2018, whereas perennial cropland remained of low importance from 2003 to 2018 (Fig. 4 and 5 left side). These findings have two interesting implications. First, the cultivation of seasonal crops has mainly replaced forest activities. Seasonal cropping in Ethiopia is typically practiced in open, treeless fields that can be easily ploughed with an ox and are therefore rather incompatible with forest-dependent livelihoods. In comparison, perennial crops such as coffee, the main perennial crop in Guraferda, require shade trees that can still be used for honey production and thus do not completely prevent NTFP collection in these plots. Second, local and migrant key informants in all kebeles reported that mainly locals adopted “new farming practices” from migrants.

Conversely, few migrants reported that they adopted, for example, honey collection from locals. The exchange of knowledge and adoption of new livelihood activities between groups happened mainly in one direction: from migrants to locals. We argue that Ethiopia's agricultural policies (including local extension programs) played a key role in determining this direction of exchange, as they encouraged the production of cereal (cash) crops to grow for national and international markets, in line with Ethiopia's economic strategy (Spielman et al. 2010, Abro et al. 2014). In addition, new markets might have resulted in higher returns for crops compared to NTFPs. New farming practices, such as the use of improved seed varieties, frequent plowing, inorganic fertilizer, and pesticide use, have been introduced and advanced in Guraferda over the past two decades (Kassa et al. 2017a). We conclude that these practices, which were already common in the open landscapes of the origin region of both migrant groups, fueled the uptake of the new farming practices by the locals. Kassa et al. (2017a) observed that these new agricultural practices led to soil and forest degradation in the southwestern highlands, a trend that was also mentioned by the key informants. We argue that this puts additional pressure on the forest-dependent livelihoods of the locals, who were already stressed because of shrinking forest cover and barriers to participation in local forest-management institutions (as outlined above). Moreover, if not counteracted, we anticipate that the degradation trend observed by Kassa et al. (2017a) could reduce yields and eventually cause additional stress in agriculture-based livelihoods, holding the potential to trigger out-migration and risk a self-reinforcing feedback loop between migration and resource degradation.

Further, migrant households in Alenga are significantly less active in the forest than households in Gelit or Semerta (cf. Fig. 4). Compared to the other two kebeles, Alenga was and is the closest to the local market and main road, which facilitates the sale of crops and could thus encourage engagement in seasonal cropping, reducing dependence on forest resources (Acheampong et al. 2018, Beyene et al. 2020). However, Alenga differs from the other two kebeles in terms of remoteness, population composition, and forest size, loss, and management. Hence, we cannot clearly determine the decisive factor(s). Nonetheless, our results suggest that meso-scale factors at the kebele level mediate household-livelihood outcomes and should therefore be considered in further studies, e.g., by using multilevel analyses accounting for spatial variations in migration-induced population growth, aspects of remoteness, and forest-loss rates.

#### Methods review

The decision to opt for a retrospective survey design, as with every decision in research, comes with certain limitations. We aimed to grasp how and why livelihoods in our study area changed over time, yet there exists no longitudinal dataset for southwestern Ethiopia that would have allowed for a similar analysis. Thus, we opted for a retrospective design, with the limitation that our data for 2003, although we chose a remarkable year, are less accurate than for 2018. Further limitations might result from a potential translation bias and the choice to ask household heads (mainly male) about the household's livelihood, as there are specific gender roles for certain livelihood activities (e.g., women usually take care of firewood collection). To reduce such a bias, we covered some of the core aspects (e.g., land use, forest use) twice

in the survey, thereby addressing them from different angles. The random-forest regression-tree procedure proved very powerful in dealing with a wide range of potential drivers and complex mechanisms in social-ecological systems. Nonetheless, our qualitative information from the interviews proved helpful to contextualize the statistical results. In sum, the insights provided with this study are novel for Ethiopia's insufficiently studied southwestern parts and provide a basis for further research on the influence of PFM schemes or meso-scale variables on livelihoods and deforestation as outlined above.

#### CONCLUSION

Existing research on in-migration-environment linkages identified in-migration as a strong driver of deforestation, forest degradation, and livelihood transition, including in southwest Ethiopia (e.g., Kassa et al. 2017a). We advanced our understanding of these linkages by providing a local-scale study, which in particular investigated the factors mediating the impact in-migration has on rural livelihoods and on deforestation in southwest Ethiopia.

We conclude that the cultivated area in our study area of southwestern Ethiopia expanded at the expense of the forest, partially due to the in-migration of smallholders from agricultural-based systems and insecure land tenure, but also due to the expansion of commercial agriculture for the production of cash crops. As a result, forest activities, especially the collection of NTFPs for forest-based local groups, were limited. In addition, participatory forest management was introduced, and forest management was transferred to the communities to protect the remaining forest patches. Our findings show that the decline in forest area, likely together with barriers to participation in the newly established forest-user groups, made it increasingly difficult for the local people to pursue their forest-based livelihoods. Rather, local people adopted migrants' agricultural practices. In addition, Ethiopia's agricultural policy, which promoted land-intensive farming practices and the production of cash crops for national and international markets, further encouraged the uptake of agricultural activities and contributed to deforestation. As such, we adopt our two original hypotheses: (i) that the engagement in forest activities and the use of forest products has declined from 2003 to 2018 for all three groups; and (ii) that reduced forest cover, which is mainly caused by clearing activities of migrants and the expansion of smallholder cropland, drives this decline in engagement in forest activities within households. Yet, the impact in-migration has on rural livelihoods and on deforestation in southwest Ethiopia is mediated by a set of different factors, and is thus far more complex, as suggested by our second hypothesis. In sum, we showed how governmental policies, commercial agriculture, tenure security and forest access mediate the effects in-migration has on rural livelihoods and the environment. Based on this, we identified the following points of leverage to reduce the adverse impacts on natural resources and related challenges for locals and migrants in in-migration areas:

1. Tenure security plays a critical role in the extent of forest clearing by migrants. However, especially in areas with many competing interests in land resources, such as in-migration areas, developing inclusive tenure policies is not an easy undertaking. Yet, there is increasing evidence that secured tenure reduces tropical deforestation and unsustainable land

use by frontier residents (Robinson et al. 2014, Holland et al. 2017), including migrants (Codjoe 2006). We suggest that tenure reforms should aim to secure long-term land-use rights for all frontier residents (including planned and unplanned migrants) who rely on (forest-) land to support their livelihoods.

2. In addition, tenure reforms should restrict the expansion of large agribusiness near kebeles and in intact, large, and common forest areas used for NTFP collection.
3. Furthermore, formalizing land rights for migrants should not have negative impacts on customary land-use rights of local or indigenous groups, as the curtailment of indigenous or local land rights can lead to a marginalization of these groups and could fuel tensions and conflicts (e.g., Dhiaulhaq and McCarthy 2020).
4. Although the in-migration of land-seeking smallholders will increase the demand for cropland, the densification of settlement sites could reduce the further sprawl of human settlement into intact forest areas and thus reduce negative impacts on biodiversity (Rodrigues et al. 2021).
5. Furthermore, PFM schemes can be a strategy for communities to simultaneously protect and benefit from forests. However, PFM schemes have to be carefully embedded in the local context and ensure equal participation, especially in regions where population groups have different cultural backgrounds. Although PFM has been shown to lower deforestation rates in Ethiopia (Tesfaye et al. 2015), there are still many bottlenecks that hinder PFM to support sustainable forest use (Kassa et al. 2017b).
6. Moreover, we have shown how intensive seasonal cropping, fueled by national policies that are not suitable for highly forested ecosystems in Ethiopia, has gradually replaced forest activities and contributed to deforestation. There is strong empirical evidence that agroforestry and trees on farms have multiple benefits for rural livelihoods, including increased well-being and incomes, improved diet, and even the potential for enhanced agricultural yields (Reed et al. 2017, Miller et al. 2020, Rasmussen et al. 2020). Thus, encouraging diversified livelihood activities consisting of a mix of agriculture and forest activities by promoting the use and marketing of non-timber forest products and REDD+ schemes (partially already started in Guraferda) could reduce pressure on forests as well as on rural livelihoods.

Our study underlines the complex, multicausal relationship between in-migration, livelihoods and environmental effects, countering simplified and deterministic narratives and a flawed framing of in-migration and migrants as threats to traditional livelihoods and natural resources in in-migration areas.

#### Author Contributions:

*JG: Writing - original draft, Conceptualization, Methodology, Investigation, Formal analysis, Data curation. RS: Conceptualization, Writing - review & editing, Supervision. PS: Conceptualization, Writing - review & editing. FS: Conceptualization, Writing - review & editing. KH: Conceptualization, Methodology, Writing - review & editing, Supervision, Funding acquisition.*

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#### Data Availability:

*The data/code that support the findings of this study are openly available at <https://doi.org/10.17605/OSF.IO/9UWR4>.*

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## Appendix 1

### Forest tenure and forest products

Forest products/ Tenure system	Customary forest tenure (kobbo system)	State tenure system
<b>Timber</b>	Kobbo owners have use rights and right to inherit, share, rent and divide their forest patches <sup>1</sup> .	Permission for harvesting timber from state authorities or (if existent) from forest-user group is required. Only selected trees can be harvested. The maximum number of trees, which can be harvested per year, is limited per kebele.
<b>Fuelwood</b>	Kobbo owners have use rights and right to inherit, share, rent and divide their forest patches <sup>1</sup> .	Only dead wood can be used.
<b>Honey and wild coffee</b>	Kobbo owners have use rights and right to inherit, share, rent and divide their forest patches <sup>1</sup> .	Collecting honey and wild coffee in the forest requires permission from the state authorities or (if existent) from forest-user group.
<b>Since when relevant in study area (year)</b>	Traditional forest tenure in the study area and currently still recognized by locals.	Enforced in our study area around 2014.

<sup>1</sup> Kassa, H. *et al.* (2017) 'Transition from Forest-based to Cereal-based Agricultural Systems: A Review of the Drivers of Land use Change and Degradation in Southwest Ethiopia', *Land Degradation & Development*, 28(2), pp. 431–449. doi: 10.1002/ldr.2575.

## Appendix 2

### Data preparation

- We received three data sets (one for each kebele) from the survey campaign
- Each data set was cleaned, in order to excluded missing response variables
- Sample was reduced from a total of 230 conducted surveys to 224 surveys (due to large inconsistencies or missing information) which were used for further analysis
- Misspelling were corrected and we created a subset of response and predictors relevant for further analysis
- We imputed missing values for our predictor variables with an iterative nonparametric imputation approach using random forest, which is suitable for mixed data types. We implemented the imputation in R with the ‘missForest’ package (Stekhoven and Bühlmann, 2012). Imputation was done for each kebele data set separately.
- We excluded from imputation all values which were indicated as ‘not relevant for a household’, e.g. if a household indicated that it never collected honey, the amount of honey collected was excluded from the imputation procedure
- We combined the three kebele data set to one and changed the data format from wide to long, in order to create variables for the year and kebele
- We calculated further numerical variables: e.g. *total available forest area*, *tlu*, etc. based on existing variables
- Dummy variables were created
- We created two subset for each year: 2003 and 2018 (see Table 2 in the main text for all variables included in our final analysis)
- Data preparation was done in R (R Core team, 2015)

### References:

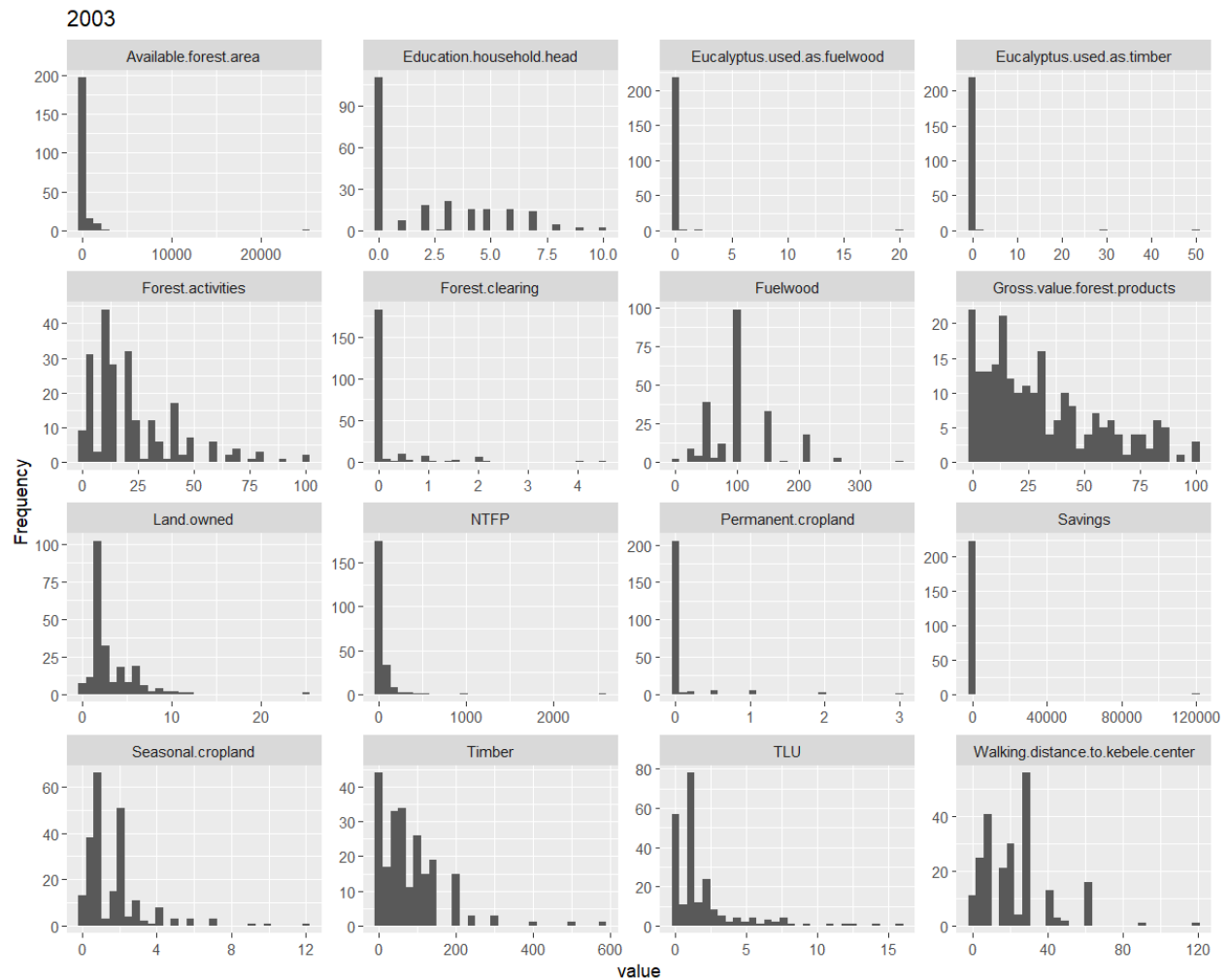
R Core team (2015) ‘R Core Team’, *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL <http://www.R-project.org/>.

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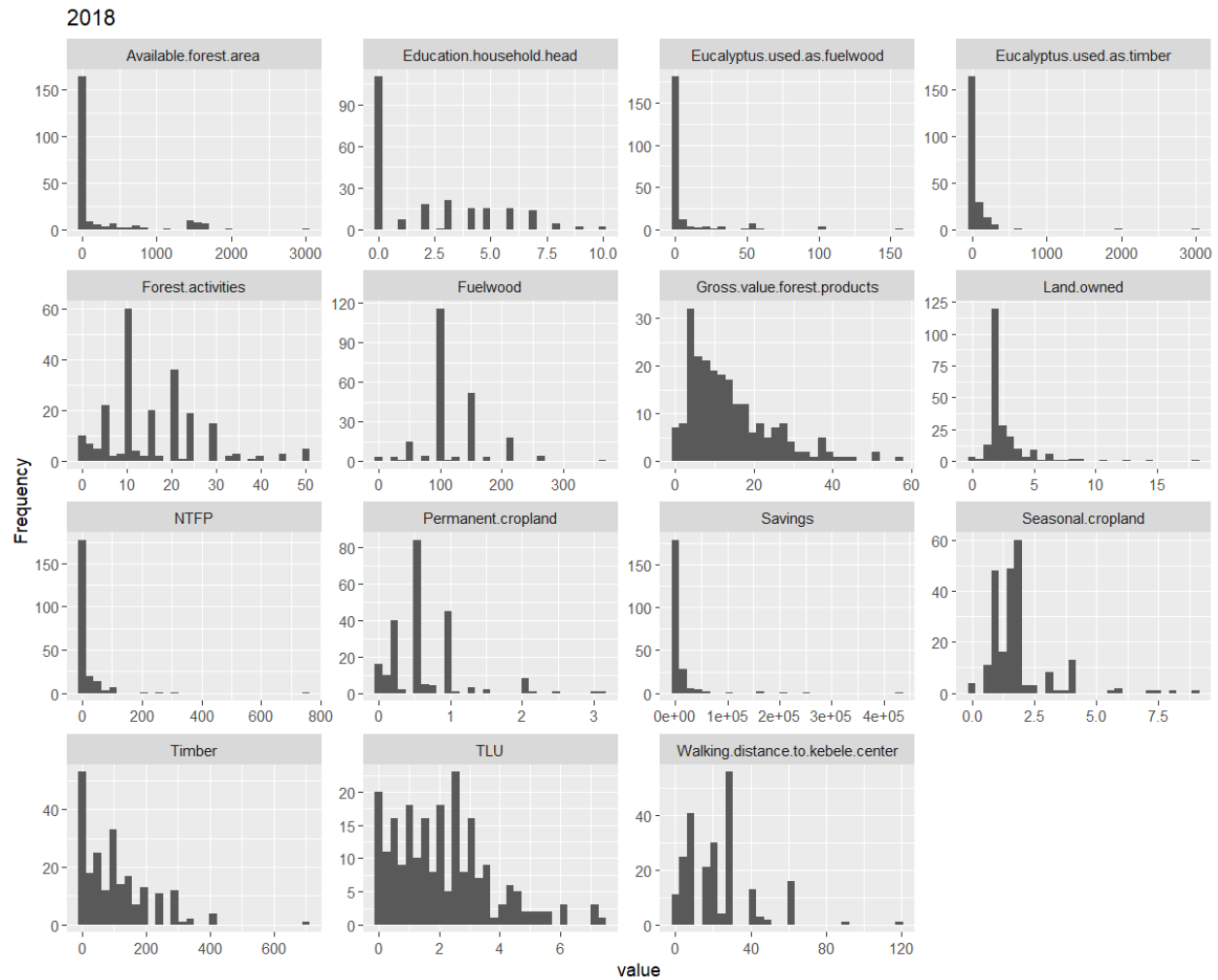
## Appendix 3

### Distribution of all continuous variables included in our analysis for 2003



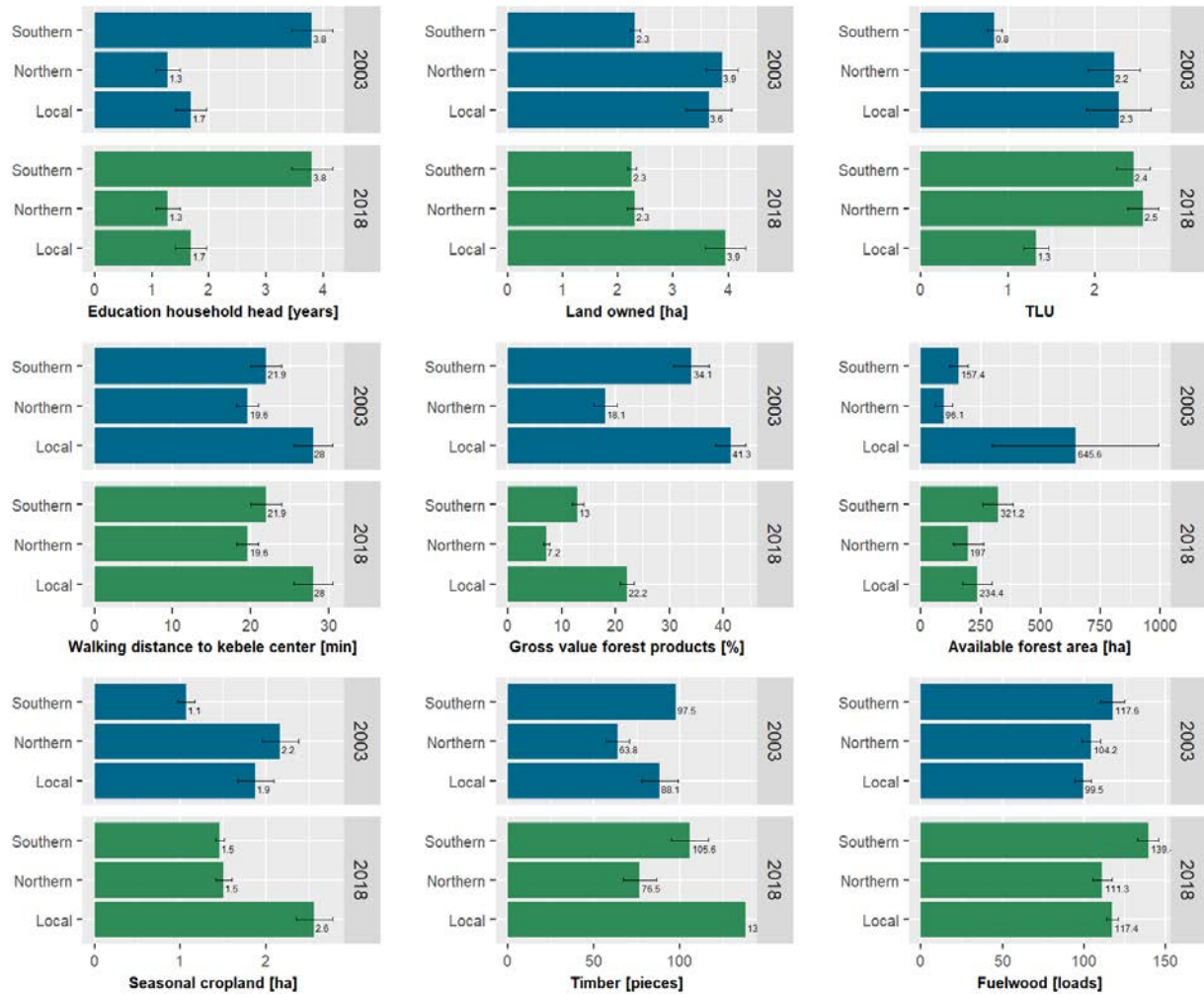
Appendix 3.1: Histograms of continuous variables in 2003

## Distribution of all continuous variables included in our analysis for 2018

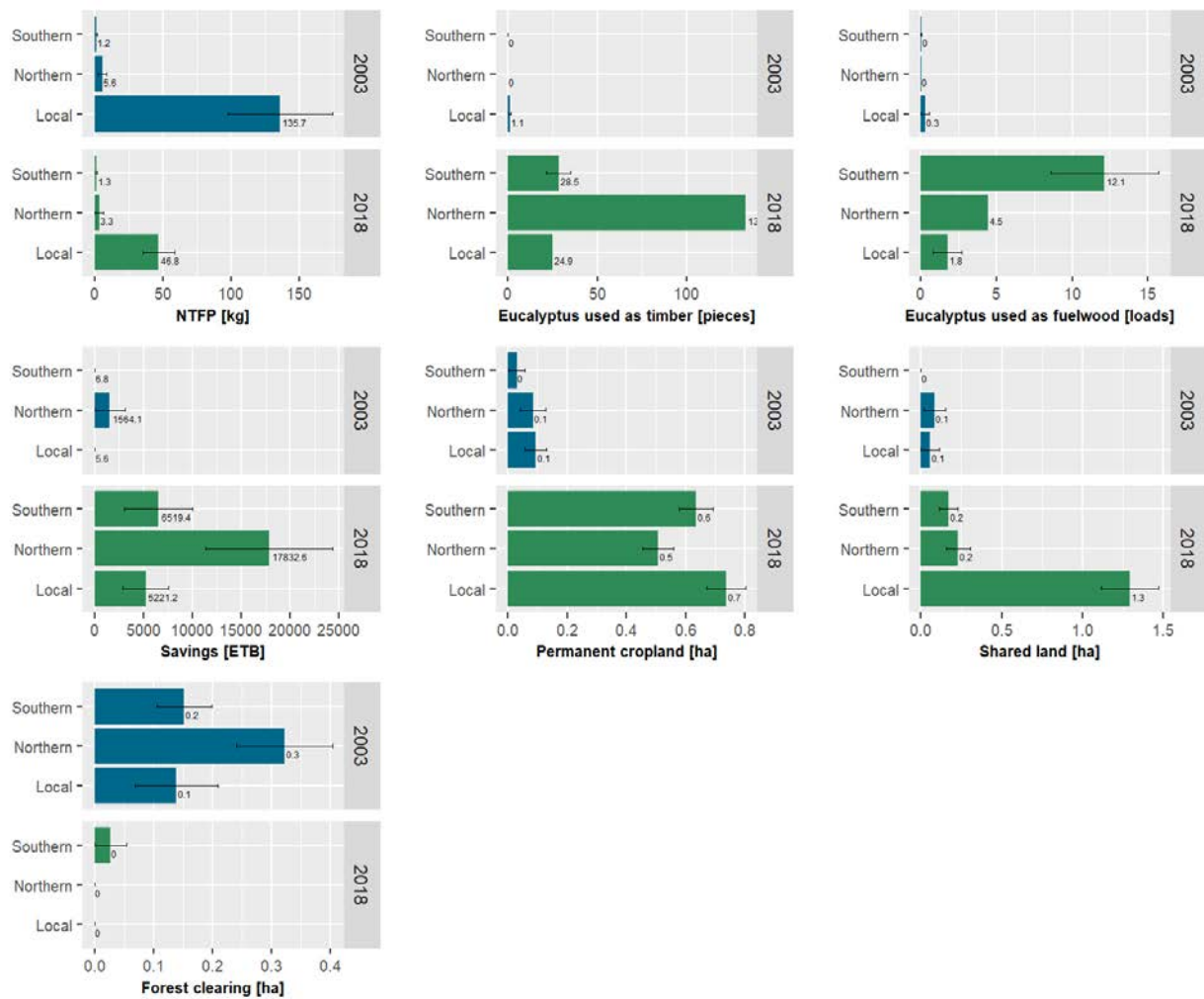


Appendix 3.2: Histograms of continuous variables in 2018.

### Means per group and standard error for all continuous variables included in our analysis in 2003 and 2018



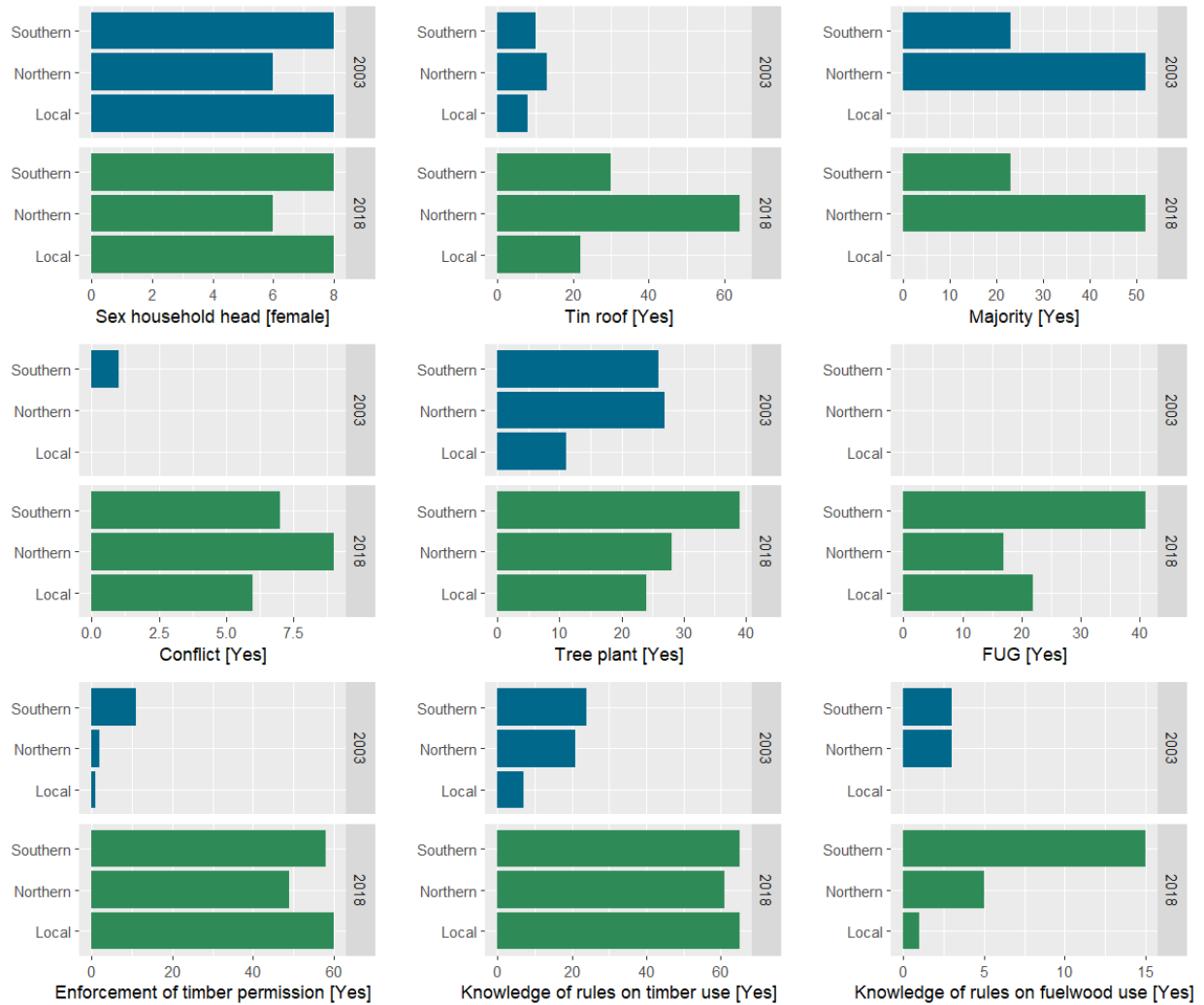
Appendix 3.3: Means per group and standard error for continuous variables in 2003 (blue) and 2018 (green)



Appendix 3.3 continued: Means per group and standard error for continuous variables in 2003 (blue) and 2018 (green)



## Frequencies for all discrete variables included in our analysis in 2003 and 2018

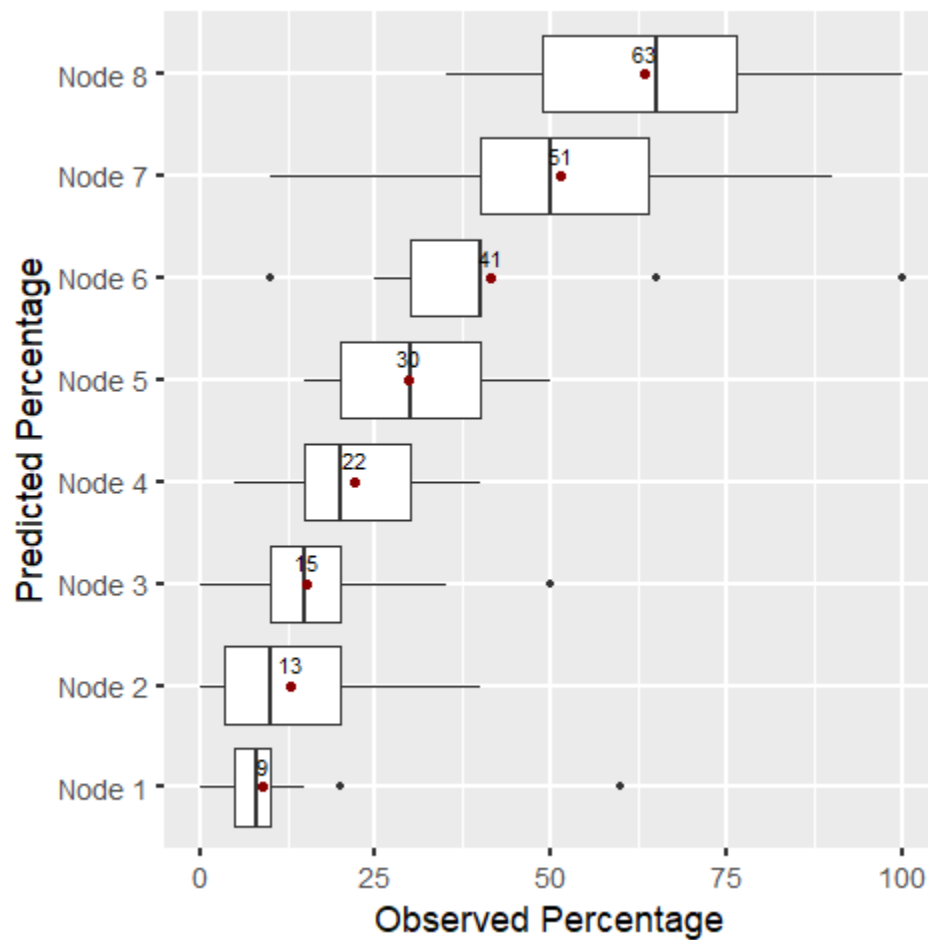


Appendix 3.4: Frequencies per group of discrete variables in 2003 (blue) and 2018 (green)

## Appendix 4

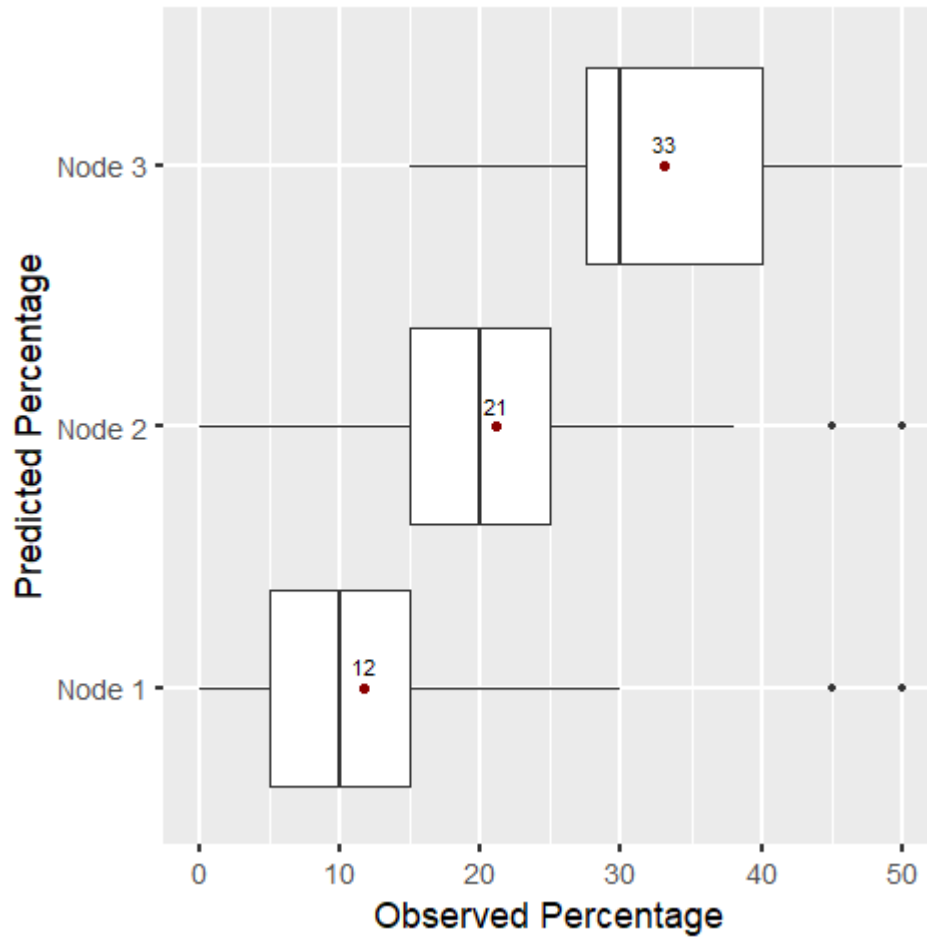
### Model uncertainties

For the pruned regression tree in 2003, the uncertainty of the model increases from low to higher shares of forest activities.



Appendix 4.1: Boxplots of predicted shares of forest activities based on the pruned regression tree for 2003 (Figure 4) against the observed shares of forest activities. The red dots indicate the predicted means of the final nodes.

For the pruned regression tree in 2018, model uncertainty stays more or less the same from low to high shares of forest activities.



Appendix 4.2: Boxplots of predicted shares of forest activities based on the pruned regression tree for 2018 (Figure 5) against the observed shares of forest activities. The red dots indicate the predicted means of the final nodes.

## Appendix 5

### Results of group comparison using Kruskal-Wallis and post hoc pairwise Wilcoxon test

<b>Forest clearing [ha] ~ group</b>		
<b>Null Hyp.:</b> There is no relation between forest clearing [ha] and population group.		
<b>Alt. Hyp.:</b> There is a relation between forest clearing [ha] and population group.		
<b>Kruskal-Wallis test results</b>		
chi-squared = 6.4882	df = 2	p-value = <b>0.039*</b>
<b>Post hoc pairwise Wilcoxon test results</b>		
	Local	Northern
Northern	<b>0.036*</b>	-
Southern	0.191	0.251

\*significance at the 5% level



## Appendix 6

### Interviewed people

Position	Organizational unit	Meeting type
Area Program Coordinator	Ethio-Wetlands and Natural Resources Association	Expert interview
Zonal Social Advisor	Bench Maji Zone	Expert interview
Zonal Administration	Bench Maji Zone	Expert interview
Agricultural expert, soil and water conservation	Guraferda woreda	Data meeting
Health expert	Guraferda woreda	Data meeting
Finance officer	Guraferda woreda	Data meeting
Kebele leader	Alenga kebele	Group discussion
Kebele manager	Alenga kebele	Group discussion
Religious leader	Alenga kebele	Group discussion
Development agent, Agroecologist	Alenga kebele	Group discussion
Farmer representatives	Alenga kebele	Group discussion
Representative northern migrant community	Alenga kebele	Key informant interview
Representative southern migrant community	Alenga kebele	Key-informant interview
Representative local community	Alenga kebele	Keyinformant interview
Kebele leader	Gelit kebele	Group discussion
Development agent, Agroecologist	Gelit kebele	Group discussion
Farmer representatives	Gelit kebele	Group discussion
Religious leaders	Gelit kebele	Group discussion
Elder	Gelit kebele	Group discussion
Representative northern migrant community	Gelit kebele	Key-informant interview
Representative southern migrant community	Gelit kebele	Key-informant interview
Representative local community	Gelit kebele	Key-informant interview
Kebele leader	Semerta kebele	Group discussion
Development agent, Natural resource manager	Semerta kebele	Group discussion
Religious leaders	Semerta kebele	Group discussion
Elder	Semerta kebele	Group discussion

Representative northern migrant community	Semerta kebele	Key-informant interview
Representative southern migrant community	Semerta kebele	Key-informant interview
Representative local community	Semerta kebele	Key-informant interview