Factors influencing farmers' forestland-use changes over 15 years (2005–2020) in Thua Thien Hue province, Vietnam

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HIGHLIGHTS

- Major livelihood and forestland-use changes have taken place in central Vietnam over the last two decades.
- There has been widespread conversion of forestland (degraded natural forests, swidden land) and cropland to acacia plantations.
- Household-scale forestland use changes were primarily driven by forestry policies, the market for woodchips, and land resource access.
- There is inequality in access to and ownership of forestland between poor and wealthier households in the mountain district of Vietnam.
- Cases of illegal forestland conversions pose challenges to ensuring sustainable forest landscapes.

SUMMARY

Over the last decades, Vietnam has seen substantial shifts in forest landscape uses and associated livelihoods. We document the livelihood transformations in Nam Dong, a mountainous district of Central Vietnam, where land uses have changed from the utilisation of products from natural forests and shifting cultivation (swidden agriculture) to acacia tree-dominated plantation forestry. Forestry policies (forestland allocation, plantation development agendas), the increase in the economic value of acacia, and household livelihood assets are the primary factors driving these changes. We also found that there are differences in the access to and ownership of forestland with regard to households of different communities and between poor vs wealthy households. Therefore, careful attention needs to be paid to guide future land use policies in the area to foster social and ecological sustainability.

Keywords: Acacia (wattle) tree plantations, environmental change, forestland-based livelihoods, forest transition, social-ecological change

Facteurs influençant les changements de l'utilisation des terres forestières par les fermiers ces quinze dernières années (2005–2020) dans la province de Thua Thien Hue, au Vietnam

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Le Vietnam a été témoin de changements substantiels dans les utilisations du paysage forestier et des revenus lui étant associés au cours des dernières décennies. Nous documentons les transformations des revenus au Nam Dong, un district montagneux du Vietnam central, où l'utilisation de la terre s'est déplacée des forêts naturelles et de la culture nomade (agriculture sur brûlis), vers une foresterie de plantation dominée par l'acacia. Les politiques forestières (allocation de terres forestières, agendas du développement des plantations), la croissance de la valeur économique de l'acacia et les moyens de subsistance des ménages sont les principaux facteurs conduisant ces changements. Nous avons également noté des différences dans l'accès aux terres forestières et dans la propriété de ces dernières chez les ménages de différentes communautés, entre les pauvres ceux plus aisés. Il est par conséquent nécessaire de surveiller de près les politiques futures d'utilisation de la terre dans cette région, pour assurer une durabilité sociale et écologique.

Factores que influyen en los cambios de uso de las tierras forestales por parte de los agricultores a lo largo de 15 años (2005–2020) en la provincia de Thua Thien Hue de Vietnam

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Vietnam ha experimentado en las últimas décadas cambios sustanciales en los usos del paisaje forestal y los medios de vida vinculados a estos paisajes. Este artículo documenta las transformaciones de los medios de vida en Nam Dong, un distrito montañoso de Vietnam Central, donde los usos del suelo han pasado de los bosques naturales y los cultivos migratorios (agricultura itinerante) a las plantaciones forestales dominadas por las acacias. Las políticas forestales (asignación de tierras forestales, programas de desarrollo de plantaciones), el aumento del valor económico de la acacia y los recursos de los medios de vida de los hogares son los principales factores que impulsan estos cambios. También se comprobó que existen diferencias en el acceso y la propiedad de las tierras forestales de hogares de diferentes comunidades entre los hogares pobres y los ricos. Por lo tanto, es necesario prestar especial atención a la orientación de las políticas futuras de uso del suelo en la zona para garantizar la sostenibilidad social y ecológica.

INTRODUCTION

A 'forest transition' (FT) describes a critical turnaround in land-use trends within a territory (a country or region) from net forest cover loss to net cover gain, usually understood to be linked to processes of socio-economic development and agricultural transformation within such a territory (Hansen *et al*. 2013, Lambin and Meyfroidt 2010, Mather 1990, 1992, Meyfroidt and Lambin 2011). Classic 'pathways of FT' proposed by Rudel *et al*. (2005) suggest processes whereby either 1.) economic growth leads to rural land abandonment through migration of farmers to industrializing urban centres (the so-called 'economic development pathway'), and/or 2.) forest resource scarcity (through over-exploitation of timber stock and other resources) leads to a social-political shift towards more investments in tree replanting, usually through new forest protection policies and tree planting schemes (the 'forest scarcity pathway'; cf also Angelsen and Rudel 2013, Lambin and Meyfroidt 2010, Meyfroidt and Lambin 2008b). With relevance to the case of Vietnam and other countries, these two general pathways were further refined. First, the so-called 'globalization pathway' (Lambin and Meyfroidt 2010, p.110) is "a modern version of the economic development pathway in which national economies are increasingly integrated into and influenced by global markets and ideologies". Second, the 'national forestry policy pathway' argues for a central role of national forestry policies in driving the transition (Meyfroidt and Lambin 2011). Third, the 'agricultural intensification pathway' sets a focus on owing to more local processes of land use intensification through rural agricultural development (i.e. higher productivity in crop fields and the establishment of tree plantations on farms) (Meyfroidt and Lambin 2010).

In Vietnam, changes in the cover of forests have been interpreted as a 'forest transition' (Cochard *et al.* 2017, 2020), whereby all the above-noted transition pathways may play a certain role in different parts of the country (cf. also Meyfroidt and Lambin 2008a, 2008b, Meyfroidt *et al.* 2010). Economic and political responses to land and forest scarcity, national economic growth, market liberalization, urbanisation, land privatization and other policy shifts, and agricultural intensification may all play a specific role in driving forest cover changes (Cochard *et al.* 2017, De Jong 2010, Kull 2019, Meyfroidt and Lambin 2008b, 2011, McElwee 2016, Nguyen 2020). Historically, forest resources in Vietnam declined and were seriously degraded. From the 1940s to the mid-1980s forest cover decreased from an estimated 43% to 22% (de Koninck 1999). Since 1992, the Vietnamese government has made significant investments to stabilize and increase forest cover by protecting and restoring existing forests and encouraging fast-growing tree plantations. As a result, Vietnam's tree cover (combining exotic-species-based plantations *alias* 'planted forests' with remaining natural forests) has increased steadily, from 25% in 1992 to 38% in 2005 (Meyfroidt and Lambin 2009), and further to 42% in 2020, i.e. 14.6 million ha of which 10.2 million ha was natural forest cover and 4.3 million ha was tree plantation cover (referred to as 'planted forests'; MARD 2021). Smallholder plantations were considered a key factor in increasing the forest cover in Vietnam (Cochard *et al.* 2017). Smallholder farmers were actively involved in planting trees and now control around 70% of the country's plantations (McElwee and Tran 2020), with acacia plantations now accounting for over 40% (La *et al.* 2020).

Here we present the findings of an interview-based study on the factors affecting household decision-making regarding land use in a district in central Vietnam. The paper represents a contribution to the literature on forest and landscape transitions at the local scale by describing the transformation of swidden cultivation, hill and home gardens, rubber tree plantations, and residual natural forests to smallholder acacia plantations. Changing land tenure arrangements (under forest land allocation, FLA) and improved supply chains for woodchip products were important driving forces for the development of household afforestation initiatives (Cochard *et al.* 2017, 2021, Meyfroid and Lambin 2008a, 2008b, Phan 2011, Tran and To 2013). In addition, the study complements previous studies in Vietnam which have documented how various household factors affect land use change, with notable differences between communities of different rural ethnicities, and between households with different socio-economic capital (McElwee and Tran 2021, Thulstrup 2015).

RESEARCH METHODS

Study site

The study was conducted in the mid-mountainous district of Nam Dong located in Thua Thien Hue Province (Central Vietnam), about 50 km south of the provincial capital Hue (Figure 1). One town and ten communes are situated within the district, with around 7 000 households and 29 000 people, including minority ethnic groups (mainly Co Tu[1] people; accounting for about 45% of the population) and Kinh[2] people (55%; Nam Dong DPC 2021). Nam Dong district has 53 979 ha of forestlands, with 48 215 ha of natural forest and 5 764 ha of plantation forest. The ratio of forest coverage in Nam Dong (including tree plantations) is much higher (83.3%) as compared to the national average (Nam Dong FPD 2021). In contrast, agricultural production (e.g., wet rice, maize, cassava) accounts for a comparatively small proportion of land use (8.4%) (Nam Dong DPC 2021).

Nam Dong may be seen as currently experiencing a smallholder-driven 'forest transition', with tree cover increasing by about 9.3% during 2005–2020, mainly due to the growth of exotic plantations (Pham *et al.* 2022). Smallholder plantation development and other changes in farmers' land use practices have led to this FT (McElwee and Tran 2020). In the early 2000s, the first tree plantation stands were harvested with substantial profits which motivated local people to convert their hill gardens and swidden land into plantations of exotic trees such as acacia, eucalyptus, and rubber (Nguyen 2015, Thiha *et al.* 2007, Tran *et al.* 2010). Acacias are the most common species used by households for plantations and these trees now play a crucial role in the livelihoods of local people (La *et al.* 2020). Up to 1 400 hectares of natural forests were converted into plantations in the past 15 years (Pham *et al.* 2022).

To analyse the intrinsic household and community characteristics affecting land use changes in the area, we selected two communes, Thuong Lo and Huong Phu, with similar forest resources but different majority ethnic groups. Thuong Lo commune is in the southeast region of the district about 1 km from the district center of Khe Tre. Huong Phu lies in the northeast area of the district, approximately 3 km from Khe Tre. Both communes have a high proportion of forestland (95% and 83%, respectively). However, the natural forests of these communes were degraded by logging by both state agencies and local people (Cochard *et al.* 2018, Nguyen 2001, Thiha 2017, Van and Cochard 2017). The population of Thuong Lo is dominated by the Co Tu ethnic group (93%) and Huong Phu by Kinh people (97%) (Thuong Lo and Huong Phu CPC 2020).

FIGURE 1 *Map showing the location of Nam Dong District and two studied communes in Thua Thien Hue Province*

[1] Co Tu is one of 53 ethnic minorities in Vietnam.
[2] Kinh people is the majority group of Vietnam.

The Co Tu people of Thuong Lo commune were originally engaged in shifting cultivation (swidden) agriculture and hunting and gathering in natural forests. However, in the late 1970s, they were resettled in Thuong Lo by the Vietnamese government (Gomiero and Giampietro 2001, Nguyen 2001). At this time, local people had difficulty adapting to the new living environment, therefore they went back to the forest to engage in shifting cultivation agriculture. In the early 2000s, local people reduced shifting cultivation and instead started to cultivate food crops around their houses and plant acacia trees on swidden land.

Huong Phu commune was established under the New Economic Program in 1975. Kinh households living in the delta and coastal districts of Thua Thien Hue province (Phu Loc, Phu Vang, Huong Thuy district) were brought to this area for resettlement. In the beginning, resettled people faced many difficulties as it was a remote area with poor infrastructure, and they were unfamiliar with the new landscape and production systems. They began shifting cultivation practices which they learned from the ethnic minorities. In 1994, Program 327 was implemented and brought some minority ethnic households from other communes of Nam Dong district to resettle in Huong Phu commune. Huong Phu is one of the communes that started to grow acacias relatively early (in the 1990s) (Cochard *et al.* 2018, Thiha *et al.* 2007).

Methodological approach and data collection

A mixed method study was applied to blend the collection of qualitative data and quantitative data (Small 2011). The mixed data analysis combined information from in-depth interviews, document reviews (secondary published data), and analyses and interpretations of quantitative data from household surveys (applying descriptive statistics and regression analyses):

(1) Government statistics, relevant literature and local secondary data were reviewed to understand farmers' land-use responses to government forestry policies. This work was carried out mosltly during January to June 2020.

(2) In-depth interviews with knowledgeable people about the development of household plantations and changes in forestland use in the locality were conducted between July and December 2020. Key informant interviews were conducted with a total of 27 respondents, purposely selected in Thuong Lo and Huong Phu communes, and in Nam Dong district offices. Firstly, formal and informal interviews were conducted with 12 local authorities. This step helped us to have baseline information on the region, to choose focused study sites, identify relevant key informants at the local sites and to develop the household questionnaire survey. We then conducted fifteen interviews with key informants in the study communes. The majority of these interviews were with commune residents and included village headmen, members of the community forest management board, and elders with good knowledge of the area's local history. The in-depth interviews mainly focused on the process of livelihood and forestland use changes, the factors affecting this as well as key timelines. Additionally, government statistics and relevant literature were reviewed to gain insights into farmers' land-use responses to the government's forest policies (Table 1).

(3) The household survey was conducted from January to June 2021. In previous research (e.g., Thulstrup 2015) significant differences have been identified in regard to the uptake and extent of acacia planting by local households. We thus stratified the sample to get insights about differences between ethnic groups. From the list of households in the two communes, we randomly selected 222 households out of a total of 1127 households for a questionnaire interview, with an equal number of Kinh and ethnic minority households. In order to attain statistically relevant representations, we surveyed over 30 households per village. One hundred ethnic minority households were thus surveyed in total in three villages in Thuong Lo commune, i.e., the commune which is dominated by ethnic minority people. In Huong Phu commune, three villages with natural forest areas were selected among a total of eight villages. One hundred Kinh households were thus interviewed within this commune dominated by Kinh people. In addition, Kinh households living in Thuong Lo commune and ethnic households living in Huong Phu commune were surveyed to compare ethnic groups in the same communes. Due to the small number of these households (about 20 households per commune), only 11 people in each commune were interviewed (Table 2).

The literature review and in-depth interviews provided backup information to develop the questionnaire. The semi-structured questionnaire surveys were employed through face-to-face interviews and were conducted with household heads or the main labourers in their families. The information on ethnicity and household classification was extracted from documents provided by Commune People's Committee. The list of poor and near-poor households' classification is based

TABLE 1 *General information on the key informant interviews*

Agency/Level	Position	Interview number	Total of interviews
District	Staff from the Nam Dong Forest Protection Department, the Nam Dong Department of Agriculture and Rural Development, the Nam Dong Department of Natural Resources and Environment	8; 9; 11; 20; 21; 23; 26; 27	8
Communes	Staff from the Thuong Lo and Huong Phu communes	1; 5; 6; 10	4
Villages	Village headmen; members of the CFM board	2;3; 12; 14; 15; 16; 18; 24	8
Household	Elders with good knowledge of the area's local history	4; 7; 13; 17; 19; 22; 25	7

TABLE 2 *General information on the household survey sample (HHs – households)*

Commune	No. of Villages		No. of total HHs	No. of surveyed HHs			% of total HHs
	Total Villages	Surveyed Villages		Kinh	Minority ethnic	Total	
Thuong Lo	3	3	336	11	100	111	33
Huong Phu	8	3	791	100	11	111	14
Total	11	6	1127	111	111	222	19.7

on the norms[3] of 'Decision No. 59/2015/QD-TTg of The Prime Minister about Promulgating multidimensional poverty levels applicable during 2016–2020'.

A questionnaire (see APPENDIX A) was used to gather information on 1.) the respondents' profiles and household characteristics, including age, education level, ethnicity, occupation, number of people and labourers per household, household economic classification, and physical conditions of the household; 2.) the households' land-use status, including their engagement in crop agriculture, acacia and rubber tree planting, home gardens, and construction; and 3.) changes in land use over the past 15 years with a particular focus on acacia plantations, including changes in the area of acacia plantations over time; the number of acacia plots over time; the first year of planting and the corresponding plot area; and the origin of the plantation plots (i.e., what types of lands were converted, and who owned or managed these lands before transformation), and questions on why they chose to plant acacia.

Data analyses

Descriptive statistics and regression analyses were used to analyse data from household surveys. Independent T-tests were used to compare the difference in mean values of land use types between ethnic groups, household economic conditions, and communes. To investigate the main factors driving livelihood and land-use changes from 2005 to 2020, multivariate regression analysis was used with the dependent variable being 'area of forest plantation change'. This is the area of land that the surveyed households converted from the natural forest or land registered as upland crops into acacia plantations from 2005 until 2020. Land areas that were converted before 2005 were therefore excluded from the statistical model. The time 2005 to 2020 was chosen because government and interview data suggested that this was when the boom in smallholder acacia plantation development started and there are good supporting documents to analyse changes over this time. In addition, we also tried to limit the period to approximately 15 years in order to ensure that people could provide as accurate information as possible. We do, however, acknowledge that planting acacia did start before 2005, particularly through larger-scale development-driven programs.

Changing household livelihood strategies (and associated livelihood assets) can be an important driver for land use change (Liu *et al.* 2018). Furthermore, there are a number of other relevant factors with regard to the decision of households to change their land use; this includes traditional practices and/or contexts of different ethnic groups, household status (poverty classification) and the residency period (McElwee and Tran 2021, Thulstrup 2015, Thiha 2017). In our paper, livelihood assets are used as the independent variables in the regression model, as indicator of intrinsic factors affecting the household's land use decisions. The independent variables were grouped according to the five livelihood capitals, including: (1) Human assets (Age and education of HHs leader; Total labour); (2) Financial assets (Total income in 2005; Access to borrowing/credit); (3) Physical assets (Family housing quality; Gross asset value in 2005; Livestock value in 2005); (4) Natural assets (Land use type by landholder in 2005: Acacia land; Rubber land; Agricultural land; Garden land; Built-up land; Total landholding cover change between 2005–2020) (5) Social assets (Occupation in 2005; Social status and membership in associations of HH leader in 2005; The residency period) (Table 3). Before multivariate regression analyses, Shapiro-Wilks's tests were used to check for normal distribution of the data. Non-normally distributed data were transformed using a logarithmic or square root function, as described by (Kim 2013).

There were some limitations of our study. It was not always easy for respondents to recall land cover and related data from 2005, and related temporal trends. To tackle these limitations, detailed questions were used to collect household information (livelihood assets) in 2020 and changes in land use and livelihood assets over the past 15 years. This information was the basis to help respondents evoke and remember the data of their family in 2005. In some cases, we cross-checked the information from the household survey with other members of the interviewees' families, village heads and elders who had access to household data to enable triangulation of information. These were cases where the households had data that was distinct from the general trend or where the respondents were uncertain about the information being recalled. We also cross-checked information provided with land cover maps between 2005 and 2020.

[3] These norms include income norm (VND/person/month) and norms on deprivation of access to basic social services (access to medical services; health insurance; education level of adults; school attendance of children; housing quality; average housing area per capita; residential water sources; hygienic latrines and toilets; telecom services; and assets to serve information access) (Decision No. 59/2015/QD-TTg).

TABLE 3 *Descriptions of the variables used for analysis*

Variables		Measurement unit	Data type
I. Dependent variables			
1. Area of forest plantation change		Number of square meters (Sqrt_transformed)	Continuous
II. Independent variables			
Human assets	1. Age	Number of years	Continuous
	2. Education	1=Illiteracy, 2=Primary, 3=Secondary, 4=High school; 5=Higher	Ordinal
	3. Total labour	Number of people	Continuous
	4. Ethnic group	1=Kinh; 0=Ethnic minority	Categorical
	5. Household classification	1=Poor/near-poor; 0=Non-poor	Categorical
Financial assets	6. Total income in 2005	Number of Vietnamese Dong (Sqrt transformed)	Continuous
	7. Access to borrowing	1=Borrowing; 2=Otherwise	Categorical
Physical assets	8. Family housing quality	1=Multistoried house; 2=Bungalow; 3=Temporary house	
	9. Gross asset value in 2005	Number of Vietnamese Dong (Sqrt transformed)	Continuous
	10. Livestock value in 2005	Number of Vietnamese Dong (Sqrt transformed)	Continuous
Natural assets	11. Acacia land in 2005	Number of square meters (Log10 transformed)	Continuous
	12. Rubber land in 2005	Number of square meters (Log10 transformed)	Continuous
	13. Agricultural land in 2005	Number of square meters (Log10 transformed)	Continuous
	14. Garden land in 2005	Number of square meters (Log10 transformed)	Continuous
	15. Built-up land in 2005	Number of square meters (idf transformed)	Continuous
	16. Total landholding cover change 2005–2020	Number of square meters (Log10 transformed)	Continuous
	17. Access to natural forest	1=Member of community forest; 0=Non	Categorical
Social assets	18. The residency period	1=1-<5 years; 2=5-<10 years; 3=10-<20 years; 4=>20 years	Ordinal
	19. Occupation in 2005	1=Unemployed; 2=Agriculture; 3=Fishery; 4=Forestry; 5=Being employed related to plantation; 6=Other employed; 7=Harvesting NTFPs; 8=Selling, service; 9=Industry; 10=Tourism; 11=Civil servant; 12=Corporation, Populace; 13=Retirement	Categorical
	20. Social status or membership in associations in 2005	1=Civil servants or district/communes/villages officials or membership in associations; 2=Non	Categorical

RESULTS

Households' land use and acacia plantation development

The survey data showed that households' agricultural land (including short-term cropland and wet rice paddy) and aquaculture land were very low in Huong Phu and Thuong Lo communes. On average, households had between 0.06–0.09 ha under agricultural land and less than 0.01 ha of land under aquaculture.

The mean land area for most land use types and total land ownership of households was significantly higher in Huong Phu commune, for Kinh people, and non-poor households as compared to Thuong Lo commune, ethnic minority people, and poor households (Table 4). Unlike other land use types, there were no significant differences between poor and non-poor households for aquaculture and agricultural production land ownership (Table 4).

Between 2005 and 2020 major changes took place in dominant land uses of households and associated income streams. For example, rubber used to contribute significantly to the overall income of local people in some communes of Nam Dong in the past [Interview #2,5,7 Mar 2020]. However, acacia was considered the main commercial tree in recent years, with an average plantation area of 1.5–2.3 ha per household (compared to 0.3–1 ha/HH of rubber land). Acacia plots were established in different years and were harvested and replanted every 4–5 years. Profits from short-cycle afforestation have motivated local people to expand their acacia plantations.

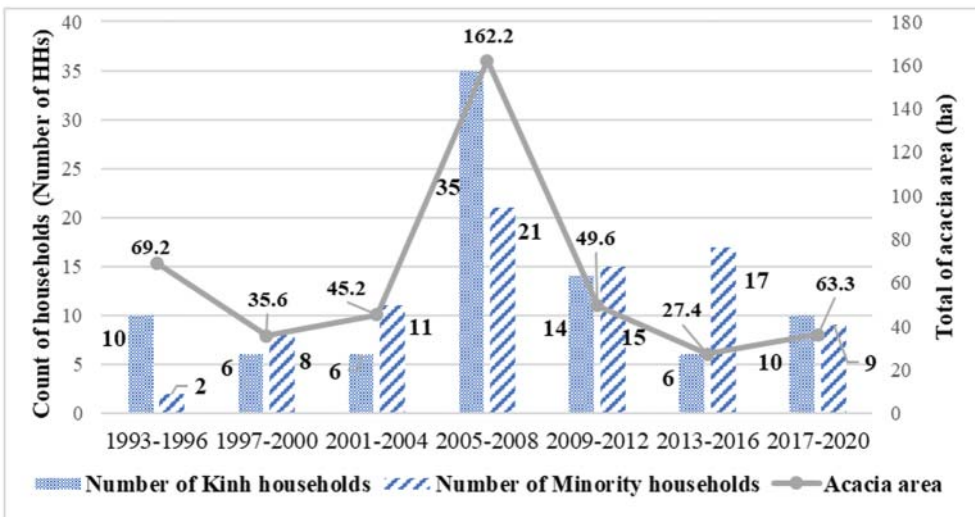
Despite the support of afforestation programs since the 1990s, only a few households invested in plantation forests at that time because most of the local people did not see the economic value of acacia forests (Figure 2). The availability of land for afforestation was initially not limited, so some households with enough labour and financial resources could expand their acacia plantation rapidly at this time. Therefore,

TABLE 4 *Mean ± standard deviation of household land ownership (in ha) and comparisons of mean land area ownership between ethnic groups, communes, and household economic conditions using Independent Sample T-tests*

	Agricultural land area	Acacia land area	Rubber land area	Built-up land area	Household garden land area	Aquaculture land area	Total
Huong Phu	0.06±0.2	2.3±2.6	1±1	0.02±0.03	0.1±0.2	0.01±0.05	3.6±3.2
Thuong Lo	0.09±0.1	1.5±1.6	0.3±0.5	0.01±0.01	0.06±0.1	0.002±0.01	2±1.8
P-value[a]	**0.001****	**<0.001*****	**<0.001*****	**0.007****	**<0.001*****	0.144	**0.002****
Kinh hosueholds	0.06±0.2	2.4±2.7	0.9±1.0	0.02±0.03	0.2±0.3	0.02±0.05	3.5±3.4
Minority ethnic households	0.1±0.1	1.4±1.4	0.4±0.6	0.01±0.02	0.06±0.1	0.002±0.01	2.0±1.7
P-value[b]	**<0.001*****	**<0.001*****	**0.002****	**0.007****	**<0.001*****	**0.045***	**0.002****
Non-poor households	0.08±0.2	2.2±2.3	0.7±0.9	0.02±0.02	0.1±0.2	0.001±0.004	3.20±2.9
Poor households	0.06±0.1	0.8±0.8	0.2±0.5	0.01±0.01	0.07±0.2	0.001±0.003	1.2±1.0
P-value[c]	0.227	**0.003****	**<0.001*****	**0.001****	**0.02***	0.137	**<0.001*****

Note: [a] Comparison of mean land area values between Huong Phu and Thuong Lo commune
[b] Comparison of mean land area values between Kinh and Minority ethnic
[c] Comparison of mean land area values between non-poor and poor households
** p<0.05, **p<0.01, *** p<0.001*

FIGURE 2 *Timeline of the households' first acacia plantation establishment (starting in the year 1993), as stated by respondents of the survey (in total 222 respondents)*



wealthier households and those with more labourers were able to occupy larger plantation forest areas than others [Interview #21 Mar 2021]. The support of WB3[4] projects and the development of wood chip mills since the mid-2000s are considered important factors promoting local people to grow acacia. The number of households involved in acacia cultivation grew, and the fastest expansion of plantations was between 2005–2008. By the 2016–2020 period, afforestation projects had ended and land resources for afforestation were increasingly limited. Acacia trees however continued to be planted in available spaces of 'bare lands' and by transforming other land use types (Figure 2). In particular, these new acacia plantation areas arose from the conversion of rubber lands to acacia and through the encroachment into natural forest areas [Interview #7,15 May 2020].

Conversion of forestland to plantations

Many of the surveyed households (n=126, 57%) first started growing acacia plantations between 2005–2020, accounting for over 229 ha. On average each household planted more than one ha of acacia in this period. Acacia plantations were established on lands converted from natural forest areas through illegal natural forest encroachment by local people

[4] Forest Sector Development Project (WB3): family-based economic afforestation project with concessional loans from the World Bank.

and through afforestation programs (about 138 ha for 70 households), as well as through the conversion of other land use types (hill gardens, swidden land and rubber plantation lands) with approximately 91 ha for 56 households. Fifty-six (25%) surveyed HHs asserted that they expanded their acacia by clearing natural forests. More Kinh households (54%) and non-poor households (85%) converted forestlands to acacia as compared to ethnic minority people (46%) and poor households (15%). There was a significant difference in the total land and other forestland area converted to acacia plantations between the poor and non-poor households ($p<0.05$). However, differences between ethnic groups were not statistically significant (Table 5).

Economic influences on forestland use changes

The increasing market demand for woodchips and pulpwood has pushed local people to convert natural forestland and other land uses to acacia plantations. Vietnam's woodchip exports increased sharply in the periods of 2004–2006 and 2009–2011. In 2011, Vietnam became the largest exporter of woodchips in the world (Tran and To 2013). Rapid construction of woodchip factories and booming export markets for woodchips has provided an important impetus for the expansion of plantation forests (90% of which is acacia) across Vietnam (Tran and To 2013, To *et al*. 2016, Iwanaga *et al*. 2020). In upland Thua Thien Hue, it was only really in the early 2000s that people started to see the economically beneficial value of exotic tree plantations (Nguyen and Kull 2022) which eventually promoted mass uptake of planting by people. Since the mid-2000s many woodchip companies were established, and market demand for raw wood is still growing. In the region, up to 80% of planted forest woodstock is sold to woodchip companies for export; in 2011 the factories' demand for raw materials still surpassed the effective supply of wood (Phan 2011). The purchasing price of timber for pulping has increased significantly, from 37.3 USD/ton in 2004 to 43.6 USD/ton in 2007 and 52.8 USD/ton[5] in 2010. Accordingly, households have gained confidence to participate in afforestation initiatives (Phan 2011). In Nam Dong district, the decision not to plant rubber, or to convert from rubber to plantations influenced the increase in acacia in the area. With a high investment, the average cost per hectare of rubber (cultivation, fertilizers, herbicides, labour) was 2 427 USD[6] from planting to latex extraction after 7 years. Investments for acacia were much lower. Local people only spent about 946 USD/ha[6] for tillage, planting, and taking care of acacia plantations [Interview #11,17 May, Dec 2020]. This allowed many more households (including some relatively poor) to participate in planting acacia. In addition, local people extensively planted rubber up until the early 2000s because of high and increasing rubber latex prices. However, in recent years (2018–2020), the rubber latex price dropped sharply (0.31–0.48 USD/kg[7] compared with 2.21–2.65 USD/kg[6] in 2005–2008) [Interview #5,11 Mar, May 2020]. Therefore, many households started to cut rubber trees down and replace them with acacias [Interview #2,5,7 Mar 2020]. In addition, from 2001–2008, many households in Nam Dong got financial support (loans from Agribank for rubber plantation). As a result, many households are in debt which motivated them to sell their rubber plantations and plant new acacia fields to pay off the debts faster [Interview # 11, May 2020].

Policies affecting forestland use changes

Although policies and projects to reduce forest losses and promote tree planting were first initiated in the 1990s, many were not very successful. In 1991, the Vietnamese government promulgated the Law on Forestry Protection and Development. This law and associated policies regulated that production

TABLE 5 *Conversion of natural forest and other forestlands to acacia plantations between 2005 to 2020*

		Natural forest to acacia		Other forestlands		Total	
		No. HHs	**Area (ha)**	**No. HHs**	**Area (ha)**	**No. HHs**	**Area (ha)**
Ethnic groups	Kinh ethnic	36 (51%)	89	32 (57%)	56	68 (54%)	145
	Minority ethnic	34 (49%)	49	24 (43%)	35	58 (46%)	83
	P-value[d]		0.590		0.223		0.117
Household classification	Non-poor	58 (83%)	123	49 (88%)	84	107 (85%)	207
	Poor/near-poor	12 (17%)	15	7 (12%)	7	19 (15%)	22
	P-value[e]		0.28		**0.038***		**0.01****
Total		70	138	56	91	126	229

Note: [d] Comparison of mean converted land area values between Kinh and Minority ethnic
[e] Comparison of mean converted land area values between poor and non-poor households
** p<0.05, **p<0.01, *** p<0.001*

[5] The exchange rate between Vietnam Dong and US Dollar was 15,697 VND/USD, 16,070 VND/USD, and 18,932 VND/USD in 2004, 2007, and 2010, respectively.
[6] The exchange rate between Vietnam Dong and US Dollar was 15.863VND/USD in 2005.
[7] The exchange rate between Vietnam Dong and US Dollar was 22.825 VND/USD in 2018.

forests could be allocated to state enterprises, corporations, and households. Since 1995, through the implementation of the Forest Land Allocation project under FAO assistance, Nam Dong district authorities allocated land without forests to households for afforestation. Thus, a series of afforestation and reforestation programs were carried out in the Nam Dong district such as the 'PAM' project (1992–1997), Program 327 (1993–1997), and Program 661 (1997–2005). *"To carry out these projects, we have converted the shifting cultivation areas near natural forests into plantation forests with the expectation that this will prevent encroachment of natural forests for crop cultivation"* – as recounted by a Nam Dong district official who used to participate in the implementation of afforestation [Inteview #21 Mar 2021]. However, only a few farmers took part in the extension activities of this program (Gomiero and Giampietro 2001). Village officials in Huong Phu commune remember that: *"We had difficulty persuading the households in the village to accept the forest. Most local people joined the afforestation programs only for cash income purposes through clearing, planting, and caring for forests"* [Inteview #5 Mar 2020].

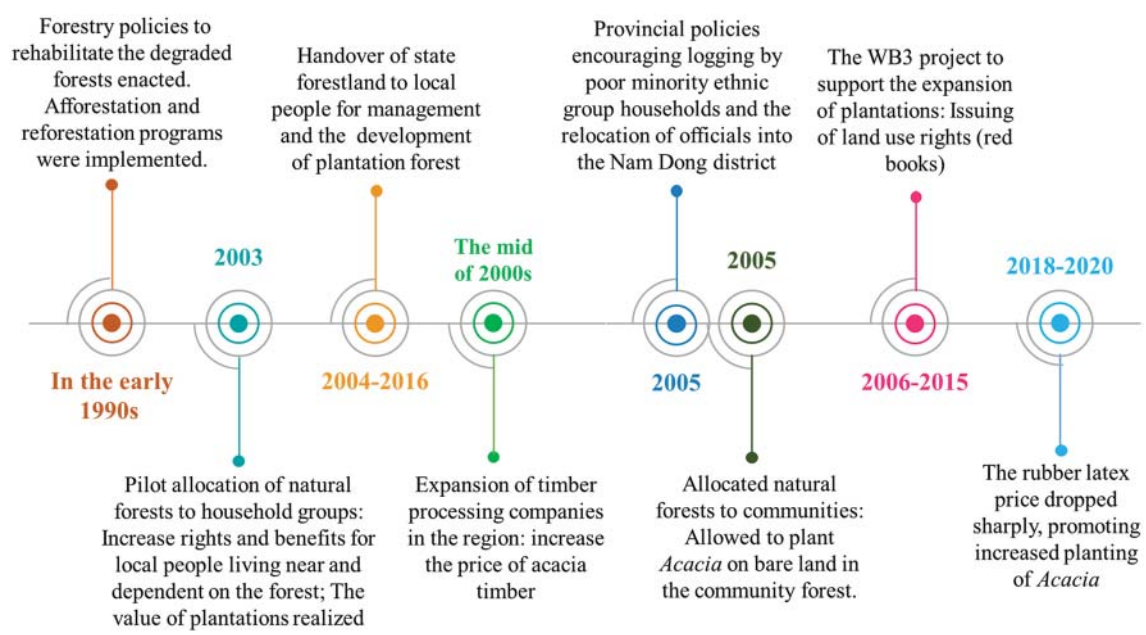
After the year 2000, forest planting initiatives have had greater uptake by local people. Our policy and literature review as well as information provided by key informants show that various factors have affected households' land use decisions (especially planting acacia) and resultant forest cover in the two communes over the last 20 years. In the next few paragraphs, we detail the provincial policies that supported the changes, focusing on (1) natural forest exploitation, (2) exotic tree plantations, and (3) the allocation of forestlands to community groups (Figure 3).

From 2005 to 2010, some provincial policies encouraged logging in natural and semi-natural forests. The Provincial People's Committee allowed the exploitation of timber from some sub-zones of natural forests to serve essential domestic timber needs of some households and district officials (Thua Thien Hue PPC 2005a, 2005b). Accordingly, permission to log 1 557 m^3 of wood was granted to 519 households in Nam Dong district (45 households in Thuong Lo and 20 households in Huong Phu commune) (Thua Thien Hue PPC 2005b). District officials and village elders in Thuong Lo commune recall:

> *"Previously, to encourage cadres from other places to come to Nam Dong district to work, the local government had undertakings that licensed to exploit 5 m^3 of wood per official to build houses. Because the transport permit does not have a specific time and date, many local people took advantage of that license to smuggle illegal timber back and forth. Then, local people also took the opportunity to convert logged-out areas into acacia forests."* [Interview #11, 19 May 2020].

The period from 2005 to 2010 was also characterized by provincial policies encouraging fast-growing economic tree plantations. According to Resolution No. 4e/2005/NQ-HDND, Thua Thien Hue province strived to plant 23 500 hectares of forest, of which 50% needed to be economic (plantation) forest. Therefore, projects on the development of planted forests were promoted and implemented. The WB3 project played the most important role in expanding the plantation forest area of Nam Dong district. From 2006–2015, this project was implemented in five communes of Nam Dong district (including Huong Phu and Thuong Lo communes), with 1 247 households participating in the afforestation of 1 200 ha. Before 2003, the Nam Dong district authorities encouraged local people to receive land for planted forests through afforestation and reforestation programmes (PAM, 661 and 327 Programs), but a majority of them refused as they did not see a long-term benefit of the plantation forest. Since 2006, the WB3 project and associated financial support facilitated the issuing of red books (land-use certificates) which motivated

FIGURE 3 *Timeline of important historical events related to forestland use changes in Nam Dong district*



people to become more active in tree planting [Interview #5,11, 26 Mar, May 2020, May 2021]. In order to join the WB3 project households however also needed capital to invest in afforestation. Not all local people were thus registered to participate in tree planting, but only those who had economic resources or could realize the value of plantation forests.

From 2003 to 2016, the Nam Dong district authorities implemented policies to allocate natural forests and hand over forestland from state forestry institutions to local communities. In 2003, natural forests were allocated to household groups in two pilot communes in the Nam Dong district. Since 2005, based on the Law of Forestry Protection and Development 2004, under the sponsorship of projects, the Nam Dong district authorities had started allocating natural forests to the communities (Hoang 2015). Additionally, since 2005, Nam Dong and Khe Tre SFE were merged into the Nam Dong Protection Forest Management Board (PFMB) (Vietnamese Government 2005). A large part of the land under their management was assigned to local people to plant acacia, rubber, and cash crops. Simultaneously, from 2004 to 2016, the Bach Ma National Park and Nam Dong PFMB handed over 13 500 ha of forestland to the People's Committees of nine communes in Nam Dong district (1 300 ha of Huong Phu and 2 700 ha of Thuong Lo commune). Around 26% (3 500 ha) of this forestland was allocated to households for developing plantation forests. However, shortcomings in the forest allocation process and weak community forest management have also promoted the encroachment of acacia plantations within natural forests. In addition, some land areas were handed over to communities without a map showing the location and boundaries of the plots on the minutes, allowing for forestland encroachment as well as inducing confusion over ownership rights. Specifically, there were 331 ha and 505 ha plantations in Huong Phu and Thuong Lo communes, respectively, with unidentified owners (Thua Thien Hue PPC 2019, No.270/KL-UBND).

Further encroachment onto forestlands

The situation of plantation encroachment onto natural forestlands is complicated in Nam Dong district. Overall, 571.6 hectares have been identified at a high risk of encroachment, particularly in community forests and Nam Dong PFMB forests. From 2011 to 2015, 91.4 hectares of natural forest were cleared for afforestation (Thua Thien Hue DARD 2021). In 2020, there were 99 cases (12.1 ha) of acacia plantation encroachment on natural forests (Thua Thien Hue PPC 2020).

Many households intentionally expand plantations onto degraded forestlands before the forest is allocated. Some households even expressed regret that they did not dare to clear natural forests like their neighbours, so now they do not have land to grow acacia. *"In the early days of receiving community forest management, many people in my village clandestinely cleared that forest to plant acacia for their land. I did not dare to do it. So, I don't have any piece of acacia plantation now and I have become an employee for them"* – the memory of a woman from a poor household in Phu Hoa commune, Huong Phu district [Households survey, March 2021]. Moreover, the forestland handed over from state forestry organizations (Bach Ma NP and Nam Dong PFMB) to communities has generated various issues. For example, some households were allocated land because they had good relationships with local authorities, while many poor households who lacked productive land were not allocated any forestland. This led to conflicts among local people. Many households were dissatisfied with this process of land allocation, so they opted to illegally encroach on the natural forestlands and converted them into plantation forests [Interview #6,7,9 May 2020].

Local people encroach on the natural forest in many ways without being caught or criminally prosecuted. Often some illegal deforestation occurs by clearing the natural forest contiguous with household acacia plots a little bit each year. This is difficult to detect and address because the damaged areas are small. Such incipient encroachment was initially practised by only a few households. Gradually, people learned from each other and the practice became rather common in most communes [Interview #19 Dec 2020]. Out of the total of 222 surveyed households, there were 56 households (31 Kinh and 25 ethnic minority households) who had acacia plots for which red books (land ownership permits) had not yet been issued. Most of these areas were expanded without legal approval around their acacia areas and range from 0.5 ha to 2 ha per household (Household Survey). Many violations have been administratively or criminally sanctioned, but the occupied land area was not recovered and acacia trees remain. In some cases, households were allowed to keep the acacia stand until it was harvested; after this, the land was returned to the community [Interview #15 May 2020].

Internal factors affecting household forest and land use change

Besides the external factors discussed above, household livelihood assets are internal factors influencing people's decisions to change land use practices. The multiple regression analysis revealed that three variables were significantly associated with the change in households' acacia plantation area. The education level of the household leader had the strongest influence ($p < 0.01$), followed by household poverty classification ($p < 0.05$) and the residency period ($p < 0.05$). Education levels of household leaders and residency periods of households were positively associated with increases in acacia plantations. In contrast, increases in acacia area over time were lower for poor households as compared to non-poor households (Table 6).

Our data show that poor households maintained considerably less acacia area before 2005 than the non-poor (0.4 ha/HH compared to 1.2 ha/HH); equally, after 15 years, the expanded acacia area was still considerably less than that of non-poor households (0.8 ha/HH compared to 2.2 ha/HH). Considering the ethnic minority group only, there was essentially no difference in land access between poor and non-poor people before 2005 ($p = 0.351$). There was however a significant difference in 2020 ($p = 0.003$), with non-poor households having

TABLE 6 *Results of the Multiple Regression Analysis assessing the factors affecting change in acacia plantation area of households between 2005 and 2020*

Variable	Unstandardized Coefficients		Standardized Coefficients	Sig.	Collinearity Statistics (VIF)
	B	Std. Error	Beta		
(Constant)	-243.941	98.498		0.015	
Age	0.841	0.749	0.147	0.265	2.441
Education of HHs leader	26.962	7.559	0.409	**0.001****	1.861
Total of labour	-2.561	7.368	-0.038	0.729	1.663
Ethnic group	-4.713	22.039	-0.034	0.831	3.636
Household classification	-43.470	17.598	-0.277	**0.016***	1.774
Total HHs income in 2005	0.011	0.008	0.169	0.174	2.150
Access to borrowing	-0.906	14.846	-0.006	0.952	1.430
Family housing quality	6.164	5.089	0.129	0.229	1.614
Gross asset value in 2005	0.004	0.004	0.129	0.289	2.064
Livestock value in 2005	3.094E-05	0.003	0.001	0.992	2.448
Acacia land in 2005	-13.641	7.644	-0.191	0.078	1.618
Rubber land in 2005	-1.279	5.669	-0.023	0.822	1.502
Agricultural land in 2005	-6.092	4.824	-0.146	0.210	1.901
Garden land in 2005	9.428	5.360	0.185	0.082	1.565
Built-up land in 2005	0.023	0.034	0.072	0.496	1.573
Total landholding cover change 2005–2020	2.205	4.207	0.060	0.602	1.825
Access to natural forest	11.390	16.842	0.083	0.501	2.120
The residency period	24.345	10.964	0.220	**0.029***	1.394
Occupation in 2005	-3.299	2.007	-0.207	0.104	2.234
Respondent's social status	49.128	27.521	0.214	0.078	2.025
Model summary statistics					
Adjusted R Square	0.435[1]				
Durbin-Watson (DW)	1.964				
ANOVA (Sig.)	<0.001[b]				

*Note: * p<0.05, **p<0.01*

[1] The Adjusted R Square index (0.435) shows that 20 independent variables explained the dependent variable (Forest use change) by around 43.5%. Durbin-Watson was used to test the autocorrelation of adjacent errors (also known as first-order serial correlation), and the results show that the value DW = 1.964 (close to 2), so there is no autocorrelation first-order sequence. Therefore, it can be concluded that the collected data is good. The F-test in the ANOVA shows that Sig. < 0.001, thus concluding that this linear regression model is generalizable and applicable to the population.

more acacia area than poor households (0.9 ha/HH compared to 0.5 ha/HH). Meanwhile, regarding the Kinh ethnic group there is a very clear difference in the acacia area between poor and the non-poor households already before 2005 and in 2020 ($p < 0.001$). Poor households had very little acacia area (0.1 ha/HH before 2005 and increase to 0.4 ha/HH in 2020) compared to non-poor households (1.4 ha/HH before 2005 and 2.7 ha/HH in 2020; Table 7). Our results showed that non-poor households tried to grow acacia by hiring poorer people to clear natural forests or through buying more forestland. Poorer people found it difficult to invest capital for afforestation; they therefore often participated in afforestation initiatives to receive direct cash or work as hired labour for other households, possibly leading to poverty traps [Interviews #19 Dec 2020]. Many poor farmers sold their land and became contracted labourers on these same lands. A community member from Thuong Lo commune recounted: *"Because I needed money to build my house, I sold my allocated plantation land to my neighbour. Now that I haven't land to grow acacia, I often work as hired labour to earn money for a daily living*."

Households with better education were more likely to adopt new ways of using land for long-term economic purposes and to encourage long-term land use. In addition, people with a higher level of education often established social relationships

TABLE 7 *Changes in mean ± standard deviation household acacia plantation area between 2005 and 2020*

		Before 2005		In 2020		Increases area from 2005 to 2020	
		Mean (ha)	**sig.**	**Mean (ha)**	**sig.**	**Mean (ha)**	**sig.**
Thuong Lo and Huong Phu commune	Kinh ethnic	1.3±2.9	0.115	2.4±2.7	0.002**	1.3±1.7	0.004**
	Minority ethnic	0.8±1.2		1.5±1.4		0.8±0.9	
Thuong Lo and Huong Phu commune	Non-poor	1.2±2.5	0.001**	2.2±2.3	<0.001***	1.2±1.5	<0.001***
	Poor/near-poor	0.4±0.8		0.8±0.8		0.5±0.7	
Thuong Lo commune	Minority ethnic (100 HHs)	0.7±1.3	0.878	1.4±1.3	0.407	0.8±0.9	0.111
	Kinh ethnic (11 HHs)	0.8±1.5		2.2±2.9		1.8±1.8	
Huong Phu commune	Minority ethnic (11 HHs)	1.2±1.5	0.896	1.8±1.5	0.447	0.8±0.7	0.297
	Kinh ethnic (100 HHs)	1.3±3		2.4±2.7		1.3±1.7	
Only minority ethnic (111 households)	Non-poor	0.8±1.4	0.351	1.7±1.5	0.003**	0.9±1	0.042*
	Poor/near-poor	0.6±0.9		1.0±0.9		0.5±0.7	
Only Kinh ethnic (111 households)	Non-poor	1.4±3.1	<0.001***	2.7±2.8	<0.001***	1.5±1.7	<0.001***
	Poor/near-poor	0.1±0.3		0.4±0.7		0.5±0.7	

*Note: * p<0.05, **p<0.01, *** p<0.001*

which could benefit them economically (i.e., education could be strongly linked to differences in social capital, community status, wealth and more). They also had better access to a wide range of jobs as well as to information, science, and technology. Hence, they saw the market opportunity of acacia trees earlier, and have had more opportunities to participate in development projects, including acacia plantations, which led them to convert other tree species plantations and natural forests to acacia earlier and more rapidly.

Households with a longer residence period had better chances of accessing land due to knowledge and experiences from living in the area. For example, they also accumulated a lot of experience in applying for local land use forms, understood and grasp the market, react quickly to economic opportunities (faster than newcomers), and had social networks in place which help to access land. On the contrary, households who had just moved from another place or had just separated from their families face difficulties when land is becoming increasingly scarce. Their acacia area was mainly accumulated through buying land from others or it was given to them by their parents and relatives. People with shorter residence times in their household were often younger and also did not have the capital resources to accumulate as much land.

Our household survey data also showed that there was a difference in the mean area of acacia plantation ownership between ethnic groups (essentially equal to the two different communes) when the total sample size was analysed ($p < 0.05$). However, when comparing ethnic minorities and Kinh people in the same commune, the difference in the land area owned by these ethnic groups and the increase in the acacia area during this period is not statistically significant ($p > 0.05$). In addition, regression analysis results also indicated that ethnic group did not have an effect.

DISCUSSION

Forest areas and uses are changing globally and various factors such as policy, urbanization, agricultural livelihoods and economic development are driving this change (Cochard *et al.* 2017, 2020, Meyfroidt and Lambin, 2008a). Unlike many other areas of the world, Vietnam is seeing rapid afforestation (Cochard *et al.* 2017) and in particular four of the five FT pathways (described above; i.e. "resource scarcity', 'globalization', 'national forestry policy', and 'agricultural intensification'; cf. Lambin and Meyfroidt 2010, Meyfroidt and Lambin 2008a, 2008b, Rudel *et al.* 2005) appear as valid interpretations in our case study site. Forest scarcity and degradation and associated forest policies as well as economic transitions started this trend in afforestation in Vietnam and represent more broad-scale and top-down processes. However, with time the more localised smallholder agricultural intensification has become the biggest driving force of the tree cover transitions in the study area. Our results show that in Vietnam, numerous afforestation policies and regulations as well as land rights access (red books), are considered major factors directly driving the change, particularly through the conversion of natural forests, swidden and agricultural lands to acacia plantations. Economic changes (drop in rubber price), increasing value of acacia wood, subsidies and other factors are secondary drivers of this change. This case is different to other regions undergoing afforestation and land use change, where drivers are less direct and more subtle and can relate to urbanization and associated land abandonment, changing incomes, and environmental change factors like climate change or species invasions (Debolini *et al.* 2018, Jiménez-Olivencia *et al.* 2021, Lasanta *et al.* 2017, Plieninger *et al.* 2016, Rijal and Cochard 2016, Shackleton *et al.* 2013).

Our study in Nam Dong recorded major forestland conversions as a result of the boom of acacia plantations. Forest policy and economic drivers are the most important factors in this change. Acacia initially appeared and gradually expanded in the area under the support of forestry policies from the 1990s to the early 2000s and large-scale top-down initiatives. With time more localized and smaller scale microeconomic drivers embedded in larger national and global trends strongly influenced households to invest in acacia plantations. As a result of the intersecting scales and processes local people in the area have drastically changed forest and swidden lands to acacia plantations in legal (participating in afforestation programs) and illegal (encroachment) ways. Previous studies in the Nam Dong district suggested that natural forest allocation policies and livelihood changes have led to major forest degradation through their transformation into acacia monocultures (Hoang 2005, Thiha 2017). We add to these discussions, in particular, with evidence relating to the illegal encroachment of forest areas to plant acacia monocultures.

At a fine scale, our findings show that household land use and livelihood decisions and actions were primarily affected by education level and residence time. Households which had a higher education level of the household leader or those with a longer residence period, had larger increases in the area of acacia plantations in the past 15 years. There were also significant differences in land ownership between poor and non-poor households with regard to total landholding, including acacia plantations. Our results contrast with other research in the Northwest Mountains and North Central Provinces of Vietnam that suggests a household's forestland ownership is not related to income and/or poverty (Tran 2015a, 2015b). However, our finding is consistent with results from other studies in the central provinces of Vietnam which suggest that well-off households are more able to access land via afforestation programmes than poor households (Cochard *et al.* 2021, La *et al.* 2020, McElwee 2009, McElwee and Tran 2021, Nguyen and Kull 2022, Thiha 2017, Sikor and Nguyen 2007).

Thulstrup (2015) shows that in another central province of Vietnam, there were differences in land use changes between ethnic minority and majority groups. Kinh people promoted the expansion of the acacia forest first and so had more acacia plantations, while the ethnic minority people only started planting acacia later. In line with results from other studies (e.g. Castella *et al.* 2005, Thiha 2017) our study suggests that ethnicity is less relevant as a factor in household level land use change.

Our findings also correspond with other studies. In a neighbouring mountainous commune, A Luoi, Nguyen and Kull (2022) show major livelihoods and land use transitions – specifically the rapid uptake of acacia plantations. This trend leads to the risk of a boom-and-bust cycle of plantations. There is no guarantee that the price of woodchips will remain at their current level or even keep growing. Local people continue to develop plantations by all means, putting natural forests at risk of being threatened. At the same time, this also increases the risk of conflicts of interest and land disputes between households (Nguyen and Kull 2022). On the other hand, forest growers have to contend with many risks for their plantations, including outbreaks of plant diseases and insect pests, forest fires, and natural disasters. As a result, poor acacia growing households in particular may be trapped in poverty and remain vulnerable, despite these large-scale changes (Cochard *et al.* 2021, La *et al.* 2020).

CONCLUSION

Our study highlights that forestry policies such as natural forest allocation, land transfer from state organizations to households and communities, economic factors, and projects to promote acacia planting were important factors driving land use change in the study area, particularly from 2005 to 2020. At the household level, we show that factors related to household livelihood capital and associated histories were determining factors for households' changing land use practices. Higher education levels and longer residential time of the households were associated with larger expansions of acacia plantations. In comparison to poor households, the non-poor households also more often converted other land to acacia plantations

Although there is a role of small-scale plantations in upland people's livelihoods and possibly in improving forest cover (Cochard *et al*. 2021, La *et al*. 2020, McElwee and Tran 2020, Nguyen and Kull 2022), it is necessary to re-evaluate the social and ecological effects of planted forests.

There is a difference in access to plantation land between poor and non-poor households. Therefore, the formulation and implementation of forestry policies should pay more attention to ensuring fairness in land access among people. Nguyen and Tran (2018) highlight that gaining access to more forestland would increase household per capita income and reduce the incidence and intensity of poverty, which might not be the case if not done equitably. Other studies showed that the plantation forest development has increased the disparity between the well-off and the poor households and increased inequality in the region (La *et al*. 2020, Sikor and Baggio 2014). Given the scope of this article, we have not covered this issue in full. Therefore, further studies are needed to assess the effects of changes in forest land use on household livelihoods and the inequality between poor and non-poor households, Kinh and ethnic minorities which could help with policy formulation in the future.

In the Nam Dong district, constellations of land access in combination with the economic value of planted forests has led to the encroachment on natural forests for the expansion of acacia plantations. The remaining forestland available for wood production is not only increasingly limited conversion from natural vegetation cover to acacia-based tree monocultures implies decreases in biodiversity and – especially after tree harvests – relevant issues of soil protection (cf. Cochard *et al*. 2021). Local forestry thus also needs to increasingly focus on sustainable forest development especially in areas where remnant natural forests are at risk of conversion to

acacia plantations (possibly in a stepwise pattern from initial forest degradation to bushlands to acacias; cf. Canh *et al*. 2023, Van and Cochard 2017). It is necessary to take measures to improve the efficiency of forest management, in particular, paying particular attention to vulnerable natural forests such as community forests, forests of the Nam Dong PFMB, and natural forests remnants adjacent to household plantations.

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APPENDIX A. QUESTIONNAIRE FOR HOUSEHOLD SURVEY

Code:……..……..…… **Interviewer:**……..……..……
Interviewee:……..……..… **Date:**……..……..……

A. GENERAL INFORMATION

A1. Address:
1. Commune……..……..…… 2. Village…….……..……

A.2. Gender 1. Male 2. Female

A.3. Age……..……..……

A.4. Education status:
1. Illiteracy 2. Primary 3. Secondary
4. High school 5. Higher

A.5. How is the relationship with the head of the household?
1. Head of household (HOH) 2. Wife or husband of HOH
3. Parent of HOH 4. The householder's child
5. Other……..……..……

A.6. Ethnic groups
1. Kinh 2. Minority ethnic

A.7. How many years has your family lived in the commune?
1. 1-<5 years 2. 5-<10 years 3. 10-<20 years 4. >=20 years

A.8. What is your job? (*Code: 1= Yes ; 2=No)*

Occupation	**In 2020**	**In 2005**
1. Unemployed		
2. Agriculture (livestock, farming, rubber)		
3. Fishery		
4. Forestry (Plant acacia, provide forestry seedlings)		
5. Being employed related to plantation		
6. Other employed (builder, maid, tailor...)		
7. Harvesting NTFPs		
8. Selling, service		
9. Industry		
10. Tourism		
11. Civil servant		
12. Corporation, Populace		
13. Retirement		
14. Other……..……..……		

A.9. How many people in your family?……..……..…..……..……
How many labours in your family?……..……..…..……..…… ……

A.10. Information on labours (Except for the person being interviewed)
Code of occupation *(A.10.5 and A.10.6):* *Graded in order from 1 to 13 according to the occupations in question A.8)*

Ordinal number	**1. Name of labours**	**2. Gender** *1. Male 2. Famale*	**3. Age**	**4. Education status**	**5. Job in 2020**	**6. Job in 2005**
1.						
2.						
3.						
…						

A.14. Household classification?
1. Poor household 2. Non-poor household

B. HOUSE AND ASSET OF HOUSEHOLD

B.1. Family housing quality
1=Multistoried house; 2. Bungalow 3. Temporary house

B.2. Does your family own this house?
1. Yes 2. No

B.3. What gross asset of your family?

Name of gross asset	**1. 2020**		**2. 2005**	
	a. Number	**b. Unit price**	**a. Number**	**b. Unit price**
1. Motorbike				
2. Truck				
3. Bicycle				
4. Smartphone				
5. Television				
6. Gas stoves				
7. Fride				
8. Speaker system				
9. Washing machine				
10. Furniture (sofa, table)				
11. Sawmill				
12. Computer				
13. Camera				
14. Other……				

B.4. What livestock asset of your family?

Name of pet	**1. 2020**		**2. 2005**	
	a. Number of pet	**b. Unit price**	**a. Number of pet**	**b. Unit price**
1. Buffalo				
2. Cow				
3. Pig				
4. Goat				
5. Chicken				
6. Duck				
7. Goose				
8. Other				

B.5. Sources of income of your family in 2020 and 2005

1. Sources of income	**2. Incomes in 2020 (VNĐ)**	**2. Incomes in 2005 (VNĐ)**
1. Selling, service		
2. Fishery		
3. Agriculture: Rice, cassava, corn…		
4. Livestock: buffalo, cow, chicken, goat, duck…		
5. Fruit trees		
6. Rubber		
7. Acacia		
8. Harvesting NTFPs		
9. PFES payments		
10. Money earned from employment related to plantation		
11. Other employed (builder, maid, tailor...)		
12. Salary		
13. Subsidies from the government and relatives		
14. Other……..……..……		

B.6. Does your family get a loan to develop acacia forest?

1. Yes 2. No

C. CHANGE IN LAND USE

C.1. Area and use rights of households' land types in 2020

Types of land	*a. Area (ha)*	*b. Land use right* *Codes: 1= Red book; 2= In process of issuing red book 3= No red book*
1. Wet rice land		
2. Swidden land		
3. Crop land		
4. Garden land		
6. Rubber land		
7. Acacia land		
8. Built-up land		
9. Aquaculture land area		
10. Other		

C.2. Households land use change from 2005 to 2020

Types of land	**1. Area** *1=Increase (How many);* *2=Keep stable* *3 = Reduce (How many)*	**2. Land use purposes** *1=Keep stable* *2= Change (How did it change)*	**3. The reason for the change in land area**	**4. The reason for the change in land use purposes**
1. Wet rice land				
2. Swidden land				
3. Crop land				
4. Garden land				
6. Rubber land				
7. Acacia land				
8. Built-up land				
9. Aquaculture land area				
10. Other				

C.3. Area and use rights of households' land types in 2005

Types of land	*a. Area (ha)*	*b. Land use right* *Codes: 1= Red book; 2= In process of issuing red book 3= No red book*
1. Wet rice land		
2. Swidden land		
3. Crop land		
4. Garden land		
6. Rubber land		
7. Acacia land		
8. Built-up land		
9. Aquaculture land area		
10. Other		

C. 4. Does your family participate in receiving natural forest for management and protection (community forest)?
1. Yes 2. No

C.5. Are community forests well protected?
1. Yes 2. No
a. If not, why? What are some descriptive examples?……
b. If yes, give some descriptive examples?……

C.6. Does your family have an acacia plantation area?
1. Yes 2. No

C.7. How many years will the family's acacia forest be harvested and replanted?……
……

C.8. How many plots of acacia plantation does your family have?: ……
……

C.9. Information about plots of your family acacia?

Numerical order of plots	**The first year when acacia in this plot was established**	**Area (ha)**	**The origin of the plantation plots**	
			What types of lands before planted acacia (Natural forest; Swidden land; Household garden; Rubber…)	**Who owned or managed these lands before converted**
1				
2				
……				

C.10. How does the acacia forest affect your family's livelihood? *(You can choose from many options)***?**
1. It helps increase income 2. Increase social relationship
3. Create jobs 4. Easy access to loans
5. It becomes more difficult due to a lot of capital investment
6. The family's life is difficult because natural disasters destroy the acacia forests
7. The family's life is difficult because acacia wood prices fell sharply
8. Others:……

C.11. How does the price of acacia wood change? Is there any influence on the household decision to grow acacia?
……
……

C.12. Why are your family involved in planting acacia forest?

……
……

C.13. Has your family ever received support programs/projects on the development of agroforestry production?

1. Yes 2. No

If yes, please list those projects

1. Name of project	**2. What does the support of the project (Fertilizers, seedlings, loans …)**	**3. Year**	**4. Objects supported (criteria for selecting supported households)**
1.			
2.			
……			

C.14. Does the development of acacia forests affect natural forests?

1. Yes 2. No

If yes, give some descriptive examples?……
……
……

C.15. What factors affect the development of household plantation forests in the locality?

……
……

C.16. In the future, what does your family plan to do/change in developing the acacia forest (Increase/decrease area, change planting method, change output market…)?

1. Yes 2. No

a. If yes, why and how?

……
……

b. If No, Why?

……
……

C.17. In your opinion, what solutions are needed to develop acacia forests effectively and sustainably?

……

C.18. In your opinion, what solutions are needed to effectively and sustainably manage and protect natural forests?

……