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PROXIMATE CAUSES AND UNDERLYING DRIVING FORCES OF LAND COVER CHANGE IN SOUTHWEST ETHIOPIA

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ABSTRACT

Investigation into the causes or drivers of land cover change in the context of sustainable development is one of the main concerns in land use change studies. However, little has been known about quantifying drivers (proximate causes and underlying forces) of land cover change in southwest Ethiopia. Thus, the study aimed to quantify the main drivers that contribute to explain land cover change in Guraferda, southwest Ethiopia. Data acquired from household survey and focus group discussion and modeling approach were integrated to quantify drivers of land cover changes. Results show that agricultural expansion was the foremost proximate cause of land cover change. Likewise, the dominant underlying driving forces are economic factors, representing 78% of all cases. Hence, the knowledge and understanding the drivers of land cover change as caused by a combination of diverse proximate and underlying forces play an essential role in the implementation of sound land use policy.

Keywords: land cover change, proximate, underlying forces, modeling approach, agricultural expansion

INTRODUCTION

Conceptualizing the causes or drivers of land use/land cover dynamics require understanding both how people make land use decision and how a given biophysical and socio-economic factors interact to influence the land use decisions (Gesit et al., 2006). Moreover, it is also essential to comprehend that land use decision are made and henceforth influenced by the complex interaction of the biophysical and social factors across a wide range of spatial scales (Lambin, Geist& Leper, 2003; Lambin & Geist, 2003).

Literature investigating drivers of cover change have borne out that the causes are diverse and are characterized by complex causative links. Over and above, these determinant causes vary across countries and regional levels. Most of the cover change in Latin America is the result of agriculture and cattle herding. In Africa, the most important driver is smallholder agriculture; however, in Asia, shifting cultivation, permanent agriculture and commercial logging characterize the situation (Lambin et al., 2003). Furthermore, factors that cause cover change were identified at the local or country level. For instance, deforestation in central Mexico was due to timber extraction, cultivation, cattle herding and urbanization (Galicia and Grcia-

Romero, 2007). Likewise, Armenteras et al. (2006) reported that cattle herding and illegal cropping loomed up as major drivers of deforestation in the Colombian Amazon.

Land use/land cover changes are very often caused by a combination of multiple factors and are characterized by a complex mode of interactions. All of which are operating at different levels within a specific human-environment system (Lambin et al., 2003). For instance, at the local level proximate or direct causes which constitute human activities or their immediate actions such as agriculture, forestry, grazing, settlement and construction, timber extraction etc. directly affect the land cover (Geist & Lambin, 2002; Lambin et al., 2003). Such direct causes operate at local level: individual farms, households or communities (Lambin et al., 2003). Conversely, the underlying causes are characterized by a complex social, political, economic, demographic, technological, cultural and biophysical variables that are deemed to be essential forces underpinning the proximate causes operate at a much broader scale (Geist and Lambin, 2002; Lambin et al., 2003; Lambin and Geist, 2003). These underlying forces usually cause a change in one or more proximate causes (Lambin et al., 2003; Lambin and Geist, 2003). These diverse driving forces trigger land use change either as an independent or separate factor or happen together independently and leading to land use change or can be interconnected as casual chains (Lambin & Geist, 2003).

It comes out from the above explanation that land use/land cover changes were caused by the interplay of varied sets of proximate and underlying factors that operate in synergetic ways (Bray and Klepeis, 2005). Or land cover changes are always caused by multiple interacting factors originating at different levels of human and environment system (Lambin et al., 2003). Moreover, land cover change is commonly understood by the numerous benefits it provides for human well-being, the production of essential goods and services of the ecosystem in particular. However, this change also causes a considerable influence on the environment. Therefore, research that focuses in minimizing or alleviating negative impacts of land cover changes on the biophysical environment is crucial in the sustainable development of land resources.

It appears that models have been developed in conceptualizing drivers of land cover changes (Angelsen and Kaimowitz, 1999; Geist and Lambin, 2002; Lambin et al., 2003; Ostwald, Wibleck & Stridbeck, 2009). In this study, a global model that has been used to examine the cause of tropical deforestation based on one hundred and fifty two case studies in a span of 116 years was employed.

Notwithstanding the paucity of studies on land use/land cover changes in Ethiopia, the existing empirical evidences confirmed land use/land cover dynamics of varied magnitude in different parts of the country. The focus and concern for most of these studies were the extent and rate of cover changes. However, there still remains much about the fundamental drivers of land cover change in the context of sustainable development. Therefore, the objectives of this study are: 1) to analyze proximate causes and underlying driving forces of cover change as described by farm households; 2) to show how the specified drivers are linked to the global analytical framework developed by Geist and Lambin (2002).

MATERIALS AND METHODS

Study area

Guraferda district is located in southwest Ethiopia, lies between 6^0 29' 12" and 7^0 13' 22"N and between 34^0 52' 23" to 35^0 23' 59" E (Fig. 1.1) and covers 2283 km^2. The topography of the area is characterized by few high peaks that

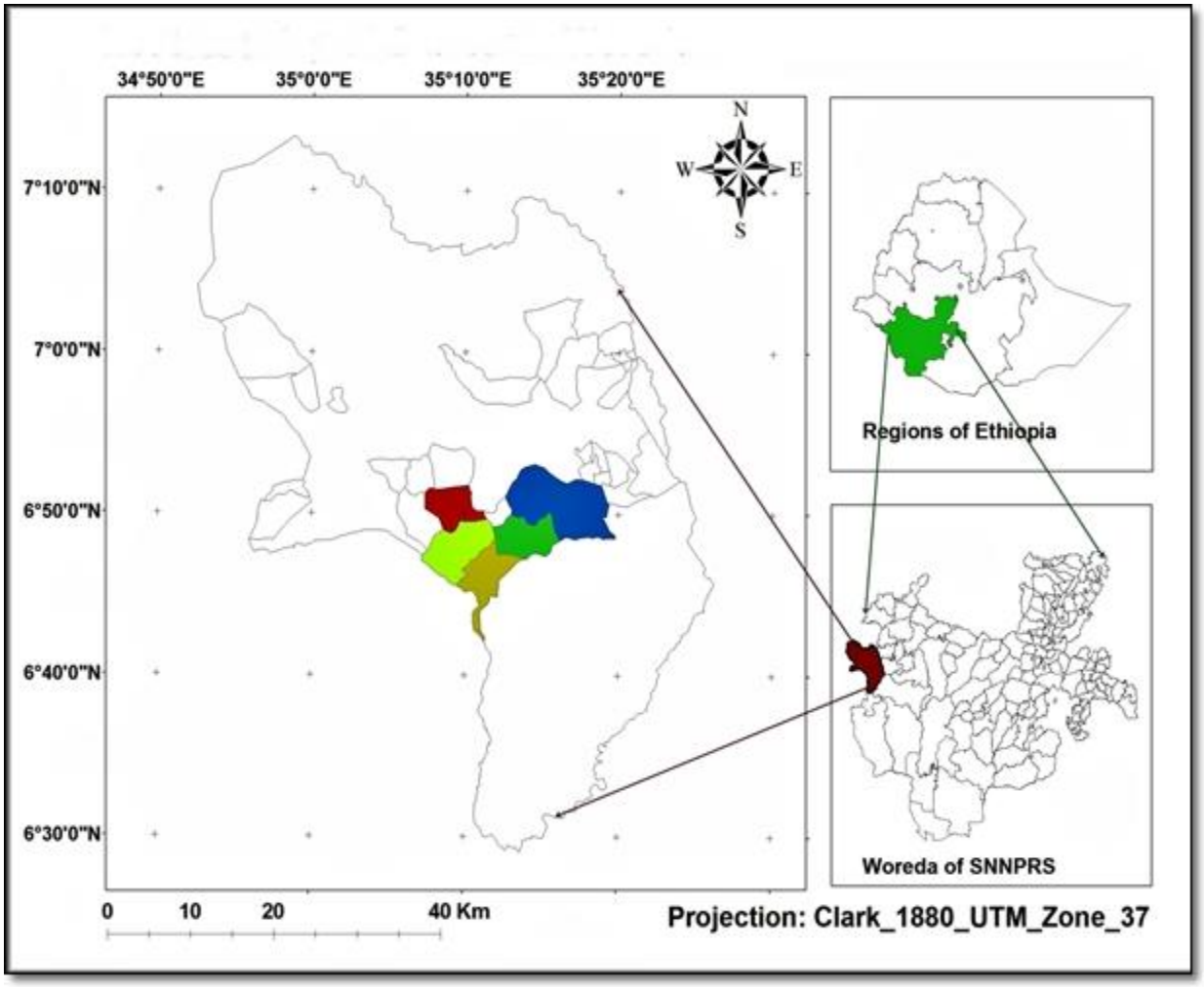

Figure 1.1 Location Map of Guraferda District

rises more than 2000m and running in a north-south direction, vast undulating landscapes, few valleys, a landform showing gentle to fairly steep slope. Elevations range between 700m and 2300m above m.s.l. The geological structure of the area is dominated by volcanic materials of the tertiary period. The major rock types include rhyolite, trachytes, tuffs, ignimbrites, and basalt (Mohr, 1971). The dominant soil types that have developed from the parent materials in the region comprise Nitosols, Acrisols, and Cambisols (Henricksen et al., 1984).

In the study area, the annual average rainfall over the period of 1983-2012 was 1639.8mm, with a maximum of 1946.3mm in 1985 and a minimum of 1289.8mm in 2004. All months of the year have rain despite overt seasonal variation. The mean annual temperature is 23.4^0C, with an observed average maximum and minimum temperature of 30.6^0C and 16.1^0C respectively. The natural vegetation is largely dominated by moist evergreen montane forest. The characteristic species in this vegetation includes *Pouteria Aningeria adolffi-friederic*, *Pouteria Aningeria altissima*, *Olea capensis*, *Prunus Africana*, *Albizia schimperiana*, *Cordia Africana*, *Mimosops kummel* (Edwards, 2010). The forest cover was about 126, 505 hectares, which corresponds to 55.4% of the total area of the district (Ashebir, 2014). Although Guraferda district is notable for its forest resource in the region, the existing land use pattern usurps a good portion of it.

The population of the study area is estimated at 34,271 (Central Statistical Authority, 2007), with average density of 15 persons per square kilometer. Smallholder agriculture is the dominant land use, with average holding size of more than two hectare per household. The varieties of crops cultivated are rice, maize, sorghum, groundnut, coffee, mango, pepper

Data source and analysis

The data were collected through household survey. A total of 264 sample farm household heads from five sample farm kebeles were interviewed by using a structured survey questionnaire on several issues such as demographic, land use/land cover, farming tradition, socio-economic aspects, household status, resettlement, access to market and main road, off-farm activities, tenure security, duration of residence. In this study, the sampling procedure was a combination of stratified and simple random sampling techniques.

Focus group discussion, a discussion held with knowledgeable elders, *kebele* leaders, and community members was also used in the selection of specific variables that are more appropriate and evident in revealing the actual drivers of land cover change in the study area. This can in turn be used to relate the specific factors to the broader explanation provided by the global analytical framework. Thus, informants' narratives were used to collect data on the possible drivers of land cover changes and it can serve as a good complement to the empirical data. Prior to the execution of focus group discussion, a list of key questions was prepared and used to guide the discussion.

This study employed the global framework developed by Geist and Lambin (2002) (Fig 1.2) to analyze the various proximate and underlying causes of land use/land cover change in Guraferda in a span of 15 years (2001 to 2015). Based on this analytical framework, three broad clusters of proximate causes relevant to the study area were considered: agricultural expansion, wood extraction, and infrastructural extension. Each of these broad groups was further subdivided into a number of specific factors. Shifting cultivation, small scale subsistence farming, commercial or modern cultivation, and resettlement were considered as essential components of agricultural expansion. The breakdowns of infrastructural expansion were road transport, settlement expansion and duration of farm house. Similarly, wood extraction also comprised specific factors such as fuel wood, charcoal production, and wood for constructional purpose, and logging.

In a similar fashion, four of the five broad underlying driving forces were considered. These are demographic, political or institutional, economic, and socio-cultural. The breakdown of these broad clusters was also identified. Accordingly, demographic factor includes population increase and population density; political factors were further

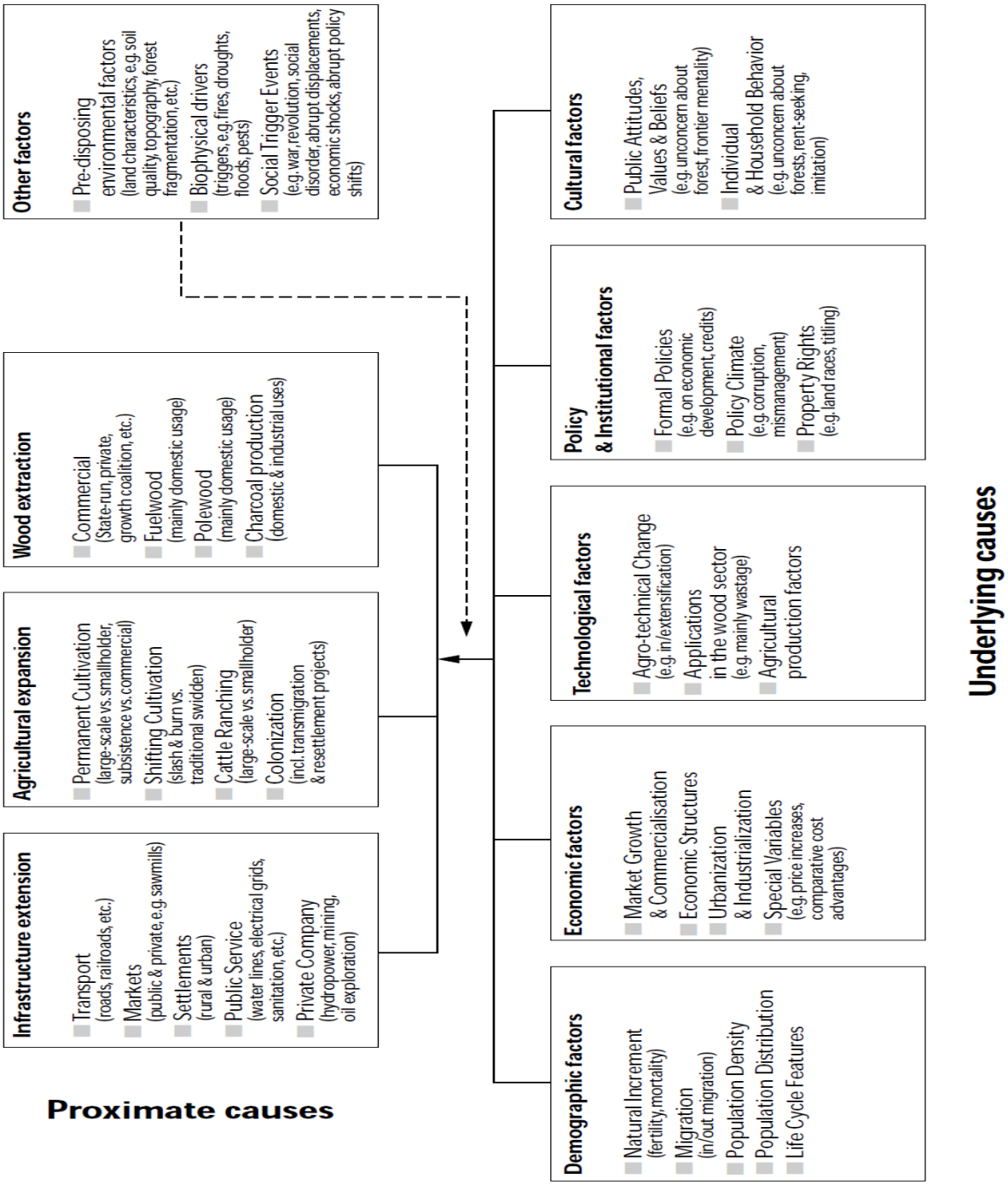

Figure 1.2 The Causes of Forest Cover Decline. Source: Adopted from Geist & Lambin (2002)

subdivided into corruption, weak institution performance, and insecure tenure. The breakdown of economic factors comprised market access, increase in the price of food crops, and increase in the annual income of farm households. The socio-cultural factors were also subdivided into changing public attitude, extensification on account of abundance of land, and religion.

Thus, on the basis of household survey, focus group discussion, and modeling approach, an assortment of factors that drive land cover change were identified to quantify the proximate causes and underlying forces of land cover changes as reported by farmers in the study area.

In the end, the frequency of occurrence of these factors was computed using the statistical package for social sciences (SPSS, version 17). However, the relative percentage of the frequency of the specific factors does not sum up to 100%, because multiple counts of responses of farm households is considered.

RESULT AND DISCUSSIONS

The proximate causes were quantitatively examined as presented in Table 1.1. Hence, it has been found that single proximate causes represented 8.0% of all land cover change cases (The word "case" was used to describe the response of an individual farm household head who took part in the household survey) in Guraferda; whereas 92% are caused by multiple factors or by synergetic factor combination. In particular, agricultural expansion as a single factor represented 6.4%, infrastructure and wood extraction explained 0.8% each.

Table 1.1 Perceptions of Respondents as to the Broad Clusters of Proximate Causes of Land Cover Change in Guraferda

Proximate Causes	**All Cases (N= 264)**		
Single Factor	Count	Relative Percentage	Cumulative Percentage
Agricultural Expansion	17	6.4	6.4
Infrastructural Expansion	2	0.8	7.2
Wood Extraction	2	0.8	8.0
Two Factors			
AGRI—INF	82	31.1	39.1
AGRI—WOOD	61	23.1	62.2
INF-----WOOD	17	6.4	68.6
Three Factor			
All	83	31.4	100.0
Total	264	100,0	

Source: Field Survey (2015)

*AGRI= agricultural expansion, INF= infrastructural expansion, WOOD= wood extraction.

Among the broad cluster of proximate causes, agricultural expansion was the foremost cause of land use/land cover change in Guraferda. Consistent with this findings, Verbist, Putra & Budidarsono (2005); Muller et al. (2011) also reported that agricultural expansion was the main proximate cause of deforestation in the Sumberjaya area of Sumatra and in the Bolivian lowlands respectively.

Table 1.2 Perceptions of Respondents as to the Specific Proximate Causes of Land Cover Change in Guraferda

Specific Factors	**All Cases (N= 264)**	
	Count	**Relative Percentage**
Agricultural Expansion	**243**	**92**
• Small scale subsistence farming	194	73
• Resettlement	172	65
• Commercial (Modern) cultivation	94	36
• Shifting cultivation	5	2
Infrastructural Expansion	**184**	**70**
• Settlement expansion	152	57
• Road transport	131	50
• Duration of house	51	19
Wood Extraction	**163**	**62**
• Fuel wood	141	53
• Charcoal production	128	48
• Wood for house construction	75	28
• Logging	31	12

Source: Field Survey (2015)

Among the specific factors, the share of small scale subsistence farming and resettlement was apparently large. They contributed to land use/land cover changes in three fourth and over two third of all cases respectively. This supports the findings of Houghton (1994) who showed smallholder agriculture as a principal agent of deforestation across the tropics. Over and above, commercial cultivation which was recently introduced in the area through agricultural investment projects also made a considerable contribution to land cover change (in 36%) of all cases. Contrary to the above noteworthy specific causes, shifting cultivation which was the dominant farming tradition of the native inhabitants is now found to be of little or no significance to deforestation on account of the introduction of a new farming tradition (ox plough) by settlers. Hence, shifting cultivation is almost out of picture and entirely replaced by the new extensification land use tradition which is by far the main proximate causes of land use/land cover change as evidenced in the study area.

Infrastructure expansion in tandem with other proximate causes explains 184 out of 264 cases of land cover changes (70%). Both settlement expansion and road transport were found to be more frequently occurred specific factors that caused land cover changes. The construction of motorable road from the administrative center of Bench-Maji Zone (Mizan-Aman town) to its western border, apart from being directly impacting the forest cover, it provided access to movement of people largely

spontaneous settlers and this further amplified land cover change on account of the conversion of a great proportion of forest land to crop land by settlers. The construction of road also caused the establishment of linear pattern settlements along the main road that stretches all the way from east to west for a distance of about 30kms and along other short distance gravel and feeder roads that were constructed for the establishment of resettlement sites. Similar to this finding, Dirzo and Garcia (1992) noted that the construction of railway and highway in the initially well forested area of Sirra de Los Tuxtlas in Mexico promoted the establishment of human settlement engaged in different development activities such as logging or timber trade, plantation, and cattle herding. These human imprints, in turn, have had a negative impact on the original forest of the area.

The two specific proximate factors: settlement and road transport contributed 57% and 50% of all cases respectively. In the same way, duration of farm houses has had some degree of contribution to the causation of land cover change. This was confirmed by about a fifth of all cases. More importantly, years of settlement for most of the sampled farm households (78%, n=264) was apparently short, which is to mean less than ten years. Therefore, contrary to the argument that residence with longer duration had a larger deforested area (Pichon, 1997), short duration in the study area has been found to be associated with more forest land clearing.

Wood extraction in combination with other proximate causes was found to lead to land cover change as confirmed by 163 out of 264 cases (62 percent). Among the specific causes of wood extraction, both fuel wood extraction and charcoal production were found to reveal a more or less similar pattern of occurrence where fuel wood occurs in slightly more than half of all cases. However, the impact of charcoal production was reported by little below a half of all cases. About10 to15 percent of the respondents also reported that fuel wood has been used for lighting that is in conjunction with its use for cooking and heating. Moreover, fuel wood extraction for sale was found to be relatively common among the natives in recent years. Thus, wood extraction mainly for fuel wood and charcoal production and for other similar uses has contributed to land cover change in the area.

Charcoal has been used for heating or cooking or both. Charcoal production for sale was confirmed by 8 percent of the farm households. Furthermore, in terms of other specific factors of wood extraction, wood for constructional purpose contributed well over a fifth of all cases whereas the impact of logging was found to be lower since it has been strictly forbidden by local government authorities in recent years.

Akin to proximate causes, the underlying driving forces are also characterized by combination of causes rather than single factor causation (Table 1.3). Single underlying forces explained about 5 percent of all cases whereas 95 percent were driven by the synergy and combination of more than one factor. Apparently, economic factor was found to be the most dominantly occurred driver of land cover change.

Table 1.3 Perceptions of Respondents as to the Broad Clusters of Underlying Driving Forces of Land Cover Change in Guraferda

Underlying Driving Forces	**All Cases (N= 264)**		
	Count	**Relative Frequency**	**Cumulative Frequency**
Single Factor			
Political	0	0	0
Demographic	4	1.5	1.5
Economic	6	2.3	3.8
Socio-Cultural	2	0.8	4.5
Two Factor			
POL—DEM	10	3.8	8.3
POL—ECO	6	2.3	10.6
POL—SOCUL	5	1.9	12.5
DEM—ECO	18	6.8	19.3
DEM—SOCUL	23	8.7	28.0
ECO—SOCUL	19	7.2	35.2
Three Factor			
POL—DEM—ECO	34	12.9	48.1
POL—ECO—SOCUL	40	15.2	63.3
DEM—ECO—SOCUL	17	6.4	69.7
POL—DEM—SOCUL	14	5.3	75.0
Four Factor			
All	66	25	100.0
Total	264	100.0	

Source: Field Survey (2015)
*POL= political factors, DEM= demographic factors, ECO= economic factors, SOCUL= socio-cultural factors.

In terms of specific factors, the contribution of each subdivision of the broad clusters has been quantitatively analyzed as shown in (Table 1.4). Economic factor in tandem with other underlying forces represented 206 out of 264 cases (78%). Increase in the price of the dominant food crops as well as other crops in the study area might have encouraged farm households to expand their cropland through clearing forest cover, particularly for the cultivation of rice and other cereal crops. Prices of the dominant crops of the area (rice and maize) skyrocketed in recent years. The price of these principal crops has grown by well over tenfold compared to their price before a decade. Thus increase in the price of crops as a specific factor underlie land cover change as confirmed by well over two third of all cases. Similarly, improved access to market (the mean distance of the nearest market place is 6.3 km) was found to be important specific factor underlying land cover change by over half of all cases. Increase in the price of crops and good access to market for the most part contributed to an increase in the annual income of farm households. And it was found to explain 38 percent of all cases.

Table 1.4 Perceptions of Respondents as to the Specific Underlying Driving Forces of Land Cover Change in Guraferda

Drivers	All Cases (N=264)	
	Count	**Relative Frequency**
Political	**175**	**66**
• Corruption	101	38
• Weak institutional performance	76	29
• Insecure tenure	88	33
Demographic	**186**	**70**
• Population increase (natural)	162	61
• Population increase (in-migration	164	62
• Population density	48	18
Economic	**206**	**78**
• Increased access to market	138	52
• Increased in crop price	180	68
• Increased in annual income	100	38
Socio-Cultural	**186**	**70**
• Change in public attitude	160	61
• Extensification	132	50
• Religion	88	33

Source: Field Survey (2015)

Political/institutional factors were found to be underlying drivers of land use/land cover change accounted for about 175 out of 264 (66 percent) of all cases. This broad category was subdivided in to corruption, insecure tenure, and weak institutional performance which were indirectly associated with land use/land cover change accounting for about 38%, 33%, and 29% of all cases respectively. Corruption (illegal acts committed by *kebele* and district officials during land grant) was also voiced during focus group discussion. Although this analysis has been framed on a descriptive statistics, it supports a cross-country research works of Koyuncu and Yilmaz (2009). These studies indicated that there is a statistically significant and strong positive relationship between corruption and deforestation.

For all intents and purposes, spontaneous settlers, especially those arrived since 2000, did not have land title or legal use right up until 2013. Moreover, there has been eviction of thousands of unreregulated settlers, especially those who arrived there after 2003/04 for their illegal act of settling in the forest areas and cleared a considerable portion of the forest cover (however, there have been dearth of reliable empirical evidence as to the extent of deforestation, often determined by preconceived notions) for crop cultivation without having a permission from the *kebele* and district government officials (as contended by the zone government officials). Above and beyond, the current land redistribution and tenure certification program have shrunk the size of farm plots of a good number of earlier arrivals. Hence, all these have aggravated the sense of tenure insecurity.

Socio-cultural factors, an important underlying driving forces of land use/land cover change, represented 186 out of 264 (70%) of all cases. Among the specific factors, change in public attitude is the most frequently occurred underlying driving

forces of land cover change as confirmed by slightly more than three fifth of all cases. Public attitude can be conceptualized as showing concern or regard that a land manger has towards resource. The place of origin of the overwhelming majority of non-native and resettled farm households is northern, central and south central Ethiopia where forest degradation was so common. Therefore, such little or meager forest environment at the place of origin might have undermined their concern to forest. On the whole, settlers limited earlier exposure to dense forest environment coupled with the prevalence of corruption and weak institutional performance at the time of hosting the spontaneous setters, settlers' expansive farming tradition and ignorance of their activities on the environment have aggravated deforestation in the study area.

Extensification in Guraferda district is a new land use type or farming system. It was introduced by spontaneous settlers. Extensification, which involved clearing of a wide area of vegetation to cropland, was widely practiced in the study area. To date, it has almost replaced the traditional shifting cultivation of the native inhabitants. In Guraferda, extensification due to land abundance was evident where the mean farm land size was 3.6 hectares. It has been identified that in about half of all cases there is extensification derived land cover change.

Dealing with faith, religion has not been reported as a driver of tropical deforestation by Geist and Lambin (2002). Nevertheless, a different situation has been observed in the study area, particularly among the natives. The dominant belief among the natives for generation was a traditional belief, animism, which they call it "wukabi" and which is preeminently central to conservation value. It is said that forests are reputed for ritual and cultural value, source of livelihood, source of streams and attract rainfall.

On the contrary, result from household survey and focus group discussion with the natives confirmed that the majority of the natives (73%) forsook this traditional belief on account of the introduction of protestant Christian religion since 1997. In other words, the breakdown of traditional belief and associated habitat taboos was largely attributed to a shift in the belief system where the overwhelming majority of the natives have been converted to protestant Christianity. Hence, they forsook and relinquished this traditional belief. Besides to the introduction of protestant Christianity; immigration, infrastructural development (mainly extension of motorable roads), resettlement schemes contributed to the fading away of the traditional beliefs and rituals that were central to resource conservation in the past. Religion as a specific factor indirectly associated with land cover change in about a third of all cases.

Demographic factors were identified to underlie 186 out of 264 (70%) of all cases of land cover change, that is in conjunction with other underlying forces. Among the specific factors, population increase was identified to be the most important underlying driver of land cover change as reported by 62% of all cases. Apparently, the current population of the study area is estimated at 50 to 60 thousand, roughly twofold increase over the 2007 population. This rapid increase was due to natural population increase as well as migration (Government sponsored resettlement program and spontaneous settlers). Population pressure has led to clearing of the forests for cropland expansion, founding settlement, for charcoal production, and fuel wood consumption. Thus, substantial population increase over the last two decades is responsible for land use and land cover

change in the study area. This finding reinforces the research result of Tsehaye and Mohammed (2013). They reported that population pressure was one of the underlying drivers of land use and land cover change in Northern Ethiopia.

CONCLUSION

The main objective of this study was to quantitatively identify and address the patterns in the direct causes and underlying driving forces of land cover change at household level. The quantitative explanation noted above borne out that land cover change in Guraferda were driven by a combination of proximate and underlying causes. Agricultural expansion (small scale farming), wood extraction for fuel wood consumption, and expansion of rural settlement were among the major proximate causes. Likewise, major underlying forces include population pressure, corruption, insecure tenure, access to market, and change in public attitude. However, the prominent drivers of land cover change as described by farmers were agricultural expansion and economic factors that is in terms of access to market, price of food crops, and farm households' annual income. Notwithstanding cross-sectional household survey, focus group discussion, and analytical framework were integrated to quantify drivers, future study should mull over a more comprehensive longitudinal datasets and improved analytical framework and advanced statistical models to make the quantitative result more robust.

Most importantly, evidence from data analysis suggested that land cover changes were driven by multitude of driving forces that operate in a synergetic way. In other words, no single factor can contributed for the changes to occur in the study area. Thus, factors driving land cover change are always attributed to the complex interaction between proximate causes and underlying driving forces. Hence, knowledge and understanding drivers of land cover change as caused by a combination of diverse proximate and underlying forces play an essential role in the implementation of sound land use policy. Moreover, empirical evidence on the drivers of land cover change provides a means to uphold sustainable rural development in the study area and beyond.

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