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Changes in community perspectives on the roles and rules of church forests in northern Ethiopia: evidence from a panel survey of four Ethiopian Orthodox communities

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Abstract: Some of the only Afromontane forest in northern Ethiopia today is on lands managed by followers of the Ethiopian Orthodox Church, where for centuries priests and communities have conserved forest groves around church buildings. The ecological value of the thousands of church forests in Ethiopia has been widely acknowledged, but little is known about the diverse local institutions that govern these resources, or how such institutions might be changing in response to Ethiopia's rapid recent economic development. This study uses a unique panel survey to explore changes in community perspectives on the social and ecological roles of church forests, and rules governing church forest use, in four Orthodox communities over time. Our sample consists of 122 household surveys conducted in 2002 and a further 122 surveys from 2014, with 71 households interviewed in both periods. We find that reported uses of church forests vary across forests and

over time, with larger forests more likely to be used for extractive purposes such as firewood and construction timber, while smaller forests have become more restricted to renewable or non-extractive uses such as natural medicines, honey, and prayer. Results of logistic regression suggest church followers' support for preserving church forests increases with age and access to alternative sources of firewood – including exotic *Eucalyptus spp.* plantations which are increasingly widespread in northern Ethiopia. We also observe a shift since 2002 away from an expectation that church followers themselves hold responsibility for rule enforcement in church forests to a perceived sharing of responsibility by church authorities (i.e. priests) and government (i.e. police) in 2014. Together the progressive introduction of exotic tree species in church forests combined with the erosion of religious norms surrounding local forest governance may threaten the integrity and diversity of these unique social-ecological systems.

Keywords: Church forests, community forest management, Ethiopia, institutional diversity, land use, religious conservation, remnant forest patches

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I. Introduction

Forests conserved by communities due to their perceived religious or spiritual significance are found worldwide, and may represent the oldest form of protected areas management (Sheridan and Nyamweru 2008; Dudley et al. 2009). In addition to providing spaces for prayer, existence values, and other cultural services (Millennium Ecosystem Assessment 2005), sacred natural sites also provide an array of ecosystem services, including water filtration, reducing soil erosion (Bodin et al. 2006; Ormsby and Ismail 2015; LoTempio et al. 2016), and serving as repositories of plant and animal biodiversity (Mgumia and Oba 2002; Baker et al. 2014). Sacred natural sites may also provide economic benefits in the form of fuel, construction wood, food, fodder or other goods, with access to such benefits subject to resource availability, and subject to local rules and norms surrounding the sacred space (Rutte 2011).

The type and extent of benefits provided by a sacred natural site depend in part upon the physical characteristics of the site itself. Some religiously-conserved forests cover vast landscapes – in Japan, Shinto and Buddhist shrine forests cover over 110,000 ha (Verschuuren et al. 2010), in India there are over 100,000 sacred groves (Bhagwat and Rutte 2006), and Tibetan sacred mountains cover

entire watersheds, offering a wealth of cultural and ecosystem benefits (Salick et al. 2007). Other sacred natural sites consist of smaller patches of forest scattered across large multipurpose (often agricultural) landscapes (Verschuuren et al. 2010) – examples include the roughly 600 sacred groves in Tanzania (Strauch et al. 2016), the more than 1400 sacred forests in Ghana (Bossart and Antwi 2016), and the thousands of “church forests” in northern Ethiopia (Wassie 2002; Wassie et al. 2005a; Meire et al. 2013; Reynolds et al. 2015; Tilahun et al. 2015; Aerts et al. 2016). Particularly in sacred natural sites systems where the forested area is relatively small and the number of people seeking benefits is large, the long-term viability of the social-ecological system is reliant upon the governance rules in place, and the degree to which resource users understand and adhere to those rules (Ostrom 1990, 2005; Janssen and Anderies 2007).

This paper contributes to the literature on sacred natural sites and social-ecological systems more broadly by exploring the diversity of institutional rules and community perspectives on those rules in four Ethiopian Orthodox church communities over time. The Ethiopian Orthodox Tewahido Church is one of the oldest Christian churches in the world, with some of the earliest church buildings dating to 300 A.D. (Wassie 2002). For centuries followers of the Ethiopian Orthodox Church have conserved patches of native trees around church buildings as sacred sanctuaries for church communities. Today there are reportedly more than 35,000 Orthodox communities in Ethiopia (Wassie et al. 2009), with remote sensing analyses by Aerts et al. (2016) estimating as many as 19,400 church forests in the Ethiopian highlands, with a total area of 39,000–57,000 ha. A recent inventory using high-resolution satellite imagery revealed more than 8000 church forests in the Amhara Region alone, ranging from <1 ha to over 100 ha in size (Reynolds et al. 2015, 2017).

From an ecological perspective, church forests represent invaluable repositories of native species biodiversity (Aynekulu et al. 2016). Less than 5% of Ethiopia is covered with dry Afromontane forest, the natural vegetation that would be expected based on ecological conditions (Darbyshire et al. 2003; Friis et al. 2010). Over the past century firewood demand, agricultural expansion, livestock grazing – compounded by political volatility and insecure land tenure (Hoben 1995; Teka et al. 2013) as well as droughts, fires, and climate change – have continued to put pressure on native forests and inhibited natural regeneration (Bongers et al. 2006; Alem et al. 2010; Nyssen et al. 2014). As a result, much of the intact natural forest in Ethiopia’s highlands today is restricted to the church forests scattered across the degraded agricultural land (Aerts et al. 2006, 2016; Cardelús et al. 2013; Reynolds et al. 2015).

Some believe church forests are centuries-old remnant forests, offering glimpses of what the long-depleted Afromontane forests around each church community might have once looked like (Aerts et al. 2016). Others question whether or how closely church forests actually represent the original forests of northern Ethiopia (e.g. McCann 1997; Bingelli et al. 2002; Meire et al. 2013), since studies of pollen records show forests in the region have been influenced by human

activity for over 3000 years, with repeated cycles of afforestation and deforestation (Eshetu and Hogberg 2000; Darbyshire et al. 2003; Sertse et al. 2011). But regardless of the history of church forest establishment, or whether church forests are remnants of native forest, natural regeneration of secondary forest, or even the result of human cultivation (i.e. “garden forests”), there is broad agreement that these forests now constitute unique ecosystems on the Ethiopian landscape (Cardelús et al. 2012; Aerts et al. 2016; Reynolds et al. 2017). Surveys of a small sample of 28 church forests by Wassie et al. (2010) revealed 168 woody species – including 160 indigenous to Ethiopia. Ongoing research further suggests church forests harbor potentially vast mammalian, bird, and insect biodiversity (Aerts et al. 2008; Ermilov et al. 2012; Girmay et al. 2015) and provide pollination and hydrological services for farmland (Lowman 2011; LoTempio et al. 2016), in addition to serving as seed banks for plants that have otherwise vanished from the region (Aerts et al. 2006).

Church forests are not ecological preserves, however. Rather, they are complex social-ecological systems that have provided a variety of cultural, ecological, and economic benefits for churches and surrounding communities for centuries (Wassie et al. 2010; Reynolds et al. 2017). In other words, the church forests of Ethiopia are not only valuable cultural and ecological resources, but they also represent a unique and longstanding conservation institution in the midst of a dynamic agrarian landscape (Berhane et al. 2013; Cardelús et al. 2013; Aerts et al. 2016; Klepeis et al. 2016; Scull et al. 2016). Many studies in other sacred natural sites in Sub Saharan Africa have indicated that such dispersed religion-based resource governance institutions can be more effective for ensuring the long-term viability of natural forests than more centralized state institutions (see Strauch et al. (2016) for a review). Other work, however, suggests even long-established sacred natural sites may be vulnerable to collapse in the face of large environmental or economic shifts. In Kirinyaga, Kenya, sacred groves that for centuries symbolized cultural cohesion declined rapidly in the late 1900s in the face of growing socioeconomic divides in the rapidly developing community (Castro et al. 1990). In India’s Western Ghats the British colonial era led to the state taking over many once-sacred forests (Nagendra and Gokhale 2008). And in a recent study of non-Orthodox sacred natural sites in southern Ethiopia, Daye and Healey (2015) found that although sacred forests have remained largely intact over time, some sacred forests have lost area over the past two decades – driven by a combination of grazing pressures, climate change, and the erosion of traditional cultural values further undermining sacred forests’ protection. Ultimately, while church rules have long protected Ethiopian Orthodox church forests in northern Ethiopia, there is rising concern about the continued resilience of these and other sacred natural sites governance systems (Verschuuren et al. 2010; Cardelús et al. 2012).

After having been seemingly stable for centuries, church forests have been visibly affected in recent decades by encroachment of adjacent farms, livestock grazing, unsanctioned harvest of forest products (Woods et al. 2017), and sanctioned expansion of grave shelters (Klepeis et al. 2016), as well as planting of

non-indigenous tree species such as *Eucalyptus spp.* (Liang et al. 2016). As part of an effort to understand the social and ecological context of church forest pressures, Wassie (2002) undertook an initial descriptive study in 2002 that included a survey of household attitudes and behaviors among members of church communities surrounding four forests. The original survey purpose was to describe household motivations for use and protection of the church forests. In 2014, we had an opportunity to repeat the household survey in the same communities in the context of a larger study on church forest institutional and ecological dynamics. Although the initial household survey was not designed to measure changes over time, and was not specifically intended to test Ostrom's ideas about common-pool resources or social-ecological systems, the repeated measure of community behavior with respect to church forests and perceptions of governance institutions offers a rich look at the dynamics of actor views about sacred natural site resources and rules.

We asked the following research questions:

- How do community members perceive and interact with church forest resources?
- How have community perspectives on church forest roles and rules changed from 2002 to 2014, and how have these changes varied across social-ecological contexts?
- How do system “disturbances” such as expanding access to markets and infrastructure affect pressures on church forests and attitudes about church forest conservation?
- What other demographic and attitudinal variables predict support for church forest conservation across communities and over time?

The paper is structured as follows: Section 2 presents the theoretical framework for our study. Section 3 describes our empirical methods, which include original panel survey data from two waves of a household survey (first administered in 2002, and then again in 2014) on attitudes and behaviors toward church forests in four church forest communities in the Amhara Region in Ethiopia's northern highlands. Section 4 presents our survey data analysis, including binary logistic regression models predicting respondent perceptions of church forest degradation, attitudes towards forest resource extraction, willingness to enforce church forest rules, and preferences surrounding church forest tree species composition over time. Section 5 discusses the implications of our findings for sacred natural sites and broader conservation efforts, and Section 6 concludes.

2. Theoretical framework

Ostrom (1990, 2005) proposed a set of institutional design principles that describe system conditions likely to foster successful self-organization in common-pool

resource (CPR) systems. These included: (i) clearly defined boundaries; (ii) congruence between rules and local conditions; (iii) channels for participation by resource-users in rule-making; (iv) graduated sanctions for rule-breaking; (v) monitoring capacity; and (vi) conflict resolution mechanisms.¹ These principles provide a good diagnostic starting point for the study of complex social-ecological systems, but as Baggio et al. (2016) note, they are quite general and the presence or absence of individual design principles says little about CPR success or failure. Instead, the interplay between design principles and other technological and ecological infrastructure may be more important in understanding CPR systems dynamics and success. Ostrom and Cox (2010) further suggest design principles can lead to overly simplistic responses – panaceas – that are not necessarily appropriate for local conditions. They stress the importance of recognizing institutional diversity, noting that in their studies of forest institutions around the world, “...it is not the general type of forest governance that is crucial in explaining forest conditions; rather, it is how a particular governance arrangement fits the local ecology and social context, how specific rules are developed and adapted over time, and whether users consider the system to be legitimate and equitable” (Ostrom and Cox 2010, 454). Thus successful institutions can vary both in rulemaking processes (who gets to make rules about resource use), as well as in resource use rules themselves (what uses are permitted, and what sanctions imposed for infractions), depending on local social and ecological conditions. While the ecological diversity of church forests in Ethiopia has received much attention, the institutions governing church forest access and use remain poorly understood. This study begins to fill the gap by examining how church forest governance institutions vary across different church communities, how local church followers perceive the legitimacy of church forest rules, and how those rules and perceptions can change over time.

A social-ecological systems (SES) perspective shifts the focus of analysis from static description of system characteristics to the interactions that govern the way a system responds to disturbances (Anderies et al. 2004; Anderies and Janssen 2011). Ostrom and Cox (2010) suggest using the SES framework (revised form described in McGinnis and Ostrom 2014) together with Schoon and Cox’s (2012) typology of SES disturbance to better examine SES dynamics. The SES framework links resource systems, resource units, governance systems and actors through “action situations.” The characteristics and conditions of resources and rules in the governance systems mediate the interaction of actors with resources. Actors interact with resources based on rules and these interactions have outcomes that feed back to affect resource systems, resource units, governance systems and actors. Thus, interactions between church community members (actors) and church forest resources (resource systems and units) are mediated by church and state rules (governance systems). Disturbances to the system can affect these

¹ See Ormsby and Edelman (2010) for another application of these principles to sacred forests in Ghana.

interactions in ways that the system can absorb, or can push the system to a different, possibly unsustainable state.² Since the effectiveness of local institutions for conserving church forests is also a function of the level of stakeholder understanding of the resource system and stakeholder adherence to institutional rules, examining stakeholder perspectives on church forests and rules – and how perspectives change – is an important part of understanding threats to these unique sacred natural sites.

2.1. Rules and rulemaking in Ethiopian Orthodox church forests

To Ethiopian Orthodox church followers, church forests are holy sanctuaries, offering space for religious and social gathering and prayer (Wassie et al. 2005a). The forests are considered sacred spaces, with the trees symbolic of angels guarding the church. The trees themselves are not seen as sacred, but the space and benefits the forests provide are considered to be in service to the church and to God (Wassie et al. 2010). Followers believe that to harm the church forest is to deny the presence of God, and that people who dishonor the forest will suffer serious consequences (Tilahun et al. 2015). But church forests also provide a variety of material benefits to local communities in the form of fresh water, food and medicinal plants, and in some cases firewood and construction timber (Aerts et al. 2016; Klepeis et al. 2016; Liang et al. 2016). Wood from church forests is traditionally used for construction and repair of church buildings, and deadwood, seedlings, fodder, or honey are often sold to church followers to generate income for the church (Bongers et al. 2006). In many communities church followers are buried in the church forests, and church members may clear trees to build shelters around graves (Klepeis et al. 2016). Church students regularly live in these grave shelters or elsewhere in the forest, and may draw from the forest subsistence goods including firewood and wild fruits (Wassie 2007).

Some of the rules governing community members' access to and use of the church grounds have been determined for centuries by church doctrine and thus are largely consistent across all Ethiopian Orthodox communities. Prohibitions on women entering certain church buildings, for example, and the use of different access points for men versus women for prayer, are more-or-less universal. But many rules for use of the church forest are not dictated by church doctrine, but rather are determined locally, by a committee led by local priests (Wassie 2007). Although there is a general belief among Ethiopian Orthodox church followers that church forest resources should not be used for personal benefit – i.e. that forest resources should only be used to benefit the church – local rules developed and enforced by priests may vary. The church committee determines who can harvest fruits, seeds, and firewood, and the circumstances under which trees can

² Schoon and Cox's (2012, 144) typology of disturbance identifies four main types of disturbance: flow (fluctuations in flow into or out of an SES), parameter (fluctuation in a parameter that affects an SES), network (a change in the internal structure of the SES), and connectivity (change in the connections between the SES and the external environment).

be harvested or land cleared. The committee also determines the consequences for violating rules, which can range from a public apology, to monetary fines, or even formal alienation from the church through a process called *gizet* (Wassie et al. 2010). Church forests thus represent a kind of quasi-common property resource: a church forest is not necessarily owned by local priests or by church followers (indeed the legal status of church forests remains largely ambiguous in Ethiopian law (Eshetu 2014; Bekele et al. 2015)), but all members benefit from the forest's good management, and the local church leadership benefits by being able to offer a stream of forest benefits to its members over time.

Given these localized rulemaking processes, combined with the diverse ecological, economic, and institutional contexts in which the thousands of geographically dispersed church forests' governance rules have developed, we would expect to find differences in church forest rules across different sites (Ostrom 1990, 2005). Indeed the limited literature on church forest institutions suggests that such institutional diversity may be substantial. In some churches relatively strict preservation is practiced, with guards and fences excluding trespassers and livestock, and entry into the forests only permitted for church followers attending religious services (Bongers et al. 2006). Other church forests serve as multipurpose religious and agro-forestry sites, with native and exotic fruit trees grown within the church grounds, or native coffee trees (*Coffea arabica*) in the understory of the forest, providing income streams for priests, religious teachers, deacons, and other church followers (Aerts et al. 2016). Elsewhere, with rising populations and incomes some communities have actively cleared forested land to construct larger church buildings or expand burial sites (Klepeis et al. 2016) – variations on ancient traditions that now often exceed forests' regenerative capacity (as has been observed in other sacred natural sites (Ormsby and Ismail 2015)). In other church forests shifts in economic incentives and cultural norms have led communities to plant exotic cash crop trees such as *Eucalyptus spp.* (Liang et al. 2016). Planting *Eucalyptus spp.* provides firewood, construction wood and income for the church, though it raises concerns among conservationists as it can reduce native species diversity as compared to the traditional practice of nurturing native tree seedlings (Bongers et al. 2006).³

The study reported in this paper is part of a larger research project examining the relationships between changing environmental conditions in northern Ethiopia and the roles of institutional diversity – including church forest institutions – in allowing local agrarian communities to adapt to those changes. Ostrom's (1990, 2005) design principles indicate that successful localized natural resource governance institutions will tend to be aligned with the local context of resource users.

³ *Eucalyptus spp.*, which was introduced to Ethiopia in the late 19th century to satisfy firewood and construction demand in the capital city, is a fast-growing species, adaptable to marginal environments. It is easy to establish and can regrow even with frequent coppicing. Its high productivity makes it economically appealing, but it is also criticized for environmental harms, including high water use, soil nutrient depletion, and allelopathic effects on agricultural land (Liang et al. 2016).

But given that both the social context (in the face of rapid economic development) and the local environmental conditions (in the face of climate change) in northern Ethiopia are highly dynamic (Karlberg et al. 2015; Stave et al. In press), successful governance institutions may need to adapt themselves to this changing context. Since the effectiveness of institutional rules also depends upon adherence to those rules by resource users – in this case, by church community members – this study focuses on exploring changes in community perspectives on the roles and rules of church forests.

3. Materials and methods

3.1. Study area

The research was conducted in 2002 and 2014 in the South Gondar Administrative Zone, in the Amhara People's National Regional State (Figure 1). The Amhara Region is in northwestern Ethiopia ($9^{\circ}20'–14^{\circ}20'N$ and $36^{\circ}20'–40^{\circ}20'E$), and covers approximately 170,000 km², including most of Ethiopia's plateaus above 1500 m – the Ethiopian northern highlands, where most of the region's population is concentrated. The region is divided into 11 zones, 140 *woredas*

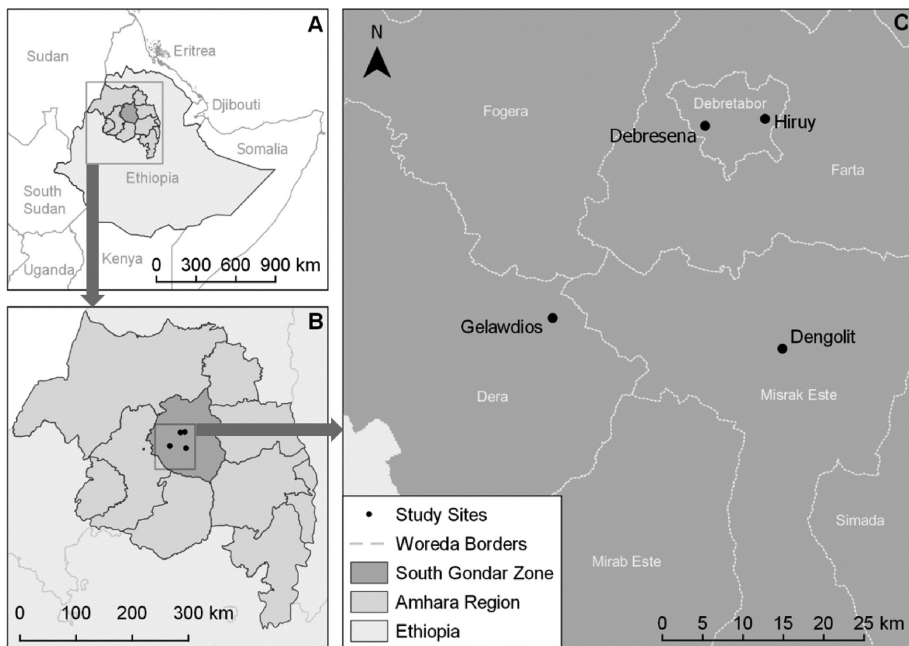


Figure 1: Map of church forest study sites in South Gondar, Ethiopia. (A) The Amhara Peoples National Regional State in Ethiopia. (B) The South Gondar Zone in the Amhara Region. (C) Study sites in the South Gondar Zone.

(an administrative unit roughly equivalent to a county), and 3429 *kebeles* (the smallest administrative unit in Ethiopia, roughly equivalent to a town or village administration).

The study was carried out in four *kebeles*, at four church forests in the Amhara Region (Table 1). The four church communities were sampled purposively from across the South Gondar Administrative Zone to explore possible variation in church forest institutional structures and community attitudes across different ecological, political and social contexts. The four selected church forests vary widely in size and composition, ranging from only 4.4 ha of mixed native and exotic trees at the small Hiruy church forest, to over 70 ha of natural forest at the large Gelawdios church forest.

In each location, the church forest manager was approached for permission to conduct research in the community; permission was also obtained from the *woreda*- and zonal-level church offices. These meetings also allowed us to collect information on church community characteristics, land use trends in and around church forests, and priests' anecdotal perspectives on changes in forests and community norms over time. These interviews with church managers in both 2002 and 2014 reveal substantial variation in socioeconomic and institutional characteristics across sites (Box 1).

To examine community member perceptions of the roles and rules of church forests, 21–40 households (representing at least 5% of the households that were members of the local church) were randomly selected from each site in 2002 from a complete list of church households to participate in a survey. In 2014 these same church communities – and most of the same households – were revisited.

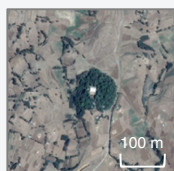
3.2. Survey data collection

Household survey data were collected in two waves, with 122 household surveys completed in 2002, and 122 surveys in 2014, for a total of 244 surveys completed at the four church forest sites. Seventy-one households were interviewed in both time periods (providing a panel sample). These data thus allow us to observe changes in aggregate community attitudes towards church forests over the past

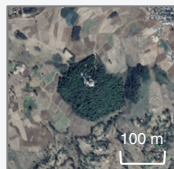
Table 1: Summary of church forest characteristics.

Church name	Location ^a	Area (ha)	Perimeter (m)	Elevation (m) ^a	Proximity to paved road (km)	Year established
Hiruy	N11°51' E38°03'	4.4	763	2611	1.8	360
Debresena	N11°51' E37°59'	11.8	1382	2690	1.4	~1500
Dengolit	N11°36' E38°04'	20.5	2197	2500	33.4	~1300
Gelawdios	N11°38' E37°48'	70.2	5560	2549	42.8	~1500

^aWe recorded forest elevation and geographic coordinates using handheld Global Positioning System (GPS) units, and calculated forest area (ha), perimeter (m) and proximity to paved roads (km) using Google Earth Pro and QGIS version 2.0.1. Actual church landholdings may differ substantially from forested area, as not all church land is church forest.

Box 1: Case study church forests in South Gondar, Ethiopia*Hiruy Kidus Giorgis*

Hiruy Kidus Giorgis (*Hiruy*) was built in the year 360 (Ethiopian calendar) in the name of St. George. The oldest and also the smallest church in the sample, Hiruy is in Farta Woreda, at an altitude of 2611 m. The church had 350 household members in 2002 and the same in 2014. The natural forest covers 4 ha, and is protected by a stone wall. An additional 0.4 ha at the edge of the church forest has been planted to *Eucalyptus spp.* The church is known for its honey – bees make honey on the window of the church; it is believed to be medicinal.

*Debresena Kidist Mariam*

Debresena Kidist Mariam (*Debresena*) was built in the 16th century in the name of St. Mary, and is in the Special Woreda of Debre Tabor (formerly Farta Woreda, but Debre Tabor has become a major urban center and now has its own local government). In 2002 Debresena reported 300 household members; this dropped to 250 in 2014 owing to the construction of another church nearby. At an altitude of 2690 m, the indigenous forest area is 11 ha. Small stands of *Eucalyptus spp.* are planted on the boundaries, including plantations owned by the church.

*Dengolit Debre Medalhu Kidist Mariam*

Dengolit Debre Medalhu Kidist Mariam (*Dengolit*) was built in 1300 (Ethiopian Calendar) in the name of St. Mary. It is in Estie Woreda at an altitude of 2500 m. The church had 400 household members in 2002 and the same number in 2014. The natural forest covers 25 ha, but church leaders report it has been highly encroached upon by the local community. According to local church scholars there are two sections of the forest: an inner section near the church (demarcated by a stone fence) that is forbidden for animals, while in the outer section animals are allowed in the shade (and consequently grazing is common). A *Eucalyptus spp.* woodlot was established on church-controlled land in the 1990s; church leaders claim this was in part to compensate for forestland that had been lost through encroachment.

*Mekane Semayat Kidus Gelawdiwos*

Mekane Semayat Kidus Gelawdiwos (*Gelawdiwos*) was built in 1500 (Ethiopian Calendar) in the name of St. Claudius. It is in Dera Woreda at an altitude of 2549 m. The church had 800 members in 2002 but had lost 120 to a new church by 2014. The main church is some 300 meters south of the edge of the forest, and a sub-parish has been built on the edge of the forest. The natural forest area comprises more than 70 ha. There is a holy spring blessed by the church. The local community regularly allows cattle in the forest for shade and sometimes sanctioned grazing. A major road has been cut through the center of the church forest, effectively dividing the forest in two halves – this new access has led to more grazing and wood extraction along the road. Bees produce honey at the gate of the church; the honey is believed to be medicinal.

decade, as well as changes in individual responses between the 2002 and 2014 surveys.

Survey instruments collected information on respondent perceptions of the roles and rules of church forests, i.e. the cultural, ecological, and economic functions of church forests in each community, and the formal and informal rules governing church forest use and conservation. The 2002 and 2014 surveys were delivered orally, by enumerators working under the supervision of the same Principal Investigator for both survey waves. Interviewers read the questions and responses in the local language, only providing clarification if the questions were

not understood. Interviews were conducted in the respondent's home or compound as a private one-on-one conversation with the interviewer.

The 2002 survey consisted of 44 questions. Six were general geographical questions (e.g. the respondent's place of residence) and six collected household data including sex, age, occupation, and educational status. The remaining 32 questions focused on respondent knowledge and attitudes surrounding church forests, including five questions about trends in church forest cover over time, four questions about the purpose of the church forest, four on benefits obtained from the church forest, five on church forest management rules, eight regarding general natural resource governance and changes in local forest resources, three regarding forests elsewhere, and eight regarding specific church forest conservation strategies. Questions were multiple choice with an "other" response option which was coded after data collection was complete.

In 2014, we successfully contacted 71 of the original 122 respondents from the 2002 survey who were still in their respective church communities, and sought their permission to be interviewed again. All 71 agreed. In the event that the original 2002 respondent was no longer in the community, he or she was replaced with another community member. If the original respondent had passed away, moved to another community, or was otherwise unavailable for interviewing in the 2014 survey round, but the original household remained, the new head of the household became the new respondent. If the 2002 household was no longer in the community, the nearest household that had not already responded to the survey was asked to participate. The 2014 survey consisted of 58 questions, including all 44 questions asked in 2002 (in the same order and exact phrasing) as well as 14 new questions including whether the respondent had participated in the 2002 survey, and additional asset and resource questions surrounding land ownership, fuel wood use, and other forest product uses.

Characteristics of the 2002 and 2014 samples are summarized in Table 2.

3.3. Data analysis

The outcome variables of interest were responses to a series of perception- and attitude-related survey questions asking respondents about local environmental conditions, rules surrounding church forest access and use, sanctions for rule-breaking (and monitoring to enforce those sanctions), and preferred church forest management strategies including tree-planting preferences. Specific questions included: (i) respondents' perception of the ecological condition of their church forest and other natural forests in their area; (ii) church forest uses that respondents felt were permitted in their community, and the benefits (economic and spiritual) they felt the church forest should provide; (iii) how respondents would respond if they observed someone breaking church forest rules (e.g. cutting trees), and what authorities (religious, state, or some combination) should be responsible for protecting the church forests; and (iv) what tree species (native versus exotic) they felt should be planted in their church forest.

Table 2: Summary of church forest community respondent and household characteristics.

	Hiruy		Debresena		Dengolit		Gelawdios	
	2002	2014	2002	2014	2002	2014	2002	2014
Male	52%	49%	93%	77%	81%	88%	68%	63%
Farmer	95%	91%	100%	100%	97%	100%	85%	80%
Age								
Under 20	14%	0%	0%	0%	0%	0%	8%	0%
20–39	29%	39%	40%	13%	65%	19%	40%	35%
40–60	38%	52%	37%	67%	26%	68%	33%	48%
Over 60	19%	9%	23%	20%	10%	13%	20%	18%
Literacy	33%	17%	43%	27%	48%	45%	45%	33%
Own woodlot	62%	52%	60%	63%	53%	55%	56%	43%
Own land	–	78%	–	97%	–	94%	–	85%
Mean land size (ha) ^a	–	1.26	–	0.88	–	1.15	–	0.71
Mean cropland (ha) ^a	–	0.74	–	0.78	–	0.95	–	0.69
Mean woodlot (ha) ^a	–	0.18	–	0.05	–	0.14	–	0.10
Mean pasture (ha) ^a	–	0.30	–	0.08	–	0.18	–	0.07
Number of respondents	21	21	30	30	31	31	40	40

^aDetailed land ownership data were collected in 2014; these variables are not available for the 2002 sample.

As predictors of these perspectives and attitudes, the demographic variables gender, age, and education were collected directly on the household survey; we hypothesized that male, older, and more educated respondents would more strongly support church forest conservation and favor native species over exotic species (in part because women are primarily responsible for firewood collection across the study area (Scheurlen 2015), and because younger and less educated respondents might be more likely to see church forests as a source of income that *Eucalyptus spp.* might better provide). Questions about access to markets and personal woodlots for obtaining firewood and construction wood were also asked directly on the survey, with both hypothesized to be associated with stronger conservation attitudes (by providing alternatives to church forest tree harvesting). Finally, a proxy for relative household income was calculated based on the self-reported landholdings of each survey respondent, including the landless (Figure 2). We hypothesized that households with more access to land and other income-generating resources would show stronger support for church forest conservation (and, inversely, less demand for extractive benefits from the church forest).

All data obtained at the household and community levels were analyzed across the four church forest sites using descriptive statistics and tests of significance in Stata 13.0. The dependent variables – attitudes towards church forests and behaviors involving church forests – were furthermore regressed on demographic and socioeconomic variables (sex, age, education, farm size, woodlot and market access) using logistic regression models controlling for community-level fixed effects to examine factors associated with current church forest-related perspectives.

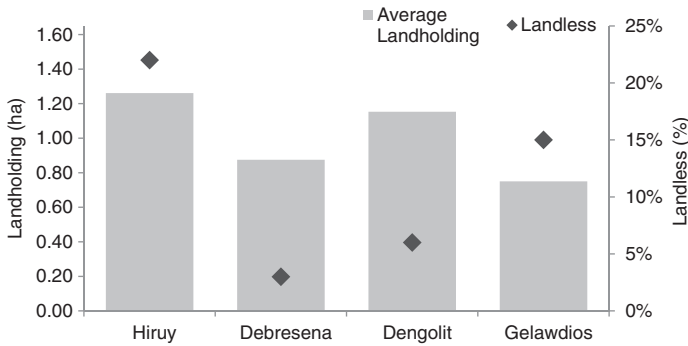


Figure 2: Landholding and landlessness across farm communities surrounding four church forest sites.

Changes in responses to survey questions between the 2002 survey and the 2014 survey rounds were compared using paired t-tests, related tests of variance, and logistic regression models with church and year fixed effects and household-level clustering. Again the dependent variables – in this case changes in attitudes towards church forests over time – were regressed on socioeconomic variables to examine potential determinants of these changes. These quantitative findings were interpreted in the context of key informant interviews with church managers and community leaders.

4. Results

4.1. Community perspectives on natural forest status and trends

In all four church communities the church forest itself is currently the single largest area of native forest present, with little or no other natural forest cover nearby (Box 1). When asked if the natural forest cover in their area had changed in recent years, respondent impressions diverged, sometimes even within the same church community. In 2002, nearly 83% of respondents reported that natural forest in their area had declined in their memory: over 90% of 2002 respondents at Debresena and Dengolit said that natural forest cover had decreased. However roughly 25% at the smallest church forest (Hiruy) and 25% at the largest church forest (Gelawdios) said that natural forest area had remained unchanged or even increased. By 2014 the differences in impressions about natural forest cover were even more pronounced: only 64% of the total 2014 sample felt that natural forest had decreased in recent years. Fully half of respondents from the two larger church forests – 49% from Dengolit and 55% from Gelawdios – reported that natural forest in their area was either constant or increasing, while the remainder reported natural forest was decreasing.

When respondents who thought natural forests were decreasing were asked why, responses also varied across church communities and over time (Figure 3).

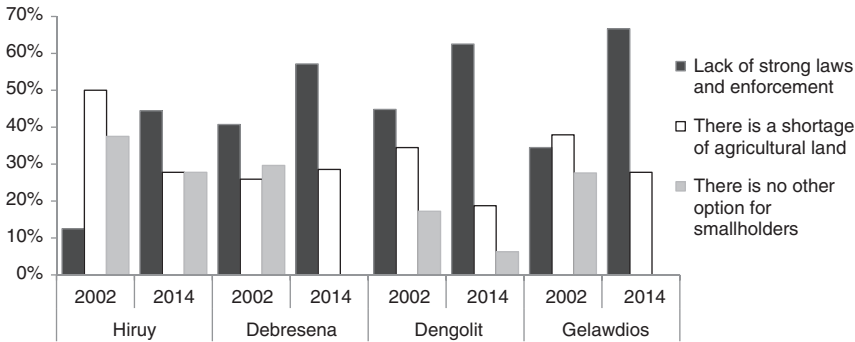


Figure 3: Beliefs surrounding why natural forests are declining in the area surrounding 4 church forest sites.

In 2002 36% of these respondents believed forest loss was due to a lack of strong laws and enforcement, while 36% cited a shortage of agricultural land. A further 27% stated that there was no other option for rural smallholders than to graze their livestock and extract firewood from natural forests. By 2014 these views had changed markedly: roughly 30% of 2014 respondents who thought forest loss was occurring still cited a shortage of agricultural land as a key driver, but fully 58% attributed forest loss to weak laws and poor enforcement – this was the largest response category in all four church communities and increased in each community from 2002 to 2014. Only 7.5% of 2014 respondents argued that there was “no other option” for smallholders (almost all in the Hiruy community, which also had the highest landlessness rates and the smallest church forest in the sample). This “no other option” category decreased in all communities from 2002 to 2014. These patterns over time show respondents perceiving a shift in the drivers of forest degradation away from poverty and individual need, and towards weak governance institutions and poor enforcement.

4.2. Variation in church forest rules and enforcement by church

All respondents in both survey rounds agreed that churches should be surrounded by natural forest, with the most cited reasons including providing beauty for the church (39% in 2002; 45% in 2014), space for prayer (11% in 2002; 10% in 2014), building materials and other uses for the church (8% in both 2002 and 2014), or all of the above (43% in 2002; 37% in 2014). The vast majority of respondents across all communities – 93% in 2002, and 89% in 2014 – believed that the forest surrounding the church building would not remain were it not for the church’s presence.

Perspectives on church forest uses, restrictions, rule enforcement, and conservation strategies varied widely across church communities and, in some

cases, across households within communities. In 2002 roughly 65% of respondents in Debreseña felt that the church forest should be closed off and protected (as opposed to the resource being utilized by the church for income, or divided up amongst community members for farming). At this time the majority of respondents in Hiruy, Dengolit and Gelawdios argued that the church forest should be managed and utilized by the church (including some extractive uses such as timber for church buildings). In 2014 respondents in all communities were more likely to support stricter conservation (rather than use by the church), and more than 70% of respondents in Debreseña and Dengolit asserted the forest should be closed off and protected from extractive uses altogether. Almost no respondents in either period advocated harvesting the church forest trees for income or distributing church lands amongst community members for farming.

When asked what benefits they themselves would like to obtain from their church forest, many community members in 2014 denied any benefits outside of the shade, beauty and prayer space provided by the natural groves. But more than half of respondents at Debreseña, Dengolit and Gelawdios – and nearly all at Hiruy – cited some form of material benefits from their church forest. Specifically, respondents were asked “If you were permitted, what benefits would you like to obtain from the church forest?” The benefits respondents stated they would like to obtain in 2014 are summarized by church in Figure 4.

In Debreseña, Dengolit, and Gelawdios, several respondents expressed interest in obtaining firewood or construction wood from the forest, and several respondents in the large Gelawdios church community also wanted access to animal fodder (i.e. grazing). In contrast, in the much smaller Hiruy church such extractive forest uses were not commonly sought; instead respondents cited access to tree seeds, cultural medicines, honey and fruit as the primary benefits they wanted from their church forest (including access to the church-blessed honey for which Hiruy church is regionally known).

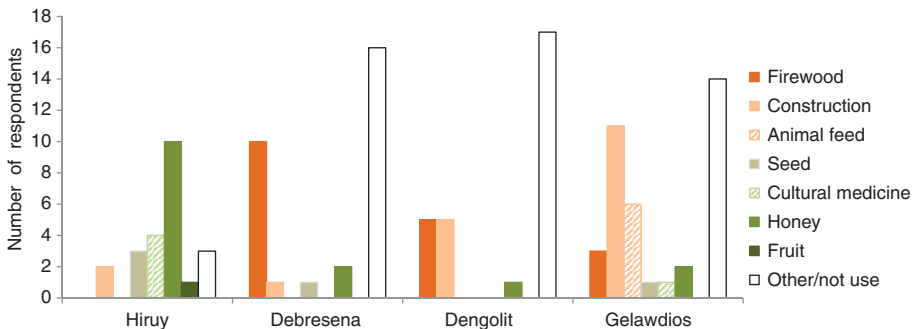


Figure 4: Extractive benefits (red shades) versus renewable benefits (green shades) sought from four church forests in 2014.

4.3. Variation in church forest attitudes and rule enforcement over time

Between 2002 and 2014 there was a clear shift among church community members regarding the types of benefits they wished to receive from church forests, with decreases in the number of respondents wanting to obtain firewood observed in all four study sites, alongside decreases in the number of respondents expecting to obtain construction wood or graze animals on church forest land (Figure 5). In the three larger forests (Debresena, Dengolit, and Gelawdios) there was a dramatic increase in the number of respondents stating they expected no benefits from the church forest beyond shade and space for prayer.

The only site where 2014 respondents expected more benefits from the church forest than 2002 respondents was in the small Hiruy church forest. However, as emphasized in both Figures 4 and 5, here the entire shift from non-use to use was due to a large increase in the number of respondents reporting largely renewable forest benefits, including access to cultural medicines, fruit, and honey. This trend towards increasing non-destructive forest uses was mirrored, though to a lesser degree, in the large Gelawdios forest, also known locally for its wild honey supplies.

With regard to responsibility for enforcement of church forest rules, when asked “What would you do if you caught someone cutting wood in the church forest?” in 2002, 57% of respondents said that they would stop him/her, followed by telling a church leader (29%) or a *kebele* administrator (9%). By 2014 only 30% of respondents said they would take action to stop someone cutting wood in the church forest, with telling a church leader (35%), a *kebele* administrator (23%) or both authorities (10%) more common. This shift away from personal responsibility to official responsibility for protecting church forests was also seen in responses to other survey questions. While in 2002 almost all respondents stated that they respected religious rules and social norms above formal

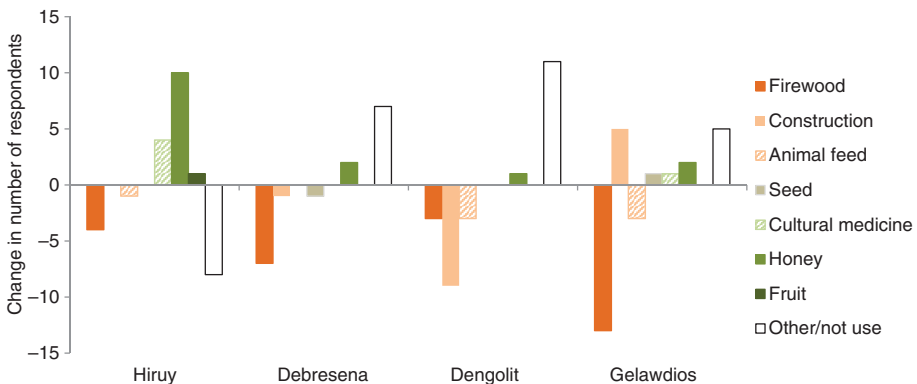


Figure 5: Changes in extractive benefits (red shades) versus renewable benefits (green shades) sought from church forests, 2002–2014.

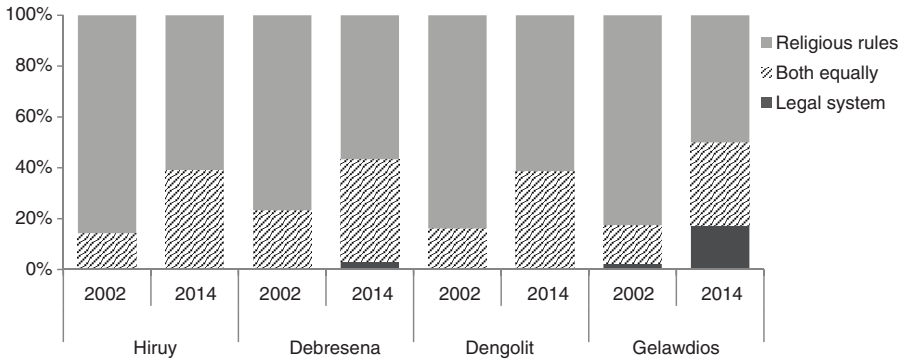


Figure 6: Changes in respect for religious versus legal authority in church communities, 2002–2014.

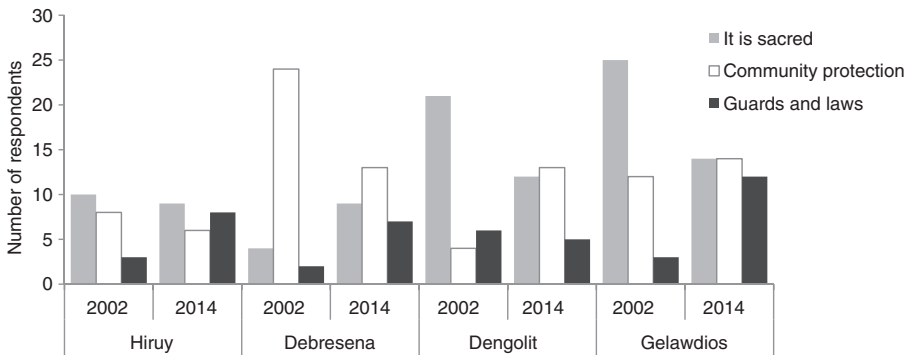


Figure 7: Changes in beliefs surrounding why church forests persist, 2002–2014.

laws, in 2014 respondents were far more likely to say that they respected both church and state laws equally or, in the case of Gelawdios, that they respected state laws more (Figure 6). Similarly, when asked why the church forests had persisted over time, in 2002 respondents mostly cited the holiness of the site and the will of the community to protect the forests – but in 2014 respondents were far more likely to attribute to the forests’ survival to formal laws (civil police) and guards (present in all church forests surveyed, as employees of the church) (Figure 7).⁴

⁴ An additional “other” category was infrequently used and in all cases “other” responses could be clearly reclassified as either “it is sacred”, “community protection”, or “guards and laws”.

4.4. Economic development and market access impacts on church forest conservation attitudes

Although more than 70% of respondents reported sourcing their firewood and construction wood from their own on-farm woodlots (in both 2002 and 2014), there was a noteworthy shift in the number reporting they obtained firewood and construction wood from markets. Only 7% of 2002 respondents sourced their firewood from the market versus 19% in 2014; and only 18% of respondents sourced construction wood from the market in 2002 versus 27% in 2014.

In 2002 there was no significant difference in woodlot ownership across church forests; however, in 2014 there were significantly more woodlot owners in Debresena and Dengolit as compared to Gelawdios ($\chi^2=13.40$; $P<0.004$). And in Gelawdios in 2014 owners of woodlots were significantly less likely to desire extractive benefits (firewood, construction wood, or grazing) from the church forest ($\chi^2=3.70$; $P<0.054$). In Gelawdios in 2002 the difference was not statistically significant, but the only respondents to *not* report wanting extractive benefits in 2002 were all private woodlot owners.

Finally, when asked what tree species they thought should be present in the church forest, a slight majority in both 2002 and 2014 favored native tree species (55% in 2002 favored native species, and 56% in 2014). The remainder of the sample in both periods thought exotic trees – almost exclusively *Eucalyptus spp.* – should be planted in the church forests. Moreover the share of respondents favoring planting *Eucalyptus spp.* rather than native tree species increased between 2002 and 2014 in all church communities with the sole exception of Gelawdios (the largest church forest in the sample), where preferences for native species increased. Older respondents were consistently more likely than younger respondents to report a preference for native tree species, with 63% of respondents over age 40 preferring native trees be planted in church forest groves, versus 47% of respondents under age 40.

4.5. Aggregate influences on church forest attitudes over time

Table 3 reports the results of logistic regressions for four church forest-related attitudes and behaviors: “Believes natural forest is declining” (as opposed to not perceiving natural forest loss in the respondent’s locality), “Wants extractive benefits from church forest” (defined as reporting firewood, construction wood, or grazing access as desired benefits from church forests versus non-extractive uses (honey, etc.) or no uses), “Would stop someone breaking church rules” (as opposed to simply reporting them to authorities), and “Prefers native trees over exotic trees in the church forest” (where respondents were weighing native trees such as *Juniperus procera*, *Olea europaea*, and *Cordia africana* against exotic plantation species such as *Eucalyptus spp.*). Each regression also controls for demographic variables and community fixed effects to capture variation in local ecology and economy. Coefficients represent the estimated

Table 3: Logistic regression results with community and year fixed effects for church forest attitudes and behaviors by year (2002 versus 2014) and using pooled sample clustered by household (2002–2014).

	(1) Believe natural forest is declining			(2) Want extractive benefits from church forest			(3) Would stop someone breaking church rules			(4) Prefer native trees over exotic in church		
	2002	2014	2002–2014	2002	2014	2002–2014	2002	2014	2002–2014	2002	2014	2002–2014
Male	-0.14	0.37	0.03	-1.37**	0.42	-0.29	1.16**	-0.25	0.21	-0.21	0.19	-0.12
Over 40	-0.60	0.60	-0.13	-0.57	-0.95*	-0.46	0.61	0.98*	0.39	0.62	-0.65	0.25
Literate	0.61	0.92*	0.68**	-0.13	0.78*	0.25	0.68	-0.57	0.10	0.21	1.94***	0.44
Own woodlot	-0.06	-2.87***	-1.46***	-0.99	0.66	-0.08	-0.20	-1.51**	-0.92**	-0.64	-0.72	-0.78***
Landholding	-	0.31	-	-	0.44	-	-	-0.62***	-	-	0.24	-
Hiruy	-	-	-	-	-	-	-	-	-	-	-	-
Debresena	1.16	1.37	1.19*	2.01**	2.06**	1.16***	-2.12***	1.73**	-0.10	-0.45	-0.19	-0.25
Dengolit	1.45	-1.66**	-0.29	2.60***	1.85**	2.03***	0.41	1.36*	0.64	-1.54**	-3.12***	-1.73***
Gelawdios	-0.21	-2.53***	-1.23**	2.33***	2.84***	2.24***	-0.25	1.25*	0.49	-1.35**	- ^a	0.37
Year	-	-	-1.21***	-	-	-1.20***	-	-	-1.09***	-	-	-0.04
Constant	1.41	2.70***	3.03***	1.12	-3.28***	-0.57	-0.19	-0.24	0.59	1.44*	0.30	1.00**
Pseudo-R ²	0.13	0.30	0.17	0.16	0.16	0.16	0.17	0.15	0.08	0.08	0.16	0.16
N	122	122	244	122	122	122	122	122	122	122	82	244

*P<0.10; **P<0.05; ***P<0.01.

^aAll respondents in Gelawdios in 2014 reported a preference for native species; hence Gelawdios is dropped from Model 4 in 2014.

increase in the log-odds likelihood of an affirmative response on the binary outcome variable.

In Model 1, there is a strong association between woodlot ownership (almost exclusively *Eucalyptus spp.*) and the perception that natural forests are not declining. In other words, people who thought that exotic *Eucalyptus spp.* was a “forest” tree also tended to think that natural forests were retaining their size or even growing. This interpretation of respondents’ confounding *Eucalyptus spp.* expansion with natural forest expansion is further supported by the significant coefficient on literacy – more educated respondents (more likely to differentiate between native versus exotic tree species) were more likely to report a perceived loss of natural forests in their communities.

In Model 2, controlling for demographic and location attributes, respondents from the three larger church forests (Debresena, Dengolit and Gelawdios) were all more likely on average to desire extractive benefits from their church forests than respondents from the small Hiruy church forest, though this expectation decreased over time. In 2002 men were less likely than women to want extractive benefits from church forests. But in 2014 gender and the economic variables landholdings and firewood access were not significant predictors of church forest extractive uses. In 2014 the only significant predictors of seeking extractive uses from church forests were age and education: older respondents were less likely to desire extractive benefits from church forests, while more educated (and generally younger) respondents were more likely to want such benefits.

In Model 3, being male and older were both positively associated with being willing to directly enforce church forest rules in 2002 (by stopping someone from cutting trees rather than reporting them to the authorities). However, controlling for demographic and regional variables, we find that respondents’ willingness to directly enforce church rules has declined over time. In particular, the 2014 and 2002–2014 models suggest that increased wealth in the form of woodlot ownership and greater landholdings was strongly negatively associated with church rule enforcement (or, alternatively, individual wealth was strongly positively associated with deference to legal authorities for enforcing church rules).

Finally, the results of Model 4 mirror the results of Model 1, and suggest that while education was positively associated with preferences for native tree species in church forests, woodlot ownership had a negative effect – possibly because woodlot owners are more inclined to see forests as a source of income for the church (which *Eucalyptus spp.* can quickly provide). Indeed, in Dengolit, where *Eucalyptus spp.* has been widely planted by the church, respondents were significantly less likely to report a preference for native trees as compared to respondents in other, more predominantly native, church forests. Notably, there does not appear to have been a shift over the past decade in community values surrounding native versus *Eucalyptus spp.* tree planting: nearly 50% of respondents in both 2002 and 2014 believed their church should plant *Eucalyptus spp.*, suggesting any changes in community values surrounding the introduction of exotic species in church forest groves must have occurred prior to the 2002 survey.

5. Discussion

As longstanding community-based forest conservation institutions, church forests exhibit many of the key design principles identified by Ostrom (1990, 2005), including clear rule-making and conflict resolution processes (both largely rooted in local church committees led by priests). But in terms of clear boundaries, and well-defined and locally appropriate rules, monitoring, and enforcement (all emphasized by Ostrom (1990, 2008)), our findings are mixed. Some broad norms of church forest use predominate – such as a general belief that church forests should not be used for extractive benefits such as firewood or household construction wood. But there has also been a declining sense of urgency surrounding natural forest conservation in many church communities over time. A significant minority of church members wish to obtain firewood, construction wood, grazing access or other benefits from their forests, particularly among younger and more educated respondents. Meanwhile, longstanding church norms such as assuming individual responsibility for church rule enforcement, or planting native tree species versus *Eucalyptus spp.* in church forest groves, have lost strength over time and among younger respondents.

As in other complex social-ecological systems, the continued resilience of the institutions governing church forest access and use – and adherence to those institutions by community members – will ultimately determine the future ecological status of these sacred natural sites (Dietz et al. 2002; Sheridan and Nyamweru 2008).

5.1. Changing perceptions of church forest ecological integrity and need for protection

Our survey respondents became less likely over time, on average, to report that the natural forest in their community was decreasing in size – with reports that natural forests were being sustained or even increasing in size most common in 2014 at the two largest church forests, Dengolit and Gelawdios, and among younger respondents. It may be that the presence of a large, long-established church forest in a community creates the illusion that natural forest loss is no longer occurring locally. This may also be an instance of “shifting baselines”, whereby survey respondents are apt to judge current forest cover as being high relative to the recent past, even when current forest cover might be lower than in the more distant past (Papworth et al. 2009; Kai et al. 2014). Alternatively our respondents may have been confusing expanding *Eucalyptus spp.* plantations (present throughout the study sites, as well as in the church forests themselves to varying degrees) with natural forest recovery. Importantly, any of these interpretations implies a declining sense of urgency for natural forest protection among church communities over time.

5.2. Changes in dominant perceptions of church forest roles and rules

In our four sample church communities in 2002 women were more likely to seek extractive benefits from church forests, and less likely to individually enforce

church forest rules – however differences between men and women were no longer significant in 2014. Though our sample of women church followers is small, this finding suggests potentially important variation in gender-based perceptions of church forests over time that merits further study. This may reflect women's primary roles in firewood collection, which makes women particularly reliant on natural forests in the absence of access to alternative fuel sources (Scheurlen 2015).

Other perceptions surrounding church forest rules have remained relatively constant over time, including a tendency for older respondents to be less likely to desire extractive benefits from church forests, and more likely to take personal responsibility for enforcing church forest rules. As evidenced by the multivariate regression models these divides between young and old respondents have become even more pronounced over time. Older respondents also tended to prefer native species over exotic *Eucalyptus spp.* in church forest groves to a greater degree than younger followers. All of these patterns are consistent with the hypothesis that social norms surrounding church forests are changing over time.

One possible explanation for the pronounced intergenerational differences in attitudes is a dramatic recent shift in technology availability: access to telecommunications and associated information has radically expanded in the study area in recent years, with the World Bank (2016) reporting that mobile phone access in Ethiopia has grown from virtually zero in 2002 to 32 mobile cellular subscriptions per 100 people in 2014. Growth in internet access has been slower – still only 2.5% of Ethiopians had access to the internet in 2014 – but the increasing use of social media such as Facebook may also have had an influence on knowledge and attitudes, particularly among younger respondents. Tilahun et al. (2015) suggest these factors may make youth less concerned about adherence to local traditional authorities such as the church.

Access to alternative sources of firewood and incomes had consistent effects on attitudes in our sample over time, with private woodlot owners in general less likely to think that natural forests are declining, less likely to take personal responsibility for enforcing church forest rules, and more likely to prefer exotic trees over native trees for planting in church forest groves. Larger landholdings – another indicator of resource access and wealth – were also associated with less individual willingness to enforce church forest rules. In interviews several priests and church followers noted that increased incomes have been associated with construction of elaborate burial tombs and expanded church buildings in many communities (see also Klepeis et al. 2016). Together these findings suggest that church forest governance institutions may be vulnerable to positive shifts in economic conditions, as has been observed in other sacred natural sites systems (Castro et al. 1990; Daye and Healey 2015). In other words, increases in individual wealth and resource access may reduce the desire of community members to individually enforce longstanding church forest conservation rules.

5.3. Changes in enforcement and preferred management strategies

The desire for non-renewable extractive benefits from church forests also varied significantly among church communities and over time, at least in part a function of local socioeconomic conditions and likely also a function of local ecological context (with larger forests able to provide more goods and services than smaller ones). In general there has been a shift over time among church communities away from desiring extractive uses such as firewood and towards renewable uses including medicines, honey, shade and prayer. It is possible that these changes in self-reported desires for extractive resources might reflect increased hesitance to report what are increasingly seen as prohibited uses of the church forest (rather than actual changes in behavior concerning forest uses). But if so, these trends still mean that harvesting firewood/construction wood/fodder was seen as more strongly prohibited in 2014 than in 2002.

However, even while reduced demand for extractive benefits might be hypothesized to support church forest conservation, we find that there has also been a recent shift away from a clear expectation that church leaders and communities hold responsibility for rule enforcement in church forests in 2002, to a perceived sharing of responsibility by church leaders and governmental authorities (e.g. police and the legal system) in 2014. These results suggest declining community demand for extractive benefits from church forests may have gone hand-in-hand with the erosion of religious and community norms protecting these shared forest resources.

Finally, in a process that appears to have begun before the 2002 survey, there has also been a noteworthy shift in church communities from a centuries-old historical preference for native tree species in church compounds to a desire for more exotic tree species such as *Eucalyptus spp.*, a preference which has remained strong since 2002 and continues to threaten church forest biodiversity today (Liang et al. 2016). Here also the results may have a mixed interpretation: access to alternative sources of fuel and construction wood including *Eucalyptus spp.* is clearly and statistically significantly associated with decreasing demand for native tree harvesting from church forests, which should support natural regeneration of native tree species on at least some church lands. But at the same time other areas of primarily indigenous church forests may be converted to less ecologically diverse *Eucalyptus spp.* stands.

We hypothesize (though cannot test in this study) that an increase in private assets, landholdings, and woodlot ownership and use may have influenced social norms surrounding what communities see as acceptable church forest uses. While in the past extracting firewood from a church forest was seen as a violation of social norms or, at best, an act of desperation by resource-poor farmers, today some people appear to see obtaining firewood or construction wood from church forests as a simple business transaction – priests reported that Debresena routinely sells deadwood harvested from the church forest as firewood to generate income for the church, Dengolit used *Eucalyptus spp.* plantations to reclaim encroached-upon land from farmers and grazers in addition to generating income,

and many churches across the Amhara Region now grow and sell *Eucalyptus spp.* poles for construction. This suggests the increasing cultivation of *Eucalyptus spp.* by church forest communities may not only threaten the ecological diversity of ancient church forest groves (by replacing centuries-old practices of nurturing native seedlings with a faster source of income from exotic *Eucalyptus spp.* planting) but may also be influencing community norms surrounding church forests – making church forests appear less like common pool resources providing shared benefits for all members, and more like private resources. Planting *Eucalyptus spp.* can provide income for the church, but it may also make the church forest seem like more of an economic enterprise that can protect itself – rather than a spiritual commons needing community protection (Rutte 2011).

6. Conclusions

Agrawal (2014) noted that “success” in CPR outcomes is often not clearly defined, and that successful institutions, sustainability of resource dependent livelihoods, or biodiverse resource systems are different definitions of success that might have different underlying causal explanations. Although the goals of the four Ethiopian Orthodox church communities in this study were not investigated directly, differences in allowed uses and types of trees planted across church forests point to potential differences in the purpose the local social-ecological systems might be serving. In addition to providing prayer spaces and other cultural benefits, church forests in northern Ethiopia are valuable repositories of biological diversity, and may even offer glimpses of what, if allowed, might one day regenerate on the degraded landscape (Aerts et al. 2006; Aynekulu et al. 2016). But church forests are also economic entities – providing food, medicine, and sometimes firewood, timber and fodder to communities around them (Bongers et al. 2006; Amare et al. 2016; Reynolds et al. 2017). Without effective governance institutions, these benefits-flows would presumably have ceased long ago. Thus the institutional similarities across church forests today – as well as the examples of institutional diversity highlighted in this study – offer valuable insights into how institutions might adapt to allow communities to manage native forests mosaicked within agricultural landscapes across a range of social, economic, and ecological contexts.

In the past the pursuit of general design principles for successful forest management has led to simplistic policy panaceas rooted in general assumptions about which property-rights regimes – state-run protected areas, for example, or private land – are appropriate for conserving resources (Ostrom and Cox 2010). The church forest is a more complex property-rights arrangement. It is neither private nor completely common land, but is managed as a collective “spiritual commons” (Rutte 2011) by the church for the benefit of church members. This study’s closer look at the relationships between actors, governance systems, and rules, norms and beliefs of church members about the church’s conservation rules over time shows the beginning of a shift in perceived dominance from the church governance institution to the state. It shows the power of the church institution

to protect the forest, but also the potential for degradation that might come with erosion of deference to the church as the primary authority over the forest. It invites further study of the feedback between community member beliefs about institutional rules, actions with respect to forest resources, changes in forest characteristics, and further adjustments to the rules.

Ultimately church forests and related religious conservation institutions may hold abundant potential for promoting stewardship and conservation behavior (Wild et al. 2008; Verschuuren et al. 2010; Rutte 2011; Ormsby and Ismail 2015), but they are also dynamic institutions operating in a dynamic context. There is already some evidence of threats to species diversity in church forests (as summarized in Aerts et al. (2016), including the possible local extinction of high-value tree species such as *Juniperus procera* and *Podocarpus falcatus* in some forests (Thijs et al. 2014), and the prevalence of relatively less diverse drought-tolerant, early successional shrubs in others (Aerts et al. 2006)). Combined with the shifts in longstanding social norms and rule enforcement mechanisms we observed in this study, such findings may ultimately reflect the decline of a longstanding community-based forest conservation institution (Dietz et al. 2002). It is possible that strategic investments in church forest conservation and management – such as payments for ecosystem services (PES) and related policies and programs blending poverty alleviation, institution-building and environmental goals (Ehui and Pender 2005; Pagiola et al. 2005) – could help promote continued forest governance where complex church and local institutions are already at work (Gibson et al. 2005; Wassie-Eshete et al. 2005b; Reynolds et al. 2010; Reynolds 2012; Díaz et al. 2012; McCarthy et al. 2012; UNEP-WCMC 2014).

At the same time, however, there is a risk that new institutions and incentives introduced to support conservation might inadvertently shift value away from pre-existing religious institutions and norms.

Institutional scholars led by Ostrom (2005), Janssen and Anderies (2007) and others have emphasized the need for expanded research into how longstanding local natural resource management systems can restructure in response to globalization and global environmental change, including ways in which such shifts might amplify social-ecological systems' fragilities. The results of this study suggest an urgent need for expanded systematic study of the diverse institutions governing the thousands of church forests all across northern Ethiopia, and in the countless sacred natural sites across Sub-Saharan Africa and beyond.

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