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Spatial Variation, Institutional Structures and Forest Composition in Northern Ethiopian Church Forests

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Introduction

Less than 5% of Ethiopia’s original Afrotropical forest cover remains intact, following decades of rapid deforestation (Boyes et al., 2004). The remaining forest in Ethiopia’s Northern Highlands is almost exclusively found as “church forests,” which are small pockets of indigenous trees surrounding Ethiopian Orthodox Christian churches that have been preserved as sacred sanctuaries for centuries (Kassa, 2002). This research uses Geographic Information Systems (GIS) and social surveys to examine the past and present condition of church forests in South Gondar, Ethiopia. We explore the following questions:

• How well does observed forest cover change over time (from satellite imagery), correspond to priest and community member accounts of church forest degradation (from social surveys)?

• How do priests and community members interpret the “rules and roles” of church forests (i.e., the ecological/social functions of the forest), and the institutional/legal rules governing church forests (as) relate to observed forest cover change over time?

We argue that temporal and informational disconnects—between ecological realities and popular perceptions of forest governance—are key to understanding the long-term health of church forest ecosystems.

Methods

Methods combine declassified aerial photography from the 1960s, US Geological Survey Landsat satellite data from 1984-2014, present-day satellite imagery, and in-person social surveys. We first develop a typology of church forests defined in terms of variation in their extents (by area) and densities (by vegetation indices) over time. We specifically focus on four church forests within the South Gondar Zone of Ethiopia (Figure 1), selected based on this typology.

On-site visits in 2013-2014 allowed for more detailed data on each forest community; we conducted 20-30 household interviews (37 questions on church forest issues, uses, and roles) within each church forest community.

We first calculated the Normalized Difference Vegetation Index (NDVI) for all Landsat data. NDVI is an indicator of green biomass and tree density on a pixel basis, which helps understand the overall extent and density of vegetation in the area. This calculation yields a range of pixel values from -1 to 1.

Typically, pixels that are:

• Less than 0.25 are non-forested land
• 0.25 to 0.4 are mixed forest
• More than 0.4 are densely forested land

We then used the Normalized Difference Vegetation Index (NDVI) to calculate forest area and density.

Other spatial and historical variables that may be associated with forest size and density were also examined. The older churches in the sample were the only church forest to increase in both size and density, while the newer church was the only site to decrease in size. Churches at higher altitudes were typically home to both in size and density. Proximity to the nearest paved road and to the nearest main water source showed no relationship to forest cover change in this small sample.

Forest Cover Change Over Time

Figure 2 visualizes the church forest change between 1984 and 2014, allowing us to identify changes in size and density for each forest (Table 1).

= No change over time (constant average NDVI)
= Increasing over time (higher average NDVI)
= Decreasing over time (fewer forested pixels)
= Increasing over time (more forested pixels)

$\text{Forest Size}$

$\text{Increase}$

$\text{Decrease}$

= Constant

= Increase

= Decrease

Community Responses

Linking social survey results to remote sensing data yields important insights into plausible drivers of the observed vegetation change trends. Figures 3-5 gauge relative levels of respect and fear for religious sanctions and civil courts and laws. Overall trends suggest that people tend to favor rules in the form of religious instruction and leadership. Conversely, trends also show that communities are more receptive to the threat of a mixture of religious sanctions and civil laws and less so to

Figure 5 shows the distribution of benefits community members obtain from their respective church forests. Note that in Dedim, a forest that has increased in both size and density over the past 40 years, zero respondents reported that they obtain any benefits from the forest.

Conclusions

Today, even in areas of deep cultural and religious significance such as church forests, the effects of economic pressures can be seen as native forests continue to be degraded by agricultural expansion, grazing, and fuel wood demand. These methods can be applied in further studies to analyze the management and success of other community managed forests in Ethiopia and beyond.

Literature Cited


