

# SCIENCE POLICY BRIEF

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## Integrated Socio-Ecological Landscape Modelling Using InVEST and the IPBES Nature Futures Framework (NFF): the Case of Entoto Mountain Forest, Ethiopia

### Overview

The Entoto Forest in Ethiopia's central highlands (ranging between 2598 and 3025 m.a.s.l) provides important ecosystem services, including biodiversity conservation, urban climate and flood regulation, and cultural and recreational benefits for local and international tourists. The urban forest with a surface area of 13,000 hectares, spans areas administered by Addis Ababa City and Sheger City. However, this study focused on the 2,146-hectare urban forest within the forest area administered by Addis Ababa City, a key component of the city's urban green infrastructure.

Over the decades, the forest has experienced significant degradation due to urban expansion and agricultural encroachment. Hence, this study to assess its biodiversity and ecosystem services, combined with an understanding of stakeholder priorities through the IPBES Nature Futures Framework (NFF) to inform sustainable forest management.

### Introduction

This policy brief highlights the vegetation diversity, key ecosystem services, and stakeholder priorities in the Entoto Forest (Fig. 1). The floristic inventory was assessed using 20 plots of 25×25 m, established within both natural and plantation forest areas. Species richness and evenness were evaluated using Shannon–Wiener indices. While, its habitat quality and carbon stored in the forest landscape were mapped using the InVEST Habitat Quality (HQ) and Carbon Storage and Sequestration (CSS) models, respectively. Stakeholder perspectives on the forest ecosystem services were integrated through 38 key informant interviews and four focus group discussions with the relevant forestry stakeholders, providing a comprehensive basis for ecosystem restoration and management planning.

### Policy recommendations

- Develop a coordinated cross-boundary forest management strategy that balances biodiversity conservation, community needs, and national and international environmental commitments.
- Explore opportunities to strengthen sustainable financing mechanisms, including carbon market initiatives, to support long-term forest conservation and restoration.
- Enhance collaboration among government agencies, local communities, the private sector, and development partners to maximize ecological and socio-economic benefits from the forest.
- Assess the potential of the Entoto Forest landscape for recognition as an IUCN Other Effective Area-Based Conservation Measure (OECM), contributing to Ethiopia's biodiversity conservation goals and the global 30×30 target.

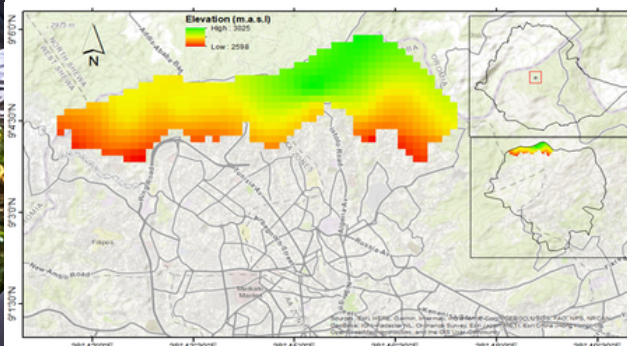


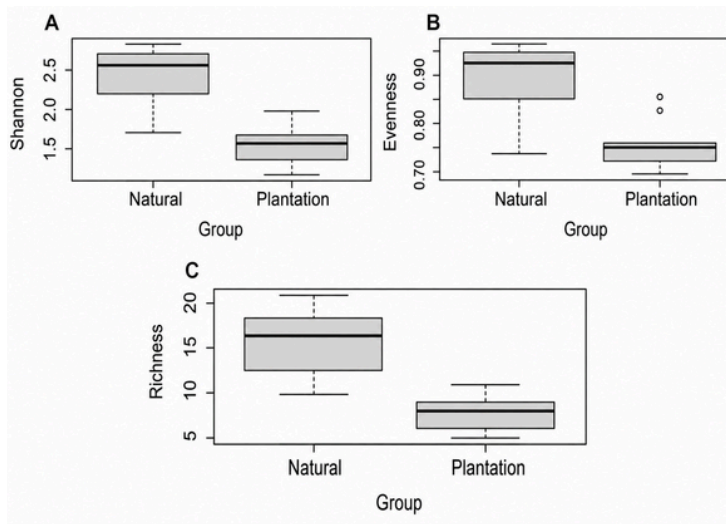
Fig. 1. Map of Ethiopia showing the Entoto urban forest



Cross-section of interviewees (former firewood collectors) during the focus group discussion in the Heritage Trust Site of the Forest

## Key findings

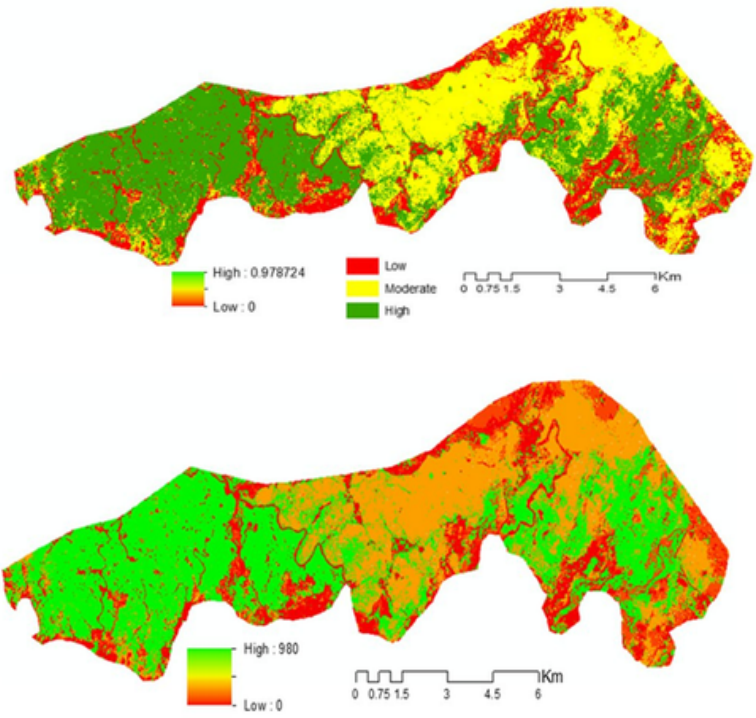
A total of 64 trees and shrubs species from 34 families were recorded with *Eucalyptus globulus* and *Juniperus procera* species showing the highest richness. Sampled plots contained an average  $\pm$  S.D. of  $11.1 \pm 5.0$  species, with a mean Shannon diversity index,  $H'$  of  $1.7 \pm 0.63$  and species evenness of  $0.73 \pm 0.14$ . The natural forests showed substantially higher biodiversity than the eucalyptus plantation forests, with greater species diversity ( $H' = 2.5$  vs.  $1.5$ ), richness ( $15.8$  vs.  $7.7$ ), and evenness ( $0.9$  vs.  $0.8$ ). This difference was statistically significant (Mann-Whitney U test:  $W = 93$ ,  $p < 0.001$ ; Fig. 2).



**Fig 2.** Box plots showing species diversity and distribution between the natural and plantation forests: Shannon diversity (A), evenness (B), and species richness (C)

The InVEST habitat quality model assessment found that 937 hectares of the forest had high habitat quality, 637 hectares had moderate quality, and 637 hectares provided no habitat. Total forest carbon storage was estimated at more than 1.11 million MtC, with an average stock of  $527.7 \text{ MtC ha}^{-1}$ . Natural forests accounted for most carbon storage (86.8%), while eucalyptus plantations contributed 11.8% (Fig. 3).

Stakeholder analysis showed that nature for society (NS) was the most important forest value (44%), followed by nature as culture (NC, 32%) and nature for nature (NN, 24%). Tourism was the most frequently cited benefit (73.7%), while 63.2% of respondents highlighted the importance of biodiversity and ecosystem services, including clean air, soil, and water.



**Fig 3.** Model results showing habitat quality map of Entoto Forest (top image) Carbon stock map of Entoto Forest (bottom image)

## Conclusion

The study underscores the critical role of natural forests in conserving biodiversity, storing carbon, and providing ecosystem services that support human well-being. While stakeholders strongly value the forest for tourism and other direct benefits, greater awareness is needed of its intrinsic ecological importance.

Strengthening community participation and improving public understanding of conservation can enhance sustainable forest management. Addressing current management challenges, including forest fragmentation, is essential to maintaining ecosystem integrity. As tourism continues to expand, coordinated action among government agencies, local communities, and other stakeholders will be vital to balance development with long-term conservation goals.

## KEY REFERENCES

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