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Community Perceptions of Cultural Ecosystem Services in Restoring Degraded Urban Forests: Evidence from Aboabo Forest, Ghana

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Research Article

Keywords: Cultural Ecosystem Services, Community Perceptions, Urban Forest, Urban Forest Restoration, Open Defecation, Aboabo Forest

Posted Date: November 6th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11072894/v1

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Additional Declarations: No competing interests reported.

Abstract

Cultural ecosystem services (CES), including aesthetic, educational, recreational, spiritual, and social values - provided by urban forests, are critical to the well-being of urban communities. However, the Aboabo Forest in Tamale, Ghana, a 138.64-hectare gazetted reserve, is severely affected by persistent open defecation (OD) by surrounding community members. While prior studies have established the prevalence and behavioural determinants of OD in this forest and its institutional management arrangements, the impact of OD on the CES of the forest and the community's preferred strategies for their restoration remain unexamined. This study addresses this gap using data drawn from a cross-sectional mixed-methods research design: a structured survey of 110 households and ten key-informant interviews with community and institutional leaders. Findings reveal that aesthetic value (91.8%), educational value (90.0%), recreational and ecotourism value (80.9%), and spiritual and religious value (76.4%) are the CES most severely degraded by OD. The degradation manifests largely through deterrence - residents avoid the forest for fear of stigmatisation and due to the foul environment - and through the desacralisation of sacred shrines. Paradoxically, OD appears to strengthen social relations among practitioners (56.4%), thus depicting a complex social facet of the practice. Community members prioritise the restoration of aesthetic (94.5%), educational (87.3%), and spiritual/religious (71.8%) CES and propose four pathways: public education campaigns, promotion of religious and cultural activities in the forest, multi-stakeholder collaboration, and integration of recreational infrastructure.

1. Introduction

1.1 Urban Forests and Cultural Ecosystem Services

Urban forests, encompassing all trees, woody vegetation, parkland, riparian corridors, and designated forest reserves within urban and peri-urban areas [16], provide a diverse range of ecosystem services that promote the sustainability and liveability of cities. These services, classified by the Millennium Ecosystem Assessment [15] into provisioning, regulatory, supporting, and cultural categories, are increasingly recognised as indispensable to urban resilience, particularly in rapidly urbanising regions of the Global South [23].

Among these, cultural ecosystem services (CES) are distinguished by their relational and experiential character. The MEA defines CES as "the nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences" [15]. These benefits include aesthetic values, educational values, recreational and ecotourism opportunities, spiritual and religious significance, cultural heritage, sense of place, social relations, and a source of inspiration [15]. They are uniquely dependent on direct physical interaction between people and the forest environment, making their values inseparable from the physical and sensory conditions of the forest itself.

Urban forests in West Africa, including the Aboabo Forest in Tamale, Ghana, have been documented as providers of cultural ecosystem services spanning leisure and entertainment, spiritual experience, educational value, and a sense of place ([17, 18, 3]). The Aboabo Forest - a 138.64-hectare gazetted reserve established in 1956 - is surrounded by five densely populated communities (Moshi-Zongo, Gumbihini, Choggu, Nyohini South, and Nyohini North) with a combined population of approximately 77,988 [11], and has historically served as a botanical learning site, a spiritual and religious gathering ground, a recreational space, and a cultural heritage site for the Tamale Metropolis.

1.2 Open Defecation as a Threat to Urban Forest CES

Open defecation (OD) - an ancient practice of defecating in open spaces, including forests, fields, and bodies of water, rather than in designated sanitation facilities - remains a major public health and environmental challenge across sub-Saharan Africa. In Ghana, the 2021 Population and Housing Census recorded that 17.7% of households resort to OD, with rates substantially higher in specific urban communities and forest-adjacent settlements; over 90% of urban OD practitioners in the Northern Region use forests or nearby bushes as their site of choice [11].

The consequences of OD for forest ecosystems are well-documented at the physical level: faecal contamination of soils and groundwater, acceleration of ground cover removal, and the generation of persistent foul odour that renders the forest environment repellent to legitimate users [8, 2, 14, 3]. However, the specific consequences of OD for the CES of urban forests - the services whose enjoyment depends most fundamentally on the physical and sensory quality of the forest environment - have not been systematically examined in the existing literature.

This study presents findings on the perceived impact of OD on the CES of the Aboabo Forest and identifies the community's proposed strategies for the sustainable restoration of the Aboabo Forest.

1.3 Research Gap and Objectives

Despite the growing body of literature and scholarly studies on OD determinants and urban forest ecosystem services, no published study has systematically examined how OD degrades the CES of an urban forest reserve, nor assessed community perceptions of restoration priorities and strategies in this specific context. This represents a critical gap, given that CES degradation directly undermines human well-being, community attachment to urban green spaces, and the governance rationale for forest conservation.

This study addresses that gap with the following objectives:

(1) To assess community perceptions of the CES degraded by OD in the Aboabo Forest;

(2) To examine the mechanisms through which OD undermines CES delivery and community well-being;

(3) To identify the CES restoration strategies proposed by community members and institutional stakeholders.

2. Literature Review

2.1 Cultural Ecosystem Services: Conceptual Foundations

The Millennium Ecosystem Assessment [15] and The Economics of Ecosystems and Biodiversity [21] provide the underlying framework for understanding CES. The MEA categorises CES into ten sub-components: cultural diversity, knowledge systems (traditional and formal), educational values, spiritual and religious values, aesthetic values, inspiration, social relations, sense of place, recreation and ecotourism, and cultural heritage values. These services are distinguished from other ecosystem services by their dependence on human perception, experience, and interaction with the natural environment - they cannot be extracted or stored, only experienced in situ.

Research on urban forest CES demonstrates their significance across global contexts. Stępniewska [20] found that Citadel Park in Poznan, Poland, provided cultural services including leisure, ecological connectivity, and spiritual experience. Berglihn and Gómez-Baggethun [7] documented that Oslo's Oslomarka urban forest delivered art inspiration, educational values, and a strong sense of place. In Ghana, Okyerefo and Fiaveh [18] identified the urban forest as a "religious space" where communities sought spiritual healing, prayer, and ancestral connection, while Nero et al. [17] found that the Accra urban forest served recreational and educational functions. These studies collectively establish that CES are not peripheral luxuries but core components of community well-being, particularly in cities where formal recreational and cultural infrastructure is limited.

2.2 Threats to Urban Forest CES in Sub-Saharan Africa

Urban forests in sub-Saharan Africa face compound threats, including encroachment by estate developers, illegal logging, invasive species, criminal activity, and widespread misuse for waste disposal and open defecation [5, 13, 4]. These threats do not merely degrade the forest's ecological functions; they also destroy the conditions under which CES can be experienced. A forest that is perceived as dangerous, malodorous, or associated with criminal and deviant behaviour loses its capacity to deliver aesthetic, recreational, spiritual, and educational services, irrespective of its botanical integrity.

The concept of "ecosystem disservices" - wherein degraded ecosystems generate costs rather than benefits for human well-being - is particularly relevant here [2]. When OD transforms a forest from a space of cultural value into a site of contamination and stigma, it creates a feedback loop: the degraded CES reduce community attachment to the forest, which in turn reduces informal surveillance and social control over its misuse, further intensifying OD and other forms of degradation [12].

2.3 Community-Based Forest Restoration: Evidence and Principles

Effective forest restoration requires more than ecological rehabilitation; it demands the restoration of the social, cultural, and relational dimensions of the human–forest relationship. Studies on community-based natural resource management in West Africa consistently demonstrate that restoration efforts

succeed when they are grounded in community participation, culturally relevant values, and locally meaningful institutional arrangements [6, 1].

Religious and spiritual values have been identified as particularly significant drivers of community stewardship behaviour in Ghanaian and broader West African contexts. Okyerefo and Fiaveh [18] found that communities which perceived the urban forest as spiritually significant exercised greater informal protective norms over it. Similarly, UNESCO [22] has documented that education plays a critical role in sustaining and restoring ecosystems, as biodiversity and natural resources are frequently undervalued when communities lack knowledge of their services.

Recreational infrastructure development has also emerged as a mechanism for restoring community–forest relationships: by creating formal, inclusive, and safe spaces for forest use, recreational facilities reestablish positive associations with the forest and generate the informal social surveillance that deters misuse [20]. These converging strands of evidence suggest that CES restoration in degraded urban forests requires a multi-pathway approach addressing education, spiritual/cultural activation, stakeholder collaboration, and physical infrastructure simultaneously.

2.4 Analytical Framework: The Millennium Ecosystem Assessment Wellbeing Model

This study uses the MEA's constituents of human well-being as an analytical lens for interpreting the consequences of CES degradation. The MEA identifies five well-being constituents: security (personal safety and secure resource access), basic material for a good life (adequate livelihoods, shelter, food), health (physical well-being and access to clean air and water), good social relations (social cohesion, mutual respect, ability to help others), and freedom of choice and action (the opportunity to achieve what individuals value). CES are expected to contribute positively to each of these constituents; their degradation therefore constitutes a multi-dimensional well-being loss, not merely an environmental one.

3. Methods

3.1 Research Design and Setting

A cross-sectional mixed-methods design was adopted for this study. Quantitative survey data (n = 110 households) and qualitative key-informant interview data (n = 10 informants) were collected concurrently from five communities bordering the Aboabo Forest: Moshi-Zongo, Gumbihini, Choggu, Nyohini South, and Nyohini North. Sociodemographic profiles and OD prevalence findings are reported in Adzah [2] and are not reproduced here; they are cited contextually where they anchor the interpretation of CES findings.

The study site is the Aboabo Forest (also known as the Waterworks or Nyohini Forest) — a 138.64-hectare gazetted reserve located at the centre of the Tamale Township, Northern Region, Ghana. Tamale has a population of 374,744 [11] and is among the fastest-growing cities in West Africa. The forest was gazetted in 1956 and is patrolled by the Forestry Commission of Ghana; it has been formally classified

by the Tamale Metropolitan Assembly (TaMA) health department as one of the most severely OD-affected sites in the metropolis.

3.2 Data Collection

For the CES impact and restoration objectives reported in this paper, the survey instrument included two dedicated modules. The first asked respondents to indicate, from a structured list of ten CES drawn from the MEA (2005) framework, which services they perceived to be degraded by OD in the Aboabo Forest, and to what extent OD might paradoxically promote any CES. The second module asked respondents to identify which degraded CES they considered most in need of restoration, and to indicate their preferred restoration strategies from a structured list including recreational park development, increased forest monitoring, and construction of toilet facilities within the forest.

Qualitative key-informant interviews were conducted with four Assembly Members, four Unit Committee Members, the TaMA District Sanitation Officer, and the Forestry Commission Director for the Tamale region. Interview guides for this study included thematic areas on the perceived impact of OD on the forest's cultural and social value, and on community-proposed strategies for sustainable restoration. Interviews were audio-recorded with informed consent, transcribed, and were conducted in Dagbani, translated into English by a qualified translator. Qualitative data were analysed thematically using NVivo 12, following Braun and Clarke's (2006)[9] six-phase framework, with themes deductively structured around the MEA CES categories.

3.3 Data Analysis

Quantitative responses to the CES impact and restoration modules were analysed using descriptive statistics - frequencies and percentages - in IBM SPSS Statistics Version 26. Results are presented as a percentage of respondents endorsing each CES category. The MEA well-being constituent’s framework was applied as a post-hoc analytical lens to map CES degradation against dimensions of human well-being, as presented in Fig. 2 Qualitative themes were extracted and mapped onto quantitative findings to provide explanatory depth and triangulate the statistical patterns.

4. Results and Discussion

4.1 Perceived Impact of OD on Cultural Ecosystem Services

Respondents were asked to identify, from the full MEA CES taxonomy, which services they perceived to be degraded by OD in the Aboabo Forest. The results, presented in Fig. 1, reveal that the majority of CES are perceived as substantially affected, with aesthetic value, educational value, recreational and ecotourism value, and spiritual and religious value emerging as the four most severely impacted.

The finding that over nine in ten respondents (91.8%) perceive aesthetic value as the most degraded CES is consistent with the fundamental mechanism by which OD damages CES: the generation of a pervasive

foul odour and the visual presence of faecal matter transform the forest from an aesthetically valued space into one that is actively repellent. This resonates with findings from Bhatt et al. [8] and Busienei et al. [10], who identified the sensory qualities of the environment — odour, visible filth — as primary drivers of avoidance behaviour in sanitation contexts.

The near-equivalent degradation of educational value (90.0%) reflects the historical significance of the Aboabo Forest as a botanical and ecological learning site. With the establishment of the Tamale College of Agriculture and the Department of Forestry at the University for Development Studies, the forest had served as a practical study ground for tree species identification and ecological observation. The TaMA District Sanitation Officer described the consequences directly:

The forest serves as a botanical garden… students can learn about a variety of tree species.

“But the faecal matter… has chased the forest guards away because they cannot stand the smell.” — TaMA District Sanitation Officer, 2023

The degradation of recreational and ecotourism value (80.9%) and spiritual and religious value (76.4%) reflects a broader dynamic of forest abandonment. Key informants consistently described how OD has driven away the full range of forest users — students, worshippers, recreationists, and casual visitors — creating a self-reinforcing cycle of disuse and further degradation:

" It is driving people away from the forest. People do not go to the forest again to pray or relax." (Forestry Commission Director, 2023)

" The place is smelling, and no decent person will go there to benefit from any of the services. People will call you a weed smoker even when you go there to worship or learn." (Assembly Member, 2023)

The threat of social stigmatisation — being assumed to have entered the forest for OD or for illegal drug use — emerged as a second major mechanism of CES degradation, distinct from the direct sensory effects of OD. This social deterrence effect extends CES harm beyond the physical boundaries of OD contamination: even areas of the forest unaffected by OD are rendered inaccessible because legitimate users fear being misidentified as OD practitioners.

The degradation of spiritual and religious value carries particular salience in the Tamale context, given the predominantly Muslim (76.4%) and religiously observant population. Several informants described how sacred shrines historically located in the forest — sites of ancestral veneration, traditional healing, and community prayer — have been overtaken by OD activity, destroying their sacred character:

" The faecal matter has damaged the entire area... areas in the forest that were created as sacred places have all been turned into defecating sites and do not serve their purpose anymore." (TaMA District Sanitation Officer, 2023)

" I think the educational value is the most affected cultural ecosystem service... Also, I think religious values and cultural heritage are being affected. This is because some clans have their shrines in the forest where they used to worship. As for the aesthetic value, I think it is wholly lost." (Forestry Commission Officer, 2023)

4.2 Implications for Human Well-Being: A MEA Framework Analysis

Applying the MEA's five constituents of human well-being as an analytical lens, Fig. 2 maps the observed CES degradation against its implications for each well-being dimension. The results indicate that OD-driven CES loss generates negative consequences across all five constituents of well-being for the majority of CES, with only social relations exhibiting a mixed pattern (discussed in section 4.3).

The pervasive negative impact pattern across the well-being matrix underscores the multi-dimensional cost of OD-induced CES degradation. The loss of aesthetic value directly diminishes "freedom of choice and action", the MEA constituent referring to the ability to pursue valued activities, because community members can no longer choose to visit the forest for recreation, reflection, or cultural participation. The degradation of spiritual and religious value represents a loss of "good social relations" — the communal bonds formed through shared worship and cultural practice — and a threat to "security" insofar as communities in Tamale associate spiritual protection and ancestral goodwill with the maintenance of sacred forest spaces.

4.3 A Paradox: CES Promoted by OD

A counterintuitive finding from the survey is that 56.4% of respondents perceived OD as promoting social relations, while 13.6% cited recreation as a CES reinforced by the practice. This finding requires careful interpretation: it does not imply that OD is beneficial for social cohesion in any normative sense, but rather that the act of communal OD — particularly the documented pattern of women going to the forest in groups for safety [2, 19] — generates a form of social bonding that occurs precisely because the behaviour is spatially concentrated and socially shared.

This paradox has important implications for intervention design. It suggests that for a significant proportion of practitioners, particularly women, OD in the forest is embedded in a social routine that provides companionship, mutual protection, and a sense of shared identity. Interventions focused solely on infrastructure provision will not dissolve this social dimension; they must offer alternative contexts for the social interaction that currently occurs around forest OD. This finding aligns with broader behaviour change literature on the social embeddedness of sanitation practices [19, 10].

4.4 Community Priorities for CES Restoration

Respondents were asked to identify which degraded CES they considered most in need of sustainable restoration. The results, presented in Fig. 3, indicate that aesthetic value (94.5%), educational value (87.3%), and recreational and ecotourism value (78.2%) are the quantitatively highest restoration priorities, followed closely by spiritual and religious value (71.8%).

The qualitative data, however, reveal a divergence from the quantitative ranking: key informants consistently prioritised spiritual and religious value and educational value above aesthetic value, arguing that religious restoration carries a multiplier effect on the other services:

"There are some respects and values we accord to our religious beliefs. Like the respect we give our churches, mosques, and shrines. I think restoring religious values can lead to restoring other cultural ecosystem services because of the respect that comes with it. If you put up a church or a mosque here, every Christian or Muslim will fight to keep the area clean because it is a place of worship. And we all know that cleanliness is next to Godliness." — Forestry Commission Director, 2023

"Educational values can be acquired anywhere, but there are some respects and values we accord to our religious beliefs that can only be found in the Aboabo forest, so I think the religious values should be restored." — Forestry Commission Director, 2023

" I think the spiritual and religious value cannot be traded for any other value, so I will recommend that the religious values be brought back. As you know, Tamale is a very religious city." — Assembly Member, 2023

Triangulating the quantitative and qualitative findings, it can be concluded that educational and spiritual/religious values represent the most essential CES for restoration from a community perspective, while aesthetic value — though rated highest quantitatively — is viewed by institutional informants as a derivative outcome of restoring the deeper cultural and spiritual significance of the forest.

4.5 Proposed Restoration Pathways

The study identified four convergent pathways for CES restoration, drawn from both quantitative responses (on behavioural prevention strategies) and qualitative thematic analysis of key-informant interviews.

4.5.1 Public Education Campaigns

Across both data sources, education emerged as the foundational restoration strategy. Despite 89.6% of OD practitioners being aware of the health and environmental consequences of their behaviour [2], this knowledge has not translated into behaviour change — a classic awareness–behaviour gap [8, 10]. Informants therefore emphasised that effective education must go beyond health risk communication to address the cultural and environmental value of the forest:

"Education is the best way to restore the affected services. We must ensure we speak to people to accept the effects of open defecation on our health and the environment. That way, people can see the forest differently." — TaMA District Sanitation Officer, 2023

Both formal educational institutions (schools, colleges) and informal community channels must be engaged, given the mixed educational attainment of the surrounding population. UNESCO's (2020)

position that education is the critical enabler of ecosystem conservation aligns strongly with the community's own perception of its importance here.

4.5.2 Promotion of Religious and Cultural Activities in the Forest

Reflecting the qualitative data's emphasis on spiritual and religious value as a restoration multiplier, informants consistently proposed that formal religious and cultural activities — prayer meetings, shrine maintenance, church gatherings — be actively encouraged and facilitated in the forest. In a metropolis where Islamic and traditional religious authority commands substantial social influence, the endorsement of religious leadership is perceived as more powerful than institutional enforcement:

"There must be a stronger collaboration between the government, the Forestry Commission, the chiefs, and the communities. We need to educate the people more on the purpose of the forest, why we need to keep it clean, and also educate them on the benefits of the forest." — Forestry Commission Director, 2023

This finding directly complements the SaniFOAM-based recommendation in Adzah [2] that chief imams and traditional chiefs be formally engaged to denounce OD in the forest as incompatible with Islamic and traditional values. The present study adds the positive counterpart: not only should religious leaders condemn OD, but they should actively reclaim the forest as a space of religious significance, creating intrinsic social norms against its misuse.

4.5.3 Multi-Stakeholder Collaboration and Participatory Management

Both the quantitative and qualitative data highlight the inadequacy of single-actor management in addressing OD and restoring CES. Survey respondents endorsed constant forest monitoring by forest guards (90.9%) as a behavioural deterrent, while key informants emphasised the need for a coordinated management framework encompassing the Forestry Commission, TaMA, traditional leaders, community assemblies, and academic institutions:

"There must be a stronger collaboration between the government, the Forestry Commission, the chiefs, and the communities. If we build a strong understanding and come together with a common goal, we can restore the cultural ecosystem services." — Forestry Commission Director, 2023

This finding is consistent with Adzah [1], which documented institutional fragmentation in Ghanaian urban forest management — overlapping responsibilities between the Forestry Commission, Lands Commission, and metropolitan authorities — as a root cause of governance failure. A Participatory Forest Management Plan, as recommended by Adzah [2], would provide the institutional foundation for coordinating the CES restoration strategies identified in this study.

4.5.4 Integration of Recreational Infrastructure

A striking quantitative finding is that 96.4% of respondents indicated that developing the Aboabo Forest into a recreational park would prevent them from practising OD there. This overwhelming endorsement of recreational development as both a deterrent to OD and a mechanism for CES restoration reflects a fundamental insight: the absence of attractive, safe, legitimate uses of the forest creates a vacuum that OD — and other deviant activities — fill. Informants articulated this directly:

"I always tell people that this forest can best be used if there are more recreational centres, because it is within the town, and we can't promote extremely wild species. We can even have restaurants, a children's park, and bouncy castles. This will invite people to come and enjoy the serene nature of the forest, like the magnolia and black box in the agric forest." — TaMA District Sanitation Officer, 2023

Similarly, 82.7% of respondents supported the construction of toilet facilities within the forest itself as a deterrent to OD — though the 17.3% who would continue to practise OD even with a forest toilet facility indicates that infrastructure provision alone cannot fully resolve the motivational dimension of forest OD [2, 24].

4.6 Additional Threats to CES: Beyond OD

The study also identified threats to CES beyond OD that compound the restoration challenge. Survey respondents identified criminal activities — drug dealing, robbery, and assault — as the most critical additional threat to CES provision (97.3%), followed by illegal encroachment by small businesses and artisans (78.3%), farming within the forest (47.3%), and the presence of dangerous reptiles (0.9%). Assembly members and unit committee leaders consistently cited the intimidating presence of drug users in the forest as both a driver of OD — by creating cover and reducing deterrence — and as an independent barrier to legitimate CES access:

"I think the weed smokers in the forest should be chased out because they are making the forest scary and unsafe, and that is attracting people to defecate there because it serves as a cover for their privacy." — Assembly Member, 2023

This finding has significant implications for restoration planning: it indicates that CES restoration cannot be achieved through education and infrastructure alone if the forest remains a site of criminal activity. Physical security measures — regular patrols, boundary management, lighting, and community surveillance — must be integrated into the restoration strategy as a precondition for the other pathways to be effective.

5. Conclusions and Recommendations

5.1 Conclusions

This study provides the first systematic examination of community perceptions of OD-induced CES degradation in an urban forest reserve and the restoration strategies preferred by affected communities. The evidence from the Aboabo Forest in Tamale, Ghana, establishes clearly that OD is not only a public

health crisis but a cultural ecosystem crisis: it degrades the aesthetic, educational, recreational, and spiritual values of the forest that are central to the well-being of surrounding communities, and it does so primarily through two mechanisms — direct sensory deterrence (odour, visible contamination) and social stigmatisation (fear of being misidentified as an OD practitioner).

The well-being matrix analysis reveals that OD-induced CES degradation generates negative consequences across all five MEA constituents of human well-being, affecting security, material well-being, health, social relations, and freedom of choice simultaneously. This multi-dimensional impact underscores the One Health dimensions of the crisis: the degradation of a shared urban ecosystem has cascading consequences for the physical, social, and cultural health of the surrounding community.

Community members and institutional stakeholders have articulated a clear and coherent restoration vision centred on four convergent pathways: public education, promotion of religious and cultural activities, multi-stakeholder collaborative management, and recreational infrastructure development. These pathways are mutually reinforcing: education builds the cognitive foundation for valuing the forest; religious reactivation creates intrinsic social norms against its misuse; collaborative governance provides the institutional framework; and recreational infrastructure creates the positive use patterns that displace OD and other deviant activities.

5.2 Recommendations

Based on the findings, the following targeted recommendations are proposed:

- The Tamale Metropolitan Assembly and Forestry Commission should jointly develop a Participatory Forest Management Plan that formalises community roles in the stewardship, monitoring, and programming of the Aboabo Forest. This plan should designate resources for the four restoration pathways identified in this study.
- The TaMA District Health Directorate, in partnership with the Ghana Education Service, should design a multi-channel education programme that specifically addresses the cultural and ecosystem service value of the Aboabo Forest, moving beyond generic health risk messaging to build positive community identity around the forest.
- The TaMA and Forestry Commission should formally engage the Chief Imam, traditional chiefs, and Christian church leaders of all five study communities to jointly reclaim the Aboabo Forest as a space of spiritual significance, with organised religious activities supported by the Forestry Commission within a sustainable management framework.
- A phased recreational infrastructure development plan should be initiated for the Aboabo Forest, including safe walkways, seating areas, a children's park, and sanitation facilities, funded through a dedicated Forest Management Fund supported by user fees, fines, and budgetary allocations from TaMA.
- Security and enforcement must be treated as a precondition for CES restoration. The Forestry Commission should establish a dedicated patrol schedule for the Aboabo Forest, and TaMA should

coordinate with the Ghana Police Service to address criminal activities that currently render the forest unsafe for legitimate CES access.

- Future research should extend this work to assess OD's impact on the provisioning, regulatory, and supporting ecosystem services of the Aboabo Forest, and should employ longitudinal methods to track changes in CES quality and community well-being following the implementation of restoration interventions.

Declarations

Competing Interests:

The author declares that there are no competing interests.

Clinical trial number

Not applicable.

Research Ethics and consent to participate

The study was conducted in accordance with the research ethics requirements of the United Nations University. Prior to data collection, the research protocol, data collection instruments, and informed consent forms were reviewed and approved by the United Nations University Research Ethics Committee. Prior to participant recruitment, reconnaissance and community-entry activities were undertaken to inform relevant community leaders about the study and to obtain permission to conduct the research in the study communities. All participants were informed about the purpose and nature of the study, and informed consent was obtained before participation. Participation was voluntary, and participants were not coerced or otherwise pressured to participate.

Given the sensitive nature of the research topic, particular attention was paid to confidentiality, privacy, and participant anonymity. No personally identifying information was collected through the household survey. Interview data and questionnaire responses were treated confidentially, and participants were not identified by name in the reporting of the findings. Audio recordings of interviews were securely stored and will be destroyed in accordance with the data-management procedures specified by the United Nations University Research Ethics Committee.

Consent for publication:

Not applicable. This research does not contain any data or images that are identifiable or can be associated with any individual.

Funding:

The research was not supported by any funding.

Author Contribution

Author Contributions: The author "Bismark Yayra Adzah" was responsible for the conceptualization, research design, data collection, data analysis, interpretation of the findings, and preparation of the manuscript.

Data availability statement:

The datasets used and/or analysed during the current study are available from the corresponding author upon reasonable request.

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Figures



Figure 1

Community perceptions of CES degraded by OD in the Aboabo Forest (n = 110).

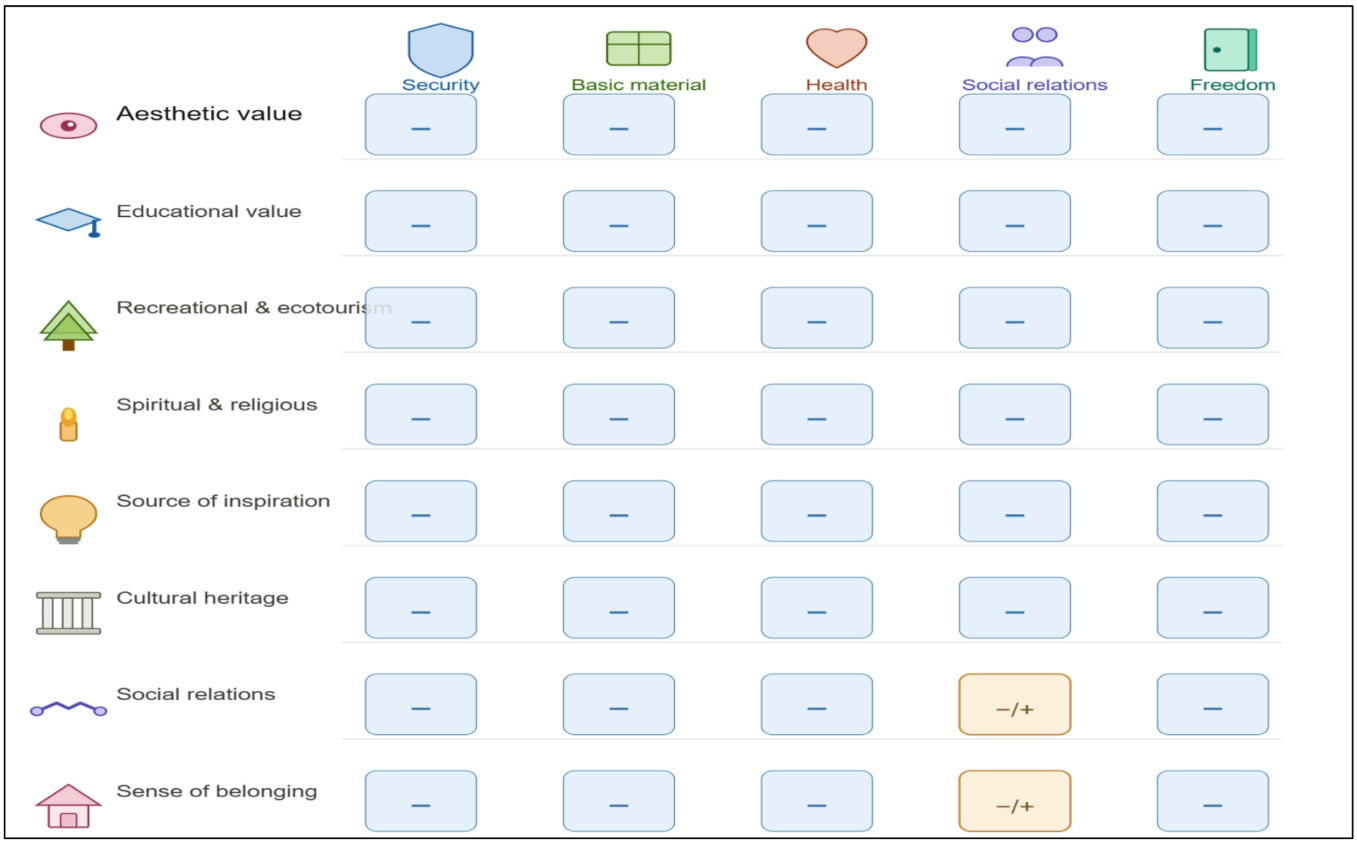


Figure 2

Perceived impact of OD-induced CES degradation on MEA constituents of human well-being. (−) = negative impact; (+) = positive impact; (− / +) = mixed impact. Adapted from MEA (2005) framework

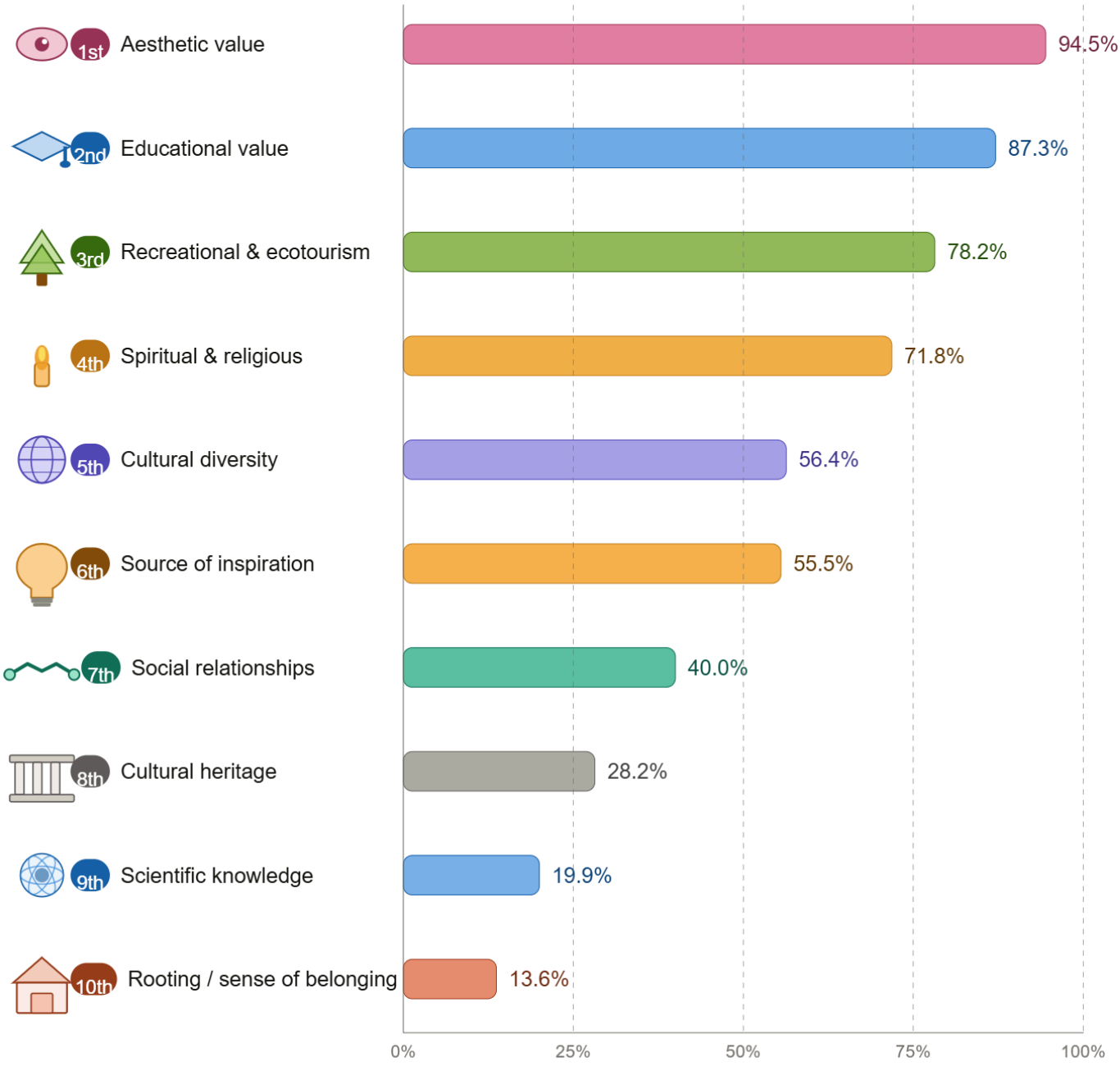


Figure 3

Community priorities for CES restoration in the Aboabo Forest (n = 110).