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Quantification of intangible forest ecosystem services in Eastern Arc Mountains of Tanzania

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ABSTRACT

Lack of recognition of the economic value of intangible forest ecosystem services has contributed to the ongoing degradation of forest resources in Tanzania. This study employed a choice experiment method to estimate the economic values of such services provided by the Udzungwa Scarp, Chome, and Uluguru Nature Forest Reserves in the Eastern Arc Mountains, by assessing households' willingness to pay (WTP). The services valued include protection of water sources, soil conservation, biodiversity conservation, climate regulation, and the provision of recreational and landscaping amenities. A simple random sampling technique was used to select 352 households from five districts: Same, Mvomero, Morogoro Rural, Kilolo, and Mufindi. Data were analyzed using a conditional logit model. The pooled analysis from the three reserves revealed that the estimated marginal WTP per month was TZS 597.40 for biodiversity conservation, TZS 1,898.49 for water source protection, and TZS 2,874.08 for soil conservation. Collectively, these services were valued at approximately TZS 22.68 million annually by all sampled households. To minimize the degradation of forest resources in the Eastern Arc Mountains region, this study recommends that policymakers incorporate the estimated economic values into forest conservation decisions, ensuring that beneficiaries of these services contribute to their protection.

Key Words: Economic valuation-willingness to pay-forest conservation-forest nature reserves-choice experiment method.

INTRODUCTION

Forests provide a wide range of ecosystem services that contribute to human well-being (Schultner *et al.* 2021). More than one billion people around the world depend on forests for their livelihoods (Aju *et al.* 2015). The forest sector employs over 60 million people globally, encompassing both formal and informal jobs (Taye *et al.* 2021). According to Li *et al.* (2022), the global forest sector directly contributed over $ 661 billion to the world economy in 2015, with 19.16 million people employed in the formal sector. In Tanzania, the forest sector plays a crucial role in the national economy, contributing 3.3% to the country's GDP (MNRT 2021). Furthermore, forest resources are a primary source of livelihoods for many Tanzanians, especially in the energy sector, which is dominated by wood fuel, mainly charcoal and firewood, on which approximately 75% of the population depends (Felix 2015). Despite these substantial contributions to human well-being, deforestation and forest degradation continue at alarming rates in Tanzania (Hamunyela *et al.* 2020, Nzunda and Yusuph 2022). The current rate of forest loss in Tanzania mainland is estimated at 469,420 hectares per year (URT 2017). Felix (2015) projected that if this trend continues, Tanzania could lose all its forest resources within 85 years from

2005, meaning future generations from the year 2090 onward may be left without forests unless effective conservation measures are implemented.

Many of the benefits provided by forest ecosystem services are not recognized in markets; as a result, they are often omitted from economic decision-making, and their values are not reflected in the calculation of the forest sector's contribution to the national economy (MNRT 2021). Market values are typically known for forest goods and services that are traded, such as timber and non-timber products because they have established market prices (Baskent 2023, Frey *et al.* 2021). However, non-marketed forest ecosystem services (NMFES), such as biodiversity conservation, climate regulation, nutrient cycling, and recreational amenities lack explicit market prices and are rarely traded, making them invisible in economic decision-making (Bigirwa *et al.* 2021, Frey *et al.* 2021, Gowdy *et al.* 2010). These services are considered public goods as they are non-excludable and non-rival in nature (Costanza *et al.* 1997). Consequently, their values can only be estimated through economic valuation methods that assign monetary values to these non-traded services (Johnston *et al.* 2017). Such valuations are essential for setting policy priorities, designing incentives for conservation, and assessing policy trade-offs (Anderson *et al.* 2010, Shrestha *et al.* 2023). Information on the economic value of ecosystem services can help decision-makers weigh the costs and benefits of land use options, ensuring more balanced and sustainable outcomes (D'amato *et al.* 2016, De Groot *et al.* 2012).

Most existing studies in Tanzania have focused on marketed services (MNRT 2021). Other specific studies include Schaafsma *et al.* (2014) which estimated the annual benefit of charcoal, firewood, poles, and thatch from the Eastern Arc Mountains (EAM) at $ 42 million. Balama *et al.* (2016) reported an annual value of TZS 51.4 billion ($ 36 million) for non-timber forest products from the Iyondo Forest Reserve in Kilombero District. Schaafsma *et al.* (2012) also estimated that charcoal trade alone generates $ 14 million annually, supplying around 11% of the charcoal used in Dar es Salaam and other major cities. Only a few studies have addressed non-marketed services. For instance, Kakuru (2016) estimated the economic value of NMFES in Minziro Nature Forest Reserve at $ 71.09 million.

In contrast, the economic value of NMFES in Tanzania remains largely unknown. This lack of data may contribute to the continued degradation of forest resources, as users and policymakers often fail to fully recognize their value in forest decision-making processes. It also leads to an underestimation of the forest sector's contribution to the country's GDP (MNRT 2021). While globally several studies have attempted to estimate the value of NMFES. For example, Costanza *et al.* (1997) estimated the annual economic value of climate regulation, soil formation, and recreation services provided by forests in the United States at $18.5 billion, $ 2.1 billion, and $ 7.6 billion, respectively. Ninan and Kontoleon (2016) valued forest ecosystem services in India's Nagarhole National Park, reporting water conservation at $ 0.19 million, soil protection at $ 0.0696 to 132.33 million, climate regulation at $ 0.379 to 0.759 million, nutrient cycling at $ 0.184 to 0.398 million, recreation at $ 0.401 million, air purification at $ 1.908 million, and biodiversity conservation at $ 3.945 million. Similarly, Badola *et al.* (2010) estimated the value of recreation and climate regulation services in India's Corbett Tiger Reserve at $ 167.619 million and $ 63.6 million, respectively. Since by knowing the monetary value of each ecosystem services is thought to contribute in conservation and protection of ecosystems which provide those services, the present study aimed to estimate the economic value of selected NMFES provided by selected nature forest reserves within the EAM so as to gauge the

willingness of people to pay for the continual provision of those services. Specifically, the study focuses on three forest blocks namely Udzungwa Scarp Nature Forest Reserve (USNFR), Chome Nature Forest Reserve (CNFR), and Uluguru Nature Forest Reserve (UNFR). The selection of these sites was informed by the need to address ongoing environmental degradation in the EAM region and to raise awareness among local communities about the importance of forest conservation. The general objective of this study was to estimate the economic value of selected NMFES by assessing households' willingness to pay (WTP) for these services. Specifically, the study aimed to: (1) assess households' preferences for selected NMFES, and (2) estimate the marginal WTP, also known as the implicit price for each selected NMFES. Consistent with Anderson *et al.* (2010), Esen *et al.* (2023), and Shrestha *et al.* (2023), the findings of this study are expected to inform efforts to incentivize sustainable forest management in the EAM region and lay the groundwork for the inclusion of the value of NMFES into national accounting systems.

MATERIALS AND METHODS

Description of study area

The study was conducted in three blocks of the EAM: the USNFR representing the southern part of the EAM; the UNFR representing the central part of EAM; and the CNFR representing the northern part of EAM (Figure 1). According to TFCG (2017), the three nature reserves are surrounded by 96 villages, and the majority of people in the area are engaged in crop farming activities.

Sampling procedures

A purposive sampling technique was used to select 13 villages surrounding the three nature reserves within five districts. The selected villages included: four villages of Mbakweni, Msindo, Menamu, and Ndolwa surrounding CNFR (Same District); four villages of Nyandila, Ndungutu, Lanzi, and Kibungo surrounding UNFR (Mvomero and Morogoro Rural Districts); and five villages of Idegenda, Masisiwe, Mbawi, Uhafiwa, and Ihimbo surrounding USNFR (Kilolo and Mufindi Districts) (Figure 1, Table 1). The household sample size (n=390) was determined based on the total number of households in the selected villages (N=4886) using Yamane's formula (Yamane, 1973). However, due to the unavailability of selected household heads or their representatives and the exclusion of incomplete questionnaires, the final sample included 352 households (Table 1). A simple random sampling technique was employed to select households within each village.

Data collection

Data for valuing the NMFES were collected from households through face-to-face interviews using choice cards. These cards were developed by combining different levels of the selected NMFES under valuation (Table 2). The services included the protection of water sources, soil conservation, climate regulation, biodiversity conservation, and the provision of recreational and landscaping amenities. In addition, following Bigirwa and Mombo (2017) and Johnston *et al.* (2017), a payment component was included to enable the estimation of individuals' marginal WTP for these services. The payment component was assigned four levels: TZS 0 (representing the status quo, where households pay nothing to access these services), TZS 3,000, TZS 5,000, and TZS 10,000. These NMFES and their corresponding levels, together with the payment levels, were used to construct the choice cards employed in the experiment.

With the five selected NMFES, four with three levels each and one with two levels alongside the payment component with four levels, a total of 648 (3^4x2^1 $x4^1$) possible alternatives or options could be generated

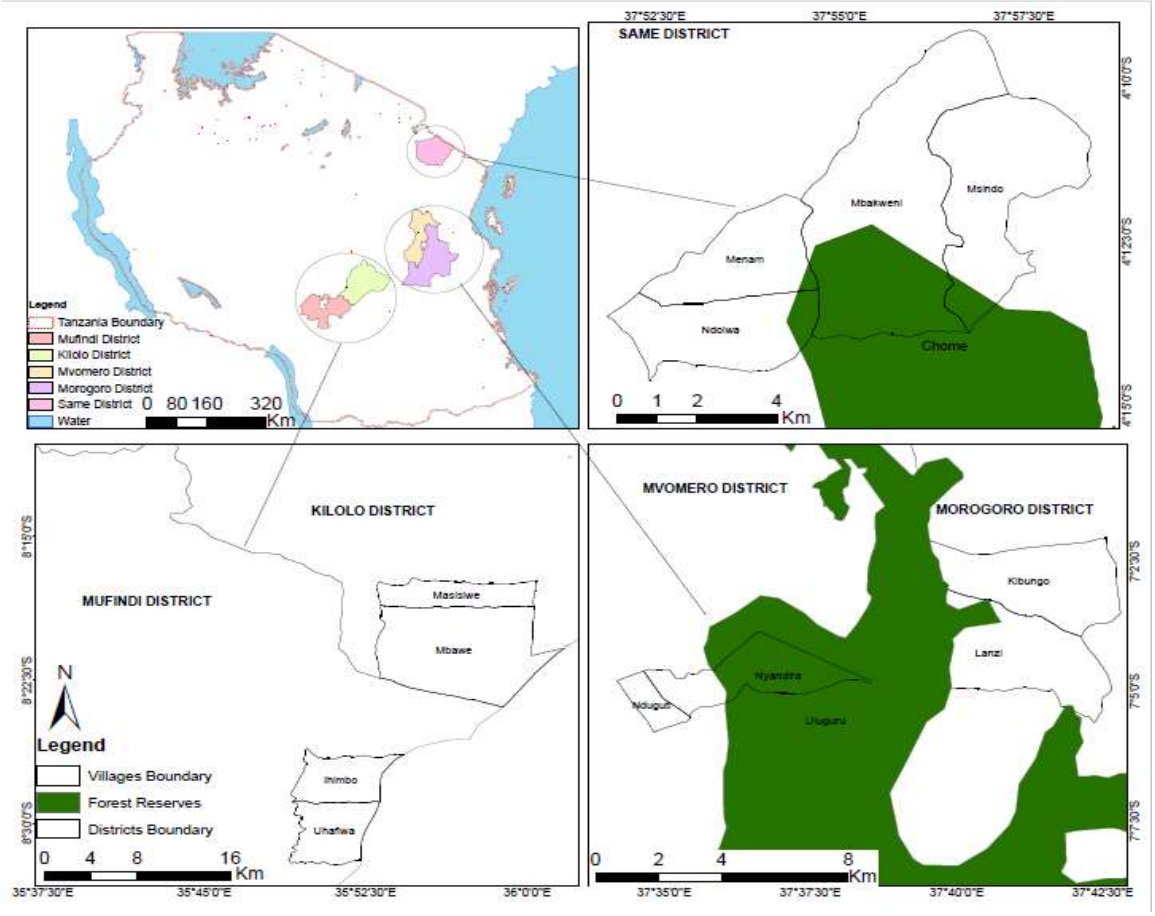

Figure 1. A map of Tanzania showing the studied villages in Same, Mvomero, Morogoro Rural, Kilolo and Mufindi districts in the three blocks of Udzungwa Scarp, Uluguru and the Chome Nature Forest Reserve in the Eastern Arc Mountains.

from all possible combinations. However, these options (648) are too large to present to the respondents, thus, a fractional factorial design was employed to reduce these options to nine [648*1/72=9] ensuring the choice sets were manageable for respondents. The nine options were grouped into three sets, each containing three choice cards. Consequently, each respondent was presented with three choice cards during the CE exercise. Each choice card presented two options for improving the provision of NMFES, along with a status quo option representing the current level of provision in the EAM. The status quo option allowed respondents who did not wish to support any improvements to choose the existing situation as their preferred alternative.

Data analysis

The collected choice data for valuing the NMFES were analysed with a conditional logit model (CL), specified in Equation 1. The CL model was chosen for this study because it is well-suited for analyzing discrete choice data, where the outcome variable is categorical and reflects the selection of one alternative from a set of options (Johnston *et al.* 2017).

$$U_{qjt} = \alpha + \beta_q X_{qjt} \qquad \text{(Equation 1)}$$

Where; U_{qjt} is indirect utility function of alternative j for respondent q at choice situation t. X_{qjt} is the vector of NMFES including a payment component, β_q are coefficient parameters to be estimated, while α is the alternative specific constant (ASC).

Table 1: Sampled households

District	Village	Number of households	Required household sample size	Actual number of households sampled
Same	Mbakweni	302	26	26
	Msindo	388	31	31
	Menamu	340	27	23
	Ndolwa	358	29	24
Mvomero	Nyandila	394	31	28
	Ndungutu	364	29	27
Morogoro Rural	Lanzi	462	36	30
	Kibungo	456	36	25
Kilolo	Idegenda	328	32	30
	Masisiwe	332	35	30
	Mbawi	400	26	26
Mufindi	Uhafiwa	456	26	26
	Ihimbo	306	26	26

Table 2: Description of the five selected NMFES

NMFES	Description	Levels
Protection of water sources	Protection of water sources or catchments within nature reserves in EAM so as to enhance the supply of water	1. Maintain the current practice 2. Reduce water conservation activities 3. Increase water conservation activities
Soil conservation for enhancing crop farming	Activities for conserving soils to enhance agricultural productivity, such as terracing, organic farming, mixed cropping	1. Plan One; stick on existing soil conservation activities (maintain the status quo) 2. Plan Two; introduce more soil conservation activities
Climate regulation	Enhancing the ability of vegetation or trees in nature reserve to regulate the climate	1. Maintain the current service 2. Reduce the current service through encouraging deforestation 3. Increase the service through discouraging deforestation
Biodiversity conservation	Conservation of animals or birds which live within the nature reserves such as the monkeys, gorilla, and other attractive animals	1. Keep the current number of biodiversity 2. Reduce the number of biodiversity 3. Increase the number of biodiversity
Provision of recreation and landscaping amenities	Enhancing the aesthetic value of the EAM, so as to increase the number of tourists who visit nature reserves in EAM	1. Maintain the quality of recreation sites 2. Degrade the quality of recreation site 3. Improve the quality of recreation sites through conserving the EAM

The protection of water sources was modelled as *"water"*, soil conservation as *"soil"*, climate regulation as *"climate"*, and the payment component as *"payment"*. All analyses were carried out in STATA version 14. Following Train (2016), the likelihood ratio tests were conducted to assess the model fitness, and all tests were statistically significant with p-values less than 0.05 (Table 3).

Households' preferences for NMFES were assessed based on the coefficients derived from the CL model. A positive and

statistically significant coefficient for a given NMFES indicates a preference for that service. Conversely, a negative coefficient, regardless of statistical significance, suggests a lack of preference. The ranking of these preferences was established by comparing the estimated implicit prices for each service. Generally, services with higher implicit prices are considered more preferred than those with lower values (Bigirwa and Mombo, 2017; Johnston *et al.* 2017). Furthermore, the implicit price also known as marginal WTP per month for each NMFES, was estimated using the coefficients derived from the CL model. Following Johnston *et al.* (2017), Equation 2 was used to calculate the marginal WTP of each service;

$$Marginal\ WTP = -\frac{\beta_{NMFES}}{\beta_{payment}} \quad \text{(Equation 2)}$$

Table 3: CL model results for the valuation of NMFES in the EAM

Variable	CNFR	UNFR	USNFR	EAM area (pooled analysis)
Water	1.8814***	0.9211**	0.2002***	0.8182***
	(0.3735)	(0.3914)	(0.3256)	(0.1946)
Soil	3.1620**	1.1137**	0.0996**	1.2387**
	(0.6176)	(0.4758)	(0.4081)	(0.8236)
Climate	-0.8070**	0.6890**	-0.0540	-0.5363**
	(0.3849)	(0.3499)	(0.3453)	(0.2004)
Biodiversity	0.2800**	0.6732**	0.0449**	0.2574**
	(0.5648)	(0.5292)	(0.4635)	(0.2762)
Recreation	-0.8324	-0.7912	-0.1844	-0.4004
	(0.5428)	(0.5601)	(0.4612)	(0.2768)
Payment	-0.0007***	-0.0005***	-0.0001**	-0.0004***
	(0.0023)	(0.0002)	(0.0001)	(0.0011)
ASC	-0.0007	-0.0848	-0.0342	-0.5325
	(0.1957)	(0.2126)	(0.1516)	(0.1020)
Summary statistics				
Number of observations	999	1017	1169	3168
Log likelihood	-420.4288	-431.1319	-534.1402	-1429.4820
LR chi^2 (7)	142.6900	135.7100	82.9200	266.8300
Prob >chi^2	0.0000	0.0000	0.0000	0.0000
Pseudo R^2	0.1451	0.1360	0.0720	0.0854

*Standard error in parenthesis, ***, ** significant at 1% and 5% level respectively*

RESULTS

Preferences for NMFES in the EAM area

The CL model results are shown in Table 3. The pooled analysis for all three nature reserves in the EAM show that the coefficients for soil conservation and biodiversity conservation were significant at the 5% level, while the coefficient for protection of water sources was significant at the 1% level. The positive signs of these ecosystem services indicate that communities living around the EAM prefer improvements in the provision of these NMFES, as such enhancements are likely to improve their livelihoods. In contrast, the estimated coefficient for the climate regulation services was negative and significant at the 5% level, suggesting that although climate regulation is recognized as an important ecosystem service, it is not preferred by the majority of people living around the EAM. The coefficient for provision of recreation and landscaping

amenities was insignificant indicating that this service is not preferred and not considered important in the area. The payment coefficient was negative and statistically significant, indicating that households prefer options with lower prices.

Implicit prices of each NMFES in EAM

Table 4 presents the implicit prices for each NMFES. The pooled analysis indicates that households in EAM are willing to pay TZS 597.40 ($ 0.22), per month to support biodiversity conservation efforts in their area, reflecting the recognition of biodiversity's value in sustaining livelihoods, for example, through practicing beekeeping activities. Similarly, the estimated implicit price per month for the protection of water sources was TZS 1,898.49 ($ 0.71). This suggests that households surrounding the EAM region are willing to pay this amount each month to ensure that all water sources originating from these mountain blocks are adequately protected. Additionally, households are willing to pay TZS 2,874.08 ($ 1.07) per month to support improvements in soil conservation practices, which would positively impact their agricultural productivity. The provision of recreation and landscaping amenities is not preferred as it had negative implicit price. This implies that households living around the EAM do not prefer this NMFES are not willing to pay for it. The results further reveal that households living around the EAM region do not prefer climate regulation services, as indicated by its negative implicit price. This suggests that they are not willing to pay for climate regulation services.

Table 4: Implicit price of each NMFES in EAM

NMFES	CNFR	UNFR	USNFR	EAM (pooled analysis)
Water	2573.86	1638.79	1016.09	1898.49
Soil	4325.59	1981.79	505.65	2874.08
Climate	-1104.09	1226.02	-274.37	-1244.32
Biodiversity	383.06	1197.94	228.15	597.40
Recreation	-1138.75	-1407.98	-935.96	-929.20

DISCUSSION

The study findings reveal that communities living around the EAM have distinct preferences for NMFES, though these preferences are not entirely homogeneous. The results highlight that communities share similar preferences regarding the protection of water sources. This shared preference reflects their recognition of the importance of water sources, as they rely heavily on these sources for their domestic water needs. Similarly, they exhibit common preferences for soil conservation, largely because the majority of households are engaged in crop farming, their primary livelihood activity. Soil conservation is particularly critical given that many of these communities reside in sloped areas where soil erosion from runoff poses a significant threat. Biodiversity conservation is also widely preferred, as it supports local livelihoods, particularly through activities such as apiculture. Even though the overall preferences for climate regulation services in the entire EAM region is negative, communities living around the UNFR diverge from this general preference as they demonstrated to have a positive preference for this NMFES. Additionally, households throughout the EAM exhibited a clear lack of preference for the provision of recreational and landscaping amenities. This

reluctance may be attributed, in part, to the limited direct benefits that local households derive from these services, which are primarily enjoyed by tourists from outside the local area. Unlike ecosystem services such as protection of water sources or soil conservation, which offer more tangible and immediate benefits to local communities, recreational and landscaping amenities provide less direct value to these households.

The estimated implicit prices per month for biodiversity conservation, protection of water sources and soil conservation in the EAM region were TZS 597.40 ($ 0.22), TZS 1,898.49 ($ 0.71) and TZS 2,874.08 ($ 1.07), respectively. Based on these estimates, soil conservation emerges as the most preferred intangible forest ecosystem service, as indicated by its highest implicit price relative to the other services. This preference reflects the community's strong dependence on agriculture and underscores the critical role of soil conservation service in sustaining their livelihoods. Protection of water sources ranks as the second most preferred service, highlighting respondents' strong concern for safeguarding water resources that largely originate from the EAM. The high value placed on water source protection is likely due to the fact that natural forest water sources constitute the primary supply of domestic water for household use. Biodiversity conservation was the least preferred among the three preferred services. This trend aligns with the findings from CNFR and UNFR but differs from USNFR, where protection of water sources was ranked highest. Regarding the implicit prices of NMFES in each specific nature reserve, higher values were observed among communities surrounding the CNFR while the lowest values were recorded around the USNFR. This suggests that communities near CNFR place a higher value on NMFES, likely due to the relatively greater level of environmental degradation in their area compared to that experienced by those living near USNFR. This observation is supported by Kirui and Mirzabaev (2014), Sara *et al.* (2011), and Seth (2022), who reported that environmental degradation in Tanzania is more pronounced in the northern part of the country than in the south. This study argues that the extent of environmental degradation influences individuals' valuation of ecosystem services, with perceived value tending to be higher in areas where such services are scarce due to degradation, and lower in areas where their provision remains relatively intact. These findings are further supported by Obeng and Aguilar (2018), who found that awareness of environmental degradation and its impacts on human well-being is a strong driver of WTP for the restoration and protection of forest ecosystem services in the United States. In line with this evidence, the current study highlights that communities in the northern and eastern parts of the EAM are more willing to support payments for NMFES than those in the southern region.

Based on the estimated implicit prices of NMFES for the pooled analysis, households are willing to pay an average of TZS 5,369.92 (approximately $ 1.99) per month for their three preferred services. Using this estimate, the 352 sampled households could collectively generate a total of TZS 22,682,748 (about $8,511.37) per year to support the protection of water sources, soil conservation, and biodiversity conservation. When these figures are extrapolated to all households (n = 936,865) in the five studied districts across the three EAM blocks, assuming all households share these preferences and a WTP, a total of TZS 60,371,243,329 ($22,726,923.59) could be generated annually. These estimates indicate that households living around the EAM are willing to support initiatives that promote forest conservation.

The current findings are comparable to those of previous studies. According to Kakuru (2016), the estimated annual economic values for selected NMFES in Minziro Nature Forest Reserve were $49,955,251 for regulating water quality,

storage, and recharge; $11,004,563 for soil fertility and moisture; and $968,799 for climate regulation services. These values are considerably higher compared to the findings of the present study. The disparity may be attributed to the valuation method employed in the Minziro study, which relied on the benefit transfer approach (Kakuru, 2016). Although useful in data-scarce contexts, this method is often criticized for its limited accuracy when not carefully applied, as it transfers values from studies conducted in different locations rather than using site-specific primary data (Costanza *et al.* 1997, Nie *et al.* 2021). In contrast, the current study provides actual site-specific estimates based on households stated WTP for NMFES offered by forest reserves in the EAM, making the findings more contextually grounded and locally relevant.

With regard to climate regulation, the present study reports a negative household preference for this service, suggesting that communities living around the EAM do not perceive this NMFES as particularly important. This may be partly due to limited knowledge and awareness of climate change and the role that forests play in climate regulation services (Sara *et al.* 2011). Their lack of preference for climate regulation services is consistent with the findings of Beukering *et al.* (2003), who reported a negative preference for climate regulation services provided by the Leuser Ecosystem in Indonesia. Costanza *et al.* (1997) estimated the economic values of climate regulation, soil formation, and recreation provided by forests in the United States at $18.5 billion, $2.1 billion, and $7.6 billion per year, respectively. Compared to the findings of the present study, these values are significantly higher. However, a notable observation is the positive preference for climate regulation and provision of recreation services. The observed variation in economic values may be largely due to differences in levels of economic development between countries. Unlike the United States, Tanzania is characterized by lower levels of economic development, which may influence households' ability and WTP for these services. Furthermore, the differences in the level of environmental literacy contributes to such variation in preferences for NMFES especially climate regulation services, with majority of rural population in Tanzania being less aware of these critical ecosystem services (Seth, 2022), in comparison to the referenced study. Additionally, most people in Tanzania show limited interest in domestic recreational activities compared to those in the United States, which may also contribute to their negative preferences for provision of recreation and landscaping amenities.

Ninan and Kontoleon (2016) estimated the economic values of NMFES in Nagarhole National Park in Karnataka, India. In contrast to the findings of the present study, communities in India demonstrated a higher WTP for NMFES, including a positive WTP for climate regulation services. These differences may be attributed to varying levels of environmental awareness, with Tanzania generally exhibiting lower awareness and understanding of ecosystem services. Similarly, Badola *et al.* (2010) estimated the economic values of recreation and climate regulation services in the Corbett Tiger Reserve, India, at $167.619 million and $63.6 million, respectively. These values contrast with the present study's findings, likely due to stronger positive preferences for recreation and climate regulation services in India, which may be explained by the more developed tourism sector in Corbett compared to the EAM. Furthermore, Strand *et al.* (2018) reported that the economic value of ecosystem services in the Amazon forests of Brazil ranged from $68.47 million to $822.76 million. These considerably higher values in comparison to the current study are likely due to the inclusion of both marketed goods, such as nuts, rubber, timber, and livestock, and NMFES in their valuation. Additionally, the vast size of the Amazon forest (approximately 5.5 million km²), compared to the much smaller EAM

(approximately 23,000 km²), contributes to the broader range of services and higher total value reported.

CONCLUSION AND POLICY IMPLICATIONS

The study findings reveal that households living around the EAM have clear preferences for NMFES and they are willing to pay to support the conservation of forest ecosystems. The highest preferences were associated with ecosystem services that have direct livelihood impacts, such as soil conservation, protection of water sources, and biodiversity conservation. The strong preference for soil conservation is attributed to the fact that the vast majority of households (97.03%) are engaged in agricultural activities. These households expect that soil conservation service would reduce erosion, given the terrain of their areas and improve soil fertility. Similarly, the protection of water sources is also preferred, as the EAM serve as a major source of domestic water for households in the study areas. The preference for biodiversity conservation stems from the direct benefits some biodiversity, such as bees used in apiculture. In contrast, the study found that households do not prefer and are not willing to pay for climate regulation services, and the provision of recreational grounds and landscaping amenities. Their lack of preference for climate regulation services is likely due to limited awareness of the benefits associated with such services. Additionally, their negative preferences for recreational and landscaping amenities may be explained by the fact that these services do not yield direct, tangible benefits for local households, unlike water provision or improvements in soil conservation.

Furthermore, the study reveals that the estimated economic values of NMFES are substantial and deserve recognition by policymakers. The average monthly WTP across all three nature reserves was estimated at TZS 5,369.92 ($ 1.99). Based on this figure, approximately TZS 22,682,748 ($ 8,511.37) could be generated annually from the sampled households. When extrapolated to all households residing in the three blocks of the EAM, the potential annual contribution rises to TZS 60,371,243,329 ($ 22,189,372.00). These results highlight the significant economic value that local communities place on forest ecosystem services and underscore the importance of integrating these values into conservation and policy planning. Based on the results, the study recommends that responsible ministries and institutions, specifically the Ministry of Natural Resources and Tourism and the Tanzania Forest Services agency incorporate the estimated economic values of NMFES into forest conservation decisions in the EAM area. For instance, these values could inform the design of community-based forest conservation programs funded through households' WTP for NMFES. This approach would enhance recognition of the economic value of intangible forest ecosystem services and support more sustainable forest conservation efforts across the EAM.

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