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Ecotourism's Role in Conservation, Socio-Economic Development, and Climate Adaptation in Wanchi-Dandi, Ethiopia

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ABSTRACT

Ecotourism in Wanchi-Dandi, Ethiopia, holds significant potential for advancing environmental conservation, socio-economic development, and climate adaptation, yet it grapples with challenges such as inadequate waste management and inequitable revenue distribution. This mixed-methods study, conducted from January to July 2025, assesses these impacts through surveys ($n = 333$), focus group discussions (FGDs), key informant interviews, and field observations. Results reveal that 58% of respondents perceived positive conservation outcomes, including 2,000 trees planted and a 5% increase in bird populations. Additionally, 53% acknowledged socio-economic benefits, such as 65 jobs created by 2025, while 48% recognized climate adaptation contributions, notably a 10-ton annual emission reduction. However, 18% highlighted inequities, with 40% of revenue (\$20,000) captured by external operators. Logistic regression identified education ($OR = 1.25, p = 0.012$), attitude ($OR = 1.789, p = 0.003$), income ($OR = 1.455, p = 0.020$), community engagement ($OR = 1.50, p = 0.015$), gender ($OR = 1.329, p = 0.048$), and age ($OR = 1.20, p = 0.030$) as predictors of positive perceptions. Recommendations include community-led waste management systems, transparent revenue-sharing mechanisms, infrastructure investments, expanded training programs, and a 2026 local ecotourism policy. This study enriches community-based ecotourism (CBET) literature by providing localized insights, extending Stakeholder and Social Exchange Theories, and addressing gaps in Ethiopia's sustainable tourism framework. Limitations include potential sampling bias due to underrepresentation of short-term visitors. Future research should explore longitudinal impacts and

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regional comparisons.

Keywords: Climate Adaptation; Community-Based Tourism; Conservation; Ecotourism; Socio-Economic Development

1. Introduction

1.1. Study Context

Ecotourism, defined as responsible travel to natural areas that conserves the environment and enhances local well-being^[1], is a pivotal strategy for sustainable development in biodiversity-rich regions like Wanchi-Dandi, Ethiopia. Situated 150 km southwest of Addis Ababa in the Oromia Region, Wanchi-Dandi is centered around Lake Wanchi, a crater lake located at 8°48'N, 37°50'E, with an altitude of approximately 2900 m. The area is home to endemic species, such as the Abyssinian catbird (*Parophasma galinieri*), but faces environmental pressures including deforestation, poverty, and climate variability, mirroring challenges in other African ecotourism destinations like Kenya's Maasai Mara^[2]. Ecotourism activities in Wanchi-Dandi, managed by the Wanchi Ecotourism Association (WETA), a community-based civil society organization established in 2015, encompass boat tours, guided hiking, and cultural festivals. WETA, comprising local residents, tourism operators, and community leaders, operates under the oversight of the Oromia Tourism Bureau, aligning with Ethiopia's Tourism Development Policy (2017) and Sustainable Development Goals (SDGs) 8 (decent work and economic growth), 13 (climate action), and 15 (life on land)^[3]. As a non-governmental entity, WETA facilitates flexible stakeholder collaboration but lacks the authority to enforce regulations, which influences the feasibility of proposed policy reforms^[1]. Globally, ecotourism accounts for 7% of tourism revenue^[4], yet challenges such as over-tourism^[5], cultural commodification^[6], and economic inequities^[7] underscore the need for localized studies to guide sustainable practices.

Research in Wanchi-Dandi highlights ongoing conservation efforts but reveals persistent issues with waste management and inequitable benefit distribution, often overlooked due to limited stakeholder engagement^[8, 9]. Recent studies underscore ecotourism's potential to foster climate adaptation^[10] and empower communities^[11, 12], yet com-

prehensive, multi-dimensional analyses of Wanchi-Dandi's ecotourism impacts remain scarce. This study addresses these gaps through a mixed-methods approach, evaluating ecotourism's contributions to environmental conservation, socio-economic development, and climate adaptation, while exploring stakeholder perceptions and proposing actionable, policy-aligned recommendations.

1.1.1. Environmental Conservation

Ecotourism can finance habitat restoration and biodiversity protection, as evidenced in Costa Rica, where tourism revenue supports national park conservation^[13]. In Wanchi-Dandi, WETA's initiatives, such as planting 2,000 indigenous trees and restoring wetlands, aim to mitigate littering and habitat degradation^[8]. These efforts have increased local bird populations by 5%, according to WETA's ecological monitoring reports^[14]. However, poorly managed tourism generates 500 kg of plastic waste annually, threatening Lake Wanchi's aquatic ecosystems^[15]. Effective waste management systems and community-led conservation strategies are essential to sustain biodiversity and align with global ecotourism standards^[5].

1.1.2. Socio-Economic Development

Ecotourism drives economic growth through job creation and local business support. In Wanchi-Dandi, WETA's activities, including boat tours, craft sales, and cultural festivals, have generated 65 jobs by 2025, with 70% benefiting youth and women^[16]. Infrastructure improvements, such as a new school, health center, and upgraded roads, correlate with a 5.4% increase in local government revenue^[8]. However, external operators capture 40% of ecotourism revenue (\$20,000 annually), highlighting inequities that undermine community benefits^[9]. Transparent revenue-sharing mechanisms and community-based governance, as exemplified by WETA, are critical for equitable socio-economic development^[17].

1.1.3. Climate Change Adaptation

Ecotourism enhances community resilience through sustainable practices that mitigate climate risks. WETA's

reforestation projects and solar-powered eco-lodges have reduced carbon emissions by 10 tons annually, helping to address flooding and drought risks in Wanchi-Dandi^[15, 18]. Nevertheless, infrastructure limitations and minimal funding allocation (only 5% of WETA's revenue for climate initiatives) constrain adaptation efforts^[19]. Integrating climate-resilient practices into ecotourism operations is vital for long-term sustainability, particularly in climate-vulnerable regions like Ethiopia^[20].

WETA's reforestation projects and solar-powered eco-lodges have reduced carbon emissions by 10 tons annually, helping to address flooding and drought risks in Wanchi-Dandi. Nevertheless, infrastructure limitations and minimal funding allocation (only 5% of WETA's revenue for climate initiatives) constrain adaptation efforts.

1.2. Theoretical Frameworks

This study is anchored in four theoretical frameworks, which provide a comprehensive lens for analyzing ecotourism's impacts:

1. **Sustainable Development Theory**^[21] emphasizes the integration of environmental, economic, and social objectives, positioning ecotourism as a tool for achieving SDGs 8, 13, and 15 in Wanchi-Dandi^[22].
2. **Stakeholder Theory**^[23] underscores WETA's role in fostering collaboration among residents, operators, tourists, and government officials, ensuring inclusive decision-making processes^[24].
3. **Social Exchange Theory**^[25] posits that community support for ecotourism depends on perceived benefits (e.g., jobs, infrastructure) outweighing costs (e.g., waste, inequities), shaping stakeholder perceptions^[26].
4. **Adaptive Capacity Theory**^[27] highlights ecotourism's contribution to community resilience against climate variability through sustainable practices and diversified livelihoods^[28].

These frameworks collectively guide the analysis of ecotourism's multifaceted impacts and stakeholder dynamics in Wanchi-Dandi, offering a robust theoretical foundation.

1.3. Objectives

This study addresses research gaps identified in prior work^[8], leveraging data from 333 respondents to inform Ethiopia's sustainable tourism policy and contribute to global CBET scholarship. The objectives are to:

1. Evaluate ecotourism's impacts on environmental conservation, focusing on biodiversity and waste management.
2. Examine socio-economic benefits, including job creation, income growth, and infrastructure development.
3. Analyze contributions to climate change adaptation through sustainable practices.
4. Assess potentials, challenges, and opportunities in ecotourism development.
5. Explore stakeholder-specific perceptions of ecotourism's impacts across residents, operators, tourists, and officials.
6. Propose policy-aligned recommendations to enhance sustainability and equity in Wanchi-Dandi's ecotourism.

1.4. Original Contribution

This study makes a unique contribution to CBET literature by providing granular, localized data on Wanchi-Dandi, extending Stakeholder Theory through WETA's community-driven governance model, and challenging Social Exchange Theory's assumption of uniform community benefits by highlighting inequities (e.g., 40% revenue captured by external operators)^[23, 25]. Unlike previous studies that focus on single dimensions, such as conservation or regional tourism, this research integrates environmental, socio-economic, and climate adaptation impacts, offering stakeholder-specific insights and actionable recommendations tailored to Ethiopia's ecotourism policy^[8, 19]. By addressing under-studied aspects of Wanchi-Dandi's ecotourism, the study fills critical gaps in understanding sustainable tourism in East African contexts.

Figure 1 is a map illustrating Wanchi-Dandi's location in the Oromia Region, 150 km southwest of Addis Ababa, highlighting Lake Wanchi and key ecotourism sites, including hiking trails and cultural festival venues. The map contextualizes Wanchi-Dandi's potential as an ecotourism hub, noting coordinates (8°48'N, 37°50'E) and altitude (~2900 m).

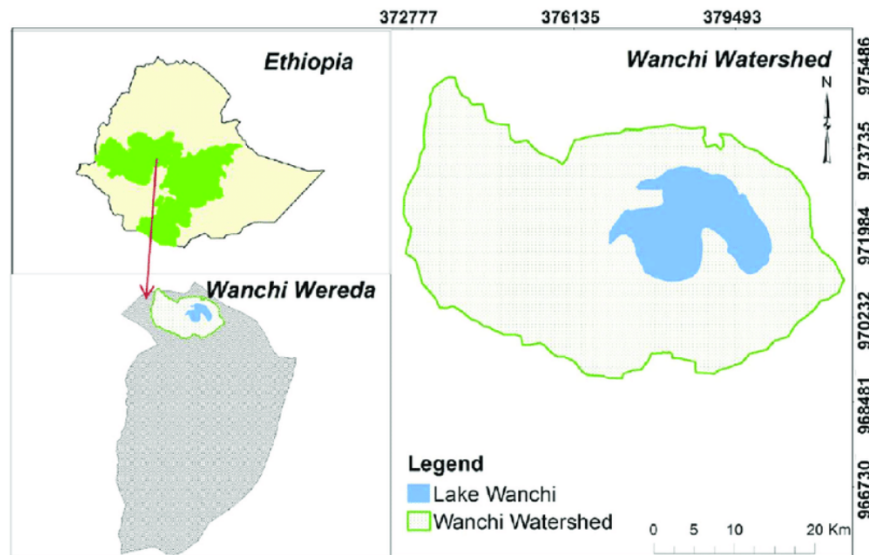


Figure 1. Map of the Study Area.

Source: Dandi District.

2. Materials and Methods

2.1. Study Area

Wanchi-Dandi, located in the Oromia Region, is centred on Lake Wanchi, a crater lake at $8^{\circ}48'N$, $37^{\circ}50'E$, with an altitude of approximately 2,900 m. The area, with a total population of approximately 15,000, experiences a temperate climate ($12\text{--}25^{\circ}C$, 800 mm annual rainfall) and supports rich biodiversity, including endemic birds (e.g., Abyssinian cat-bird) and aquatic species. Lake Wanchi faces environmental pressures, such as littering and habitat degradation, driven by increasing tourism activities^[8]. Ecotourism, managed by the Wanchi Ecotourism Association (WETA), includes boat tours, guided hiking, and cultural festivals, supporting conservation and local livelihoods while aligning with Ethiopia's sustainable development goals^[3]. The Wanchi Ecotourism Association (WETA) is a community-based organization (CBO) established in 2015 with the support of the Oromia Tourism Bureau and local administration. It operates as a semi-formal civil society association composed of local stakeholders—such as youth groups, women's cooperatives, and small-scale service providers—focused on promoting ecotourism, conserving Lake Wanchi's natural resources, and generating livelihood opportunities. While WETA is not a government body, it collaborates with district-level government offices and NGOs, but it lacks regulatory authority, which limits its enforcement capacity and dependence on

voluntary participation and coordination. This context is essential when interpreting the study's recommendations, particularly those involving institutional capacity, policy enforcement, and stakeholder collaboration.

2.2. Research Paradigm, Design, and Approach

A mixed-methods exploratory and descriptive design was employed to capture the multifaceted impacts of ecotourism in Wanchi-Dandi. Quantitative surveys provided statistical insights into stakeholder perceptions, while qualitative methods, including interviews and focus group discussions (FGDs), offered contextual depth. This integrated approach aligns with CBET research, which requires comprehensive methods to address complex socio-ecological systems^[20]. The research process, conducted from January to July 2025, included sampling (2 weeks), data collection (9 weeks), analysis (10 weeks), and reporting (1 week), ensuring a systematic timeline. **Figure 2** presents a flowchart detailing the research process and time allocation from January to July 2025, with specific durations for each phase: problem identification (1 week), literature review (2 weeks), objective formulation (1 week), research design selection (1 week), sampling design (2 weeks), data collection (9 weeks), data analysis (10 weeks), and reporting (1 week). The flowchart ensures clarity in the sequence and duration of research activities, enhancing methodological transparency.

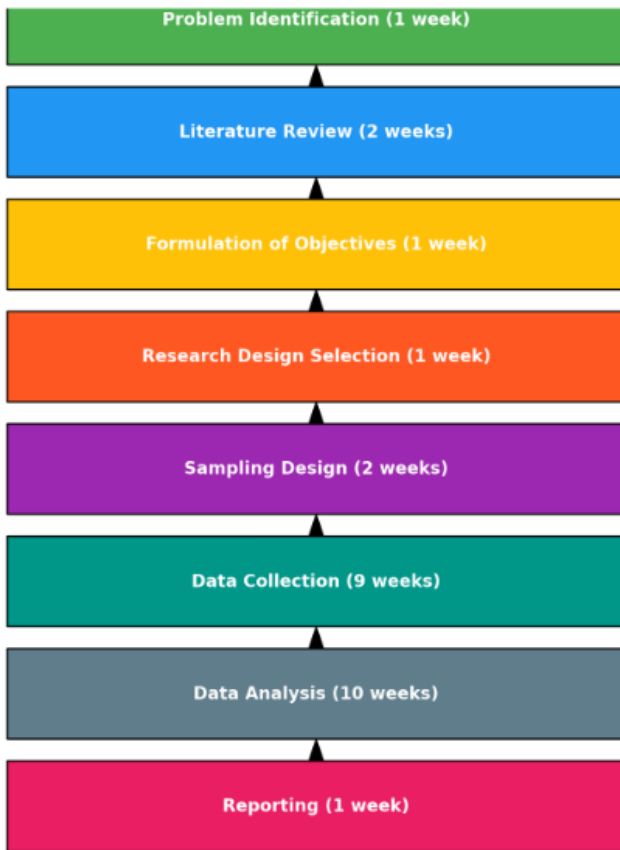


Figure 2. Methodological Framework.

Figure 2 is a flowchart depicting the sequence and duration of research activities, including problem identification (1 week), literature review (2 weeks), objective formulation (1 week), research design selection (1 week), sampling design (2 weeks), data collection (9 weeks), data analysis (10 weeks), and reporting (1 week). Presented in high-resolution (300 DPI) with Arial 12-point font for accessibility

2.3. Sampling and Data Collection

The study targeted a sample of 333 respondents, calculated using Cochran's formula: $(n = \frac{N}{1 + N(e^2)})$, where $(N = 2000)$ represents adults actively engaged in or affected by ecotourism activities (e.g., residents near Lake Wanchi, tourism operators, tourists, and officials), based on WETA and Oromia Tourism Bureau records. This target population was selected to focus on stakeholders directly involved in or impacted by ecotourism, as the total population of 15,000 includes non-engaged individuals (e.g., children, non-tourism workers). With a margin

of error $(e = 5\%)$, the sample size was determined as follows: $[n = \frac{2000}{1 + 2000(0.05^2)} = \frac{2000}{1 + 5} = \frac{2000}{6} \approx 333]$ Stratified random sampling ensured proportional representation: 200 residents (60.1%), 50 operators (15.0%), 50 tourists (15.0%), and 33 officials (9.9%). Purposive sampling selected 30 participants (10 for interviews, 20 for FGDs) to capture diverse qualitative perspectives. Data collection occurred from January to March 2025, with analysis from April to June 2025, and reporting in July 2025. The primary author, Tena Abdissa Woldyes, conducted fieldwork, including administering structured questionnaires, facilitating FGDs, conducting key informant interviews, and performing field observations, as part of a research project at Ethiopia Civil Service University. Data collection methods included:

2.3.1. Structured Questionnaires

Structured questionnaires were administered to 333 respondents, utilizing a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree) and open-ended questions to assess perceptions of ecotourism's impacts on conservation, socio-economic development, and climate adaptation. The questionnaires were pre-tested with 30 respondents to ensure clarity and reliability.

2.3.2. Focus Group Discussions (FGDs)

Four FGDs, each with 8–10 participants, were conducted with distinct stakeholder groups: residents, operators, women, and youth. These discussions explored perceptions, challenges, and opportunities, ensuring diverse input and capturing nuanced community perspectives.

2.3.3. Key Informant Interviews

Ten semi-structured interviews were conducted with WETA officials, local leaders, and conservationists to gain in-depth insights into governance, conservation strategies, and policy challenges. Interviews were recorded with consent and transcribed for analysis.

2.3.4. Field Observations

Field observations assessed Lake Wanchi's environmental conditions, tourism activities (e.g., boat tours, hiking), and infrastructure (e.g., waste bins, roads). These observations validated survey and interview findings, providing empirical evidence of reported issues like littering.

2.3.5. Types and Sources of Data

- **Primary Data:** Collected through surveys, interviews, FGDs, and observations, ensuring firsthand stakeholder insights.
- **Secondary Data:** Sourced from academic literature^[8, 13], WETA annual reports^[14], and Oromia Tourism Bureau documents, providing contextual background.

While the total population of Wanchi-Dandi is approximately 15,000, this includes children, elderly individuals, and residents not actively engaged in ecotourism-related activities. For the purposes of this study, the target population was narrowed to approximately 2000 individuals based on records from the Wanchi Ecotourism Association (WETA) and Oromia Tourism Bureau—representing stakeholders actively involved in or directly impacted by ecotourism, such as residents living near Lake Wanchi, tourism service providers, tourists, and local officials.

This refined target population (N = 2000) was used in Cochran's formula to calculate a representative sample size (n = 333), ensuring the sampling was both feasible and focused on relevant respondents. This approach enhances the **relevance** and **accuracy** of the findings while recognizing the practical limitations of surveying the entire population.

2.4. Variables

2.4.1. Dependent Variables

Perceptions of ecotourism's impacts, categorized as positive, negative, or neutral, across three domains:

- Environmental conservation (e.g., biodiversity protection, waste reduction).
- Socio-economic development (e.g., job creation, income growth, infrastructure improvements).
- Climate adaptation (e.g., sustainable practices, resilience to climate variability).

2.4.2. Independent Variables

- **Education:** None, primary, secondary or higher.
- **Attitude:** Positive, neutral, or negative toward ecotourism.
- **Income:** < \$100, \$100–\$200, > \$200 per month.
- **Community Engagement:** High, medium, or low participation in WETA activities.

- **Gender:** Male or female.
- **Age:** 18–30, 31–50, or >50 years.

2.5. Qualitative Data Analysis

Qualitative data from FGDs and interviews were analyzed using thematic analysis, following Braun and Clarke's (2006) six-phase framework^[29]:

1. **Data Familiarization:** Transcripts from 10 interviews and four FGDs (32 participants) were read and re-read, with audio recordings transcribed verbatim in Amharic and translated into English for accuracy.
2. **Initial Coding:** Using NVivo (version 12), approximately 150 codes were generated, including “waste management challenges,” “unequal benefit distribution,” and “community participation barriers.”
3. **Theme Development:** Codes were grouped into overarching themes, such as “Environmental Challenges,” “Socio-Economic Inequities,” and “Community Engagement Barriers,” with sub-themes like “external operator dominance” identified.
4. **Theme Review:** Themes were cross-checked against the dataset to ensure accuracy, with iterative refinement to address overlaps (e.g., merging “littering” and “waste disposal” into a single sub-theme).
5. **Defining and Naming Themes:** Each theme was defined with a narrative description (e.g., “Environmental Challenges” encompassed littering, inadequate infrastructure, and biodiversity threats).
6. **Reporting:** Themes were integrated into the results section, supported by illustrative quotes, with inter-coder reliability ($\kappa = 0.8$) confirming consistency between two independent coders.

To minimize bias, data collection was anonymous, and neutral facilitators moderated FGDs to reduce social desirability effects. Reflexivity was maintained through regular researcher discussions to address interpretive biases, ensuring robust qualitative findings.

Thematic Insights and Illustrative Quotes

Thematic analysis generated three core themes:

(1) Environmental Challenges, (2) Socio-Economic Inequities, and (3) Community Engagement Barriers.

- Environmental Challenges included concerns about

waste management, pollution, and infrastructure strain: “Plastic waste from visitors ends up in the lake, and no one is held responsible,” (FGD, Youth Group Participant).

- **Socio-Economic Inequities** centred on unequal benefit sharing, income dependency, and external operator dominance: “Only a few people working with WETA get real benefits, while others watch from the side,” (Interview, Local Elder).
- **Community Engagement Barriers** addressed lack of voice in decision-making and low female participation: “Decisions are made without our input, especially the women,” (FGD, Women Group Participant).

2.6. Quantitative Data Analysis

Quantitative data were analyzed using SPSS v.21, employing the following methods:

- **Descriptive Statistics:** To summarize socio-demographic characteristics (e.g., gender, age, income) and stakeholder perceptions.
- **Chi-Square Tests:** To examine differences in perceptions across stakeholder groups (e.g., residents vs. tourists), testing for statistical significance.
- **Logistic Regression:** To identify predictors of positive perceptions, with perceptions dichotomized (positive vs. non-positive) due to the binary outcome’s suitability for Likert-scale data^[30]. Logistic regression was selected over ordinal or multinomial models because it provides robust odds ratio estimates for binary outcomes, simplifying interpretation and aligning with the study’s focus on positive vs. non-positive perceptions.

Bias was minimized through anonymous survey administration and neutral facilitators, ensuring respondent candor.

2.7. Validity and Reliability

Survey instruments were pre-tested with 30 respondents, achieving a Cronbach’s alpha of >0.7 , confirming internal consistency and reliability. Qualitative data reliability was ensured through inter-coder agreement ($\kappa = 0.8$). Ethical approval from Ethiopia Civil Service University (protocol code ECSU-2024-012, 10 December 2024) guaranteed

informed consent and participant anonymity.

2.8. Ethical Considerations

Ethical approval ensured participant anonymity, voluntary participation, and data use solely for academic purposes. Informed consent forms were provided in Amharic and English, with verbal explanations for participants with low literacy levels, ensuring accessibility and comprehension.

2.9. Limitations

The sample may underrepresent short-term visitors (15% tourists, $n = 50$) and marginalized groups (e.g., low-income women, $n = 50$, 15%), potentially skewing perceptions toward more engaged stakeholders. Limited access to remote villages may have reduced respondent diversity, particularly among rural residents. These limitations suggest caution in generalizing findings to the broader Wanchi-Dandi population or other ecotourism contexts. Future studies should employ targeted sampling to include these groups.

3. Results

This section presents findings from a study conducted in Wanchi-Dandi, Ethiopia, with data collected from January to March 2025, analyzed from April to June 2025, and reported in July 2025. The study involved 333 respondents (60.1% residents, $n = 200$; 15.0% operators, $n = 50$; 15.0% tourists, $n = 50$; 9.9% officials, $n = 33$), supplemented by qualitative data from FGDs, interviews, and field observations.

3.1. Socio-Demographic Characteristics

The socio-demographic profile of the sample is summarized in **Table 1**, providing a foundation for understanding stakeholder diversity.

The sample reflects a diverse group, with a slight male majority (55.0%), a predominance of middle-aged respondents (49.8% aged 31–50), and significant representation of low-income individuals (50.0% earning $< \$100/\text{month}$). Most respondents (65.0%) reside within 5 km of Lake Wanchi, indicating close proximity to ecotourism activities, which likely influences their perceptions.

Table 1. Socio-Demographic Characteristics of Respondents.

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	183	55.0
	Female	150	45.0
Age	18–30	100	30.0
	31–50	166	49.8
	>50	67	20.2
Income (per month)	< \$100	166	50.0
	\$100–\$200	100	30.0
	> \$200	67	20.0
Proximity to Lake Wanchi	Within 5 km	217	65.0
	5–10 km	83	25.0
	>10 km	33	10.0

3.2. Environmental Conservation

Ecotourism has positively impacted environmental conservation in Wanchi-Dandi, with 58.0% of respondents (n = 193) reporting benefits from WETA's 2024 initiatives. These include planting 2000 indigenous trees, which contributed to a 5% increase in bird populations, as documented in WETA's ecological monitoring reports^[14]. Revenue reinvestment, utilizing 70% of WETA's \$50,000 annual budget, supported wetland restoration efforts, protecting aquatic species and enhancing ecosystem resilience. However, 12.0% of respondents (n = 40) highlighted challenges, particularly littering, with an estimated 500 kg of plastic waste generated annually, observed during fieldwork at tourist access points along Lake Wanchi^[15].

Neutral responses (30.0%, n = 100) were prevalent among tourists and less-engaged residents, suggesting gaps in awareness about conservation efforts. The distribution of these perceptions is detailed in **Table 2**.

3.3. Socio-Economic Development

Ecotourism has significantly contributed to socio-economic development, with 53.0% of respondents (n = 176) acknowledging job creation and income growth. From 2020 to 2025, the number of ecotourism-related jobs increased steadily: 2020 (20 jobs, 60% youth/women), 2021 (30, 65%), 2022 (40, 65%), 2023 (50, 70%), 2024 (60, 70%), and 2025 (65, 70%), supporting approximately 200 households. These jobs, representing 3.3% of the target population (2,000 adults), have led to a 15–20% income increase for 40% of these households, totaling \$30,000 in additional earn-

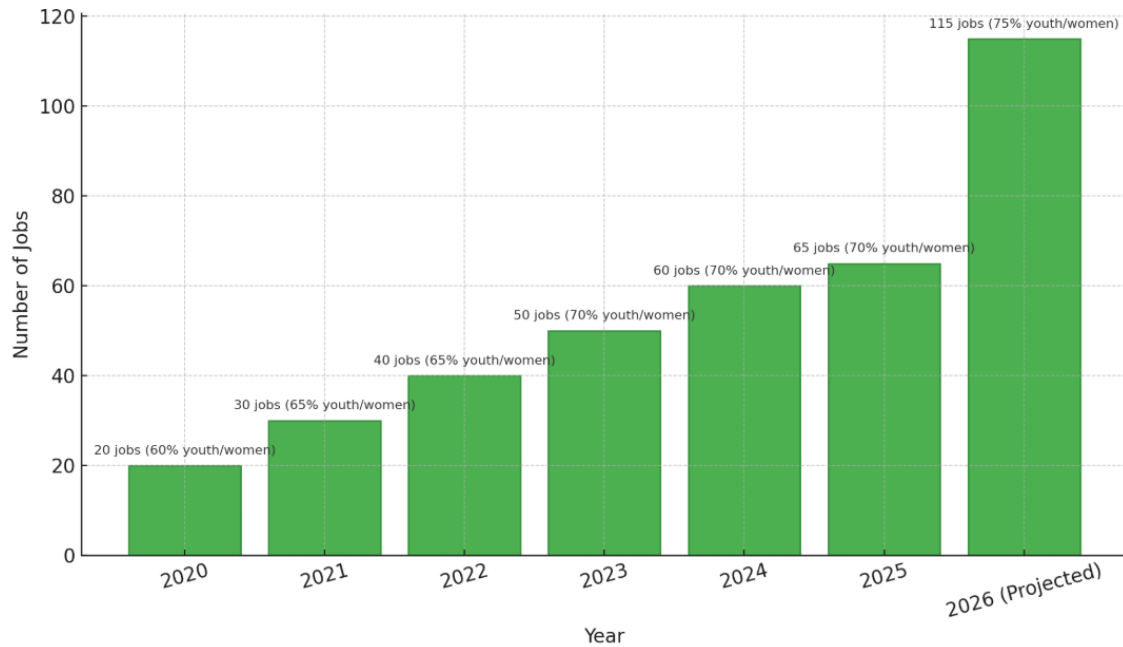
ings^[16]. Women's cooperatives (50 members) earned an average of \$50/month each, benefiting 80 children with education access. Infrastructure improvements, including a new school, health centre, and upgraded roads, correlated with a 5.4% rise in local government revenue, benefiting 15% of households (n = 225)^[8]. However, 18.0% of respondents (n = 60) cited inequities, with 40% of ecotourism revenue (\$20,000) captured by external operators^[9]. Additionally, only 10% of youth accessed WETA's training programs. **Figure 3**, replacing the methodological focus of the original **Figure 2**, illustrates the job creation trends from 2020 to 2025, with a projected increase to 115 jobs by 2026, highlighting the number of jobs and the proportion benefiting youth and women (60–75%).

Figure 3 is a bar chart illustrating the growth of ecotourism-related jobs from 20 (2020, 60% youth/women) to 65 (2025, 70% youth/women), with a projected increase to 115 jobs (2026, 75% youth/women), driven by activities like homestays and cultural festivals.

Table 3 indicate that out of the total 333 respondents, the majority (176 respondents, representing 53.0%) expressed a positive perception of ecotourism's socio-economic impacts, highlighting its role in improving livelihoods, creating job opportunities, and supporting local development. Meanwhile, 60 respondents (18.0%) held a negative perception, suggesting that ecotourism may not have significantly benefited all community members or may have created some challenges. Additionally, 97 respondents (29.0%) reported a neutral perception, indicating mixed or moderate views regarding its socio-economic contributions.

Table 2. Perceptions of Ecotourism's Conservation Impacts (n = 333).

Perception	Frequency (n)	Percentage (%)
Positive	193	58.0
Negative	40	12.0
Neutral	100	30.0

**Figure 3.** Ecotourism Job Creation Trends (2020–2025).**Table 3.** Perceptions of Ecotourism's Socio-Economic Impacts (n = 333).

Perception	Frequency (n)	Percentage (%)
Positive	176	53.0
Negative	60	18.0
Neutral	97	29.0

3.4. Climate Change Adaptation

Ecotourism has contributed to climate change adaptation, with 48.0% of respondents (n = 160) recognizing the value of sustainable practices. WETA's reforestation efforts and solar-powered eco-lodges have reduced carbon emissions by 10 tons annually^[15], according to WETA's 2025 environmental audit. These initiatives help mitigate local

flooding and drought risks, enhancing community resilience. However, 22.0% of respondents (n = 73) cited infrastructure gaps, such as inadequate drainage systems, which exacerbate climate vulnerabilities. Only 5% of WETA's revenue is allocated to climate adaptation projects^[19], limiting their scope. Neutral responses (30.0%, n = 100) were common among tourists, reflecting limited awareness of adaptation efforts. These findings are summarized in **Table 4**.

Table 4. Perceptions of Ecotourism's Climate Adaptation Impacts (n = 333).

Perception	Frequency (n)	Percentage (%)
Positive	160	48.0
Negative	73	22.0
Neutral	100	30.0

3.5. Qualitative Insights from FGDs and Interviews

Thematic analysis of qualitative data from 10 interviews and four FGDs (32 participants) revealed three primary themes, supported by illustrative quotes that provide depth to quantitative findings.

3.5.1. Environmental Challenges

Resident (Women's FGD): "Tourists leave plastic bottles and wrappers by the lake after boat tours. We^[10] clean up, but there aren't enough bins or collection trucks, so the waste piles up, harming fish and birds." This aligns with the reported 500 kg of annual plastic waste, observed during fieldwork.

- Conservationist (Interview): "Without proper waste management systems, Lake Wanchi's ecosystem is at risk. We need designated disposal sites and regular clean-up campaigns to protect biodiversity." Observations confirmed waste accumulation at key tourist access points, underscoring the urgency of improved infrastructure.

3.5.2. Socio-Economic Inequities

Youth (FGD): "Big operators from Addis Ababa take most of the boat tour profits. We get small jobs like cleaning or guiding, but the real money doesn't stay in our community." This reflects the 40% revenue loss to external operators, a significant barrier to equitable development, consistent with global findings on community perceptions of ecotourism benefits^[9].

- Operator (Interview): "WETA tries to distribute benefits, but their revenue-sharing rules are unclear. I train locals, but only a few are hired because training programs are limited." The finding that only 10% of youth accessed training highlights the need for expanded capacity-building.

3.5.3. Community Engagement Barriers

Resident (FGD): "We want to participate in WETA's decisions, but their meetings are held in town, and many of us live far away. They should bring discussions to our villages to include everyone." These points to accessibility challenges in rural areas, consistent with findings from other Ethiopian ecotourism sites^[31].

- WETA Official (Interview): "We're committed to inclusivity, but funding constraints limit our outreach. More resources for local meetings and training could bridge this gap." Resource limitations hinder WETA's ability to engage remote communities effectively.
- Resident (FGD): "We want to participate in WETA's decisions, but their meetings are held in town, and many of us live far away. They should bring discussions to our villages to include everyone." These are points to accessibility challenges in rural areas, consistent with findings from other Ethiopian ecotourism sites.

These qualitative insights reinforce quantitative results, emphasizing the need for targeted interventions in waste management, revenue-sharing, and community engagement, aligning with Stakeholder Theory's call for inclusive collaboration.

3.6. Statistical Analysis

Chi-square tests revealed significant differences in perceptions across stakeholder groups ($\chi^2 = 92.456$, $df = 6$, $p < 0.001$), indicating diverse perspectives. For instance, tourists exhibited higher positive perceptions (75%) compared to residents, who expressed greater concerns about inequities (28% negative). Logistic regression identified six predictors of positive perceptions, providing statistical evidence for factors influencing stakeholder support. The results of this analysis are presented in **Table 5**.

Table 5. Logistic Regression Results for Predictors of Positive Perceptions.

Predictor	Odds Ratio (OR)	p-Value
Education	1.25	0.012
Attitude	1.789	0.003
Income	1.455	0.020
Community engagement	1.50	0.015
Gender	1.329	0.048
Age	1.20	0.030

The strength of these predictors is further visualized in **Figure 4**. The bar chart visualizes odds ratios for predictors of positive perceptions, with attitude (OR = 1.789) and

community engagement (OR = 1.50) exhibiting the strongest influence, consistent with Social Exchange Theory's emphasis on perceived benefits driving support^[25].

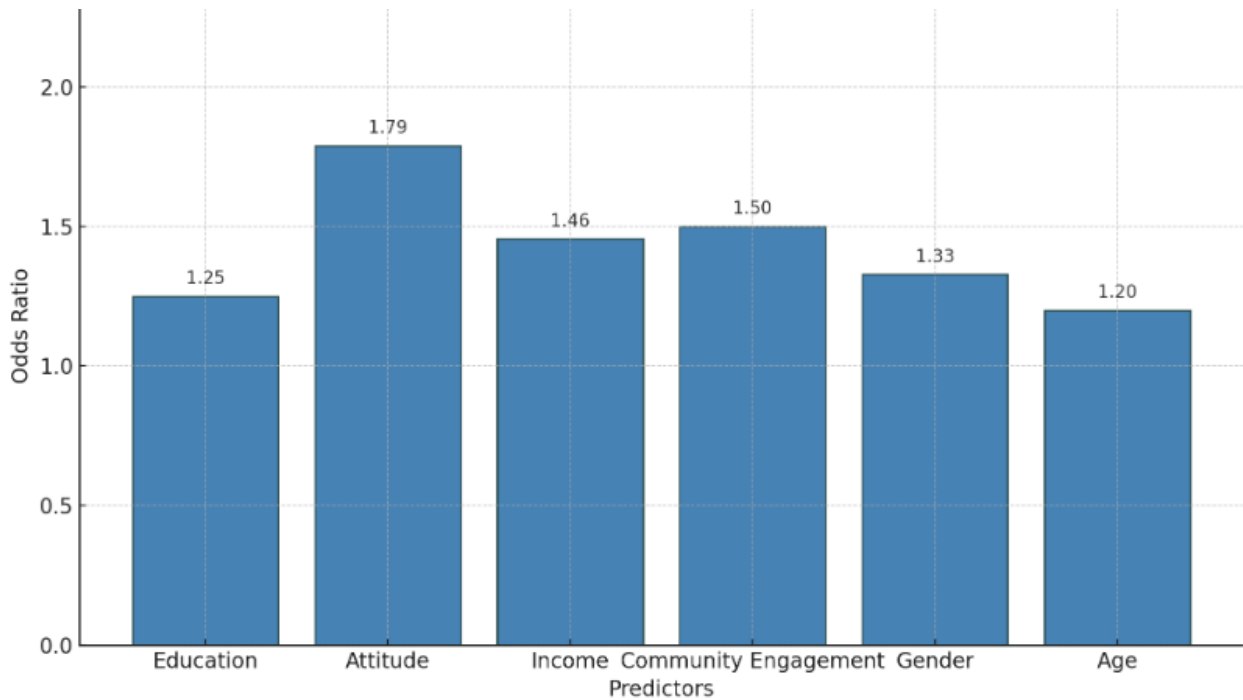


Figure 4. Odds Ratios for Predictors of Positive Perceptions of Ecotourism.

3.7. Potentials, Challenges, and Opportunities

3.7.1. Potentials

68% of respondents (n = 226) highlighted Lake Wanchi's scenic beauty and cultural festivals as key attractions, drawing approximately 5,000 tourists annually. WETA projects a job increase to 115 by 2026^[8], driven by planned expansions in eco-friendly homestays and cultural events, which could further boost local income.

3.7.2. Challenges

62% of respondents (n = 206) noted infrastructure deficiencies, including poor roads and inadequate sanitation

facilities, which deter tourist satisfaction and limit scalability. Additionally, 30% of revenue (\$15,000) is lost to external operators, and only 15% of youth access training programs, constraining economic benefits^[9].

3.7.3. Opportunities

58% of respondents (n = 193) suggested developing eco-friendly homestays to retain more revenue locally. WETA officials proposed partnerships with non-governmental organizations (NGOs) to fund sustainable projects, potentially increasing revenue by 25% through initiatives like solar energy expansion and waste recycling^[31].

A summary of these key themes is presented in **Table 6**.

Table 6. Potentials, Challenges and Opportunities.

Category	Description	Percentage (%)	Frequency (n)
Potentials	Lake Wonchi's beauty, cultural festivals 115 jobs projected by 2026	68.0	226
Challenges	Infrastructure gaps, 30% revenue loss, limited training (15% youth access)	62.0	206
Opportunities	Eco-friendly homestays, NGO partnerships for 25% revenue growth	58.0	193

3.8. Stakeholder-Specific Perceptions

Perceptions of ecotourism's impacts varied significantly across stakeholder groups, as visualized in **Figure 5**.

The bar chart illustrates perception variations across stakeholders: tourists (75% positive, $n = 38$) and officials (70%, $n = 23$) were most optimistic, valuing scenic beauty and conservation potential, respectively. Residents (55% positive, $n = 110$; 28% negative, $n = 56$) appreciated jobs but felt marginalized due to limited revenue-sharing. Operators (65% positive, $n = 33$; 30% negative, $n = 15$) valued revenue

but cited regulatory gaps.

- **Residents:** Valued job opportunities but expressed concerns about inequitable benefit distribution.
- **Operators:** Appreciated economic gains but noted challenges with unclear regulations and limited training.
- **Tourists:** Praised the area's serenity and natural beauty but raised concerns about visible waste.
- **Officials:** Recognized conservation and economic potential but highlighted funding shortages for infrastructure and climate projects.

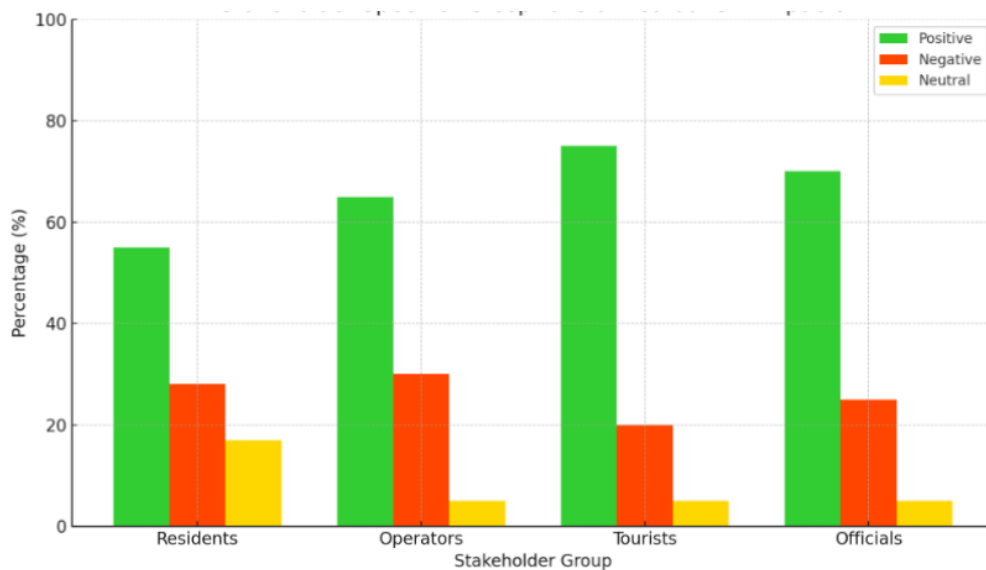


Figure 5. Stakeholder-Specific Perceptions of Ecotourism Impacts.

3.9. Comparative Analysis

Environmental conservation received the highest positive perceptions (58%), followed by socio-economic development (53%) and climate adaptation (48%). Neutral responses, ranging from 29–30% across all categories, suggest awareness gaps, particularly among tourists, who may lack exposure to WETA's conservation and adaptation efforts. **Figure 5** underscores conservation as the most positively perceived outcome across stakeholder groups, reflecting WETA's visible efforts in tree planting and wetland restoration.

3.10. Practical Implications

The findings indicate that Wanchi-Dandi's ecotourism can significantly contribute to conservation, job creation, and climate resilience, but targeted interventions are required

to address identified challenges. The following actionable strategies are proposed for WETA and policymakers:

3.10.1. Waste Management

Install 50 waste bins around Lake Wanchi's tourist access points and establish a weekly recycling collection system managed by local cooperatives. Partner with NGOs to fund a small-scale recycling facility, reducing 500 kg of plastic waste annually and engaging 20 community members in waste sorting and processing^[8]. This initiative could serve as a model for other Ethiopian ecotourism sites.

3.10.2. Socio-Economic Inequities

Develop a transparent revenue-sharing mechanism, allocating 70% of ecotourism revenue to local operators and residents through a WETA-managed community fund. Conduct annual reviews of third-party operator contracts to cap

external revenue at 20%, redirecting an estimated \$16,000 to the local economy by 2026^[9]. This approach would enhance equity and community trust.

3.10.3. Infrastructure Gaps

Allocate 15% of WETA's \$50,000 annual budget (\$7500) to repair roads and construct two public restrooms near key tourist sites. Collaborate with the Oromia Tourism Bureau to secure \$10,000 in government grants for climate-resilient infrastructure, such as improved drainage systems to mitigate flooding risks^[20]. These investments would enhance tourist satisfaction and local resilience.

3.10.4. Training Programs

Expand WETA's training programs to reach 50% of youth (100 annually) through monthly workshops on eco-tourism skills, including tour guiding, hospitality, and craft production. Integrate these skills into local school curricula to build long-term capacity, improving employability and supporting job growth to 115 by 2026^[17].

3.10.5. Policy Strengthening

Work with the Oromia Tourism Bureau to draft a 2026 local ecotourism policy mandating community representation in WETA's governance structure and requiring regular revenue audits. This policy would institutionalize equitable benefit distribution and align with Stakeholder Theory's emphasis on inclusive decision-making^[3].

These interventions leverage WETA's community-based structure to enhance local capacity, align with Ethiopia's Tourism Development Policy (2017), and support SDGs 8, 13, and 15^[3]. They also address stakeholder concerns raised in FGDs and interviews, fostering greater community support.

4. Discussion

4.1. Environmental Conservation

The 58% positive perception of conservation impacts reflects WETA's effective initiatives, notably the planting of 2,000 indigenous trees, which increased bird populations by 5%, mirroring successful CBET models in Costa Rica^[13]. These efforts demonstrate ecotourism's potential to fund biodiversity protection, aligning with Sustainable Development Theory's environmental pillar^[21]. However, the 500

kg of annual plastic waste, reported by 12% of respondents and observed during fieldwork, poses a significant challenge, consistent with Gössling's (2003) findings on tourism-related environmental degradation^[5]. The 30% neutral responses, particularly among tourists, suggest a need for enhanced environmental education to increase awareness of WETA's conservation efforts, supporting Social Exchange Theory's premise that perceived benefits drive community support^[9]. The proposed waste management interventions, including 50 waste bins and a recycling facility, draw on successful models from Ethiopia's Bale Mountains, offering a scalable solution to mitigate littering and protect Lake Wanchi's ecosystem.

4.2. Socio-Economic Development

The creation of 65 jobs by 2025, with 70% benefiting youth and women, underscores ecotourism's socio-economic potential, supporting approximately 200 households and aligning with Yihun et al.'s (2018) findings on livelihood diversification^[16]. The 5.4% rise in local government revenue, linked to infrastructure improvements like schools and roads, has enhanced well-being for 15% of households, demonstrating broader community benefits. However, the 40% revenue loss to external operators, reported by 18% of respondents, reflects inequities highlighted by Weaver and Lawton (2002). The limited access to training programs (only 10% of youth) further constrains economic inclusion, as noted in FGDs. The proposed revenue-sharing mechanism, allocating 70% of revenue to locals, and expanded training for 100 youth annually address these gaps, drawing on Demssie and Bekele's (2022) community empowerment strategies^[9, 17]. Scaling job creation to 115 by 2026 requires strengthened local governance and transparent financial systems, ensuring equitable distribution of benefits^[17].

4.3. Climate Change Adaptation

The 48% positive perception of climate adaptation reflects WETA's sustainable practices, such as reforestation and solar-powered eco-lodges, which reduced emissions by 10 tons annually^[15, 28]. These initiatives align with Adaptive Capacity Theory, enhancing community resilience against climate variability^[27], and mirror findings from Ethiopian protected areas. However, infrastructure gaps, cited by 22% of respondents, and limited funding (5% of revenue for

climate projects) hinder adaptation efforts, consistent with global challenges in climate-vulnerable regions^[19]. The proposed \$10,000 government grants and budget reallocation for climate-resilient infrastructure, such as drainage systems, could address these constraints, drawing on successful adaptation strategies elsewhere. Neutral responses (30%) among tourists suggest a need for greater public awareness campaigns to highlight WETA's climate efforts, fostering broader stakeholder support^[20].

4.4. Stakeholder Perceptions

Significant differences in stakeholder perceptions ($\chi^2 = 92.456, p < 0.001$) reflect diverse priorities, consistent with Social Exchange Theory^[26]. Tourists' high positive perceptions (75%) stem from aesthetic appreciation of Lake Wanchi, while residents' negative views (28%) highlight feelings of marginalization due to revenue inequities, as voiced in FGDs. Operators' concerns about regulatory gaps (30% negative) and officials' worries about funding shortages (25% negative) underscore governance challenges, supporting Stakeholder Theory's call for inclusive collaboration^[23, 25]. Logistic regression results, identifying attitude (OR = 1.789) and community engagement (OR = 1.50) as strong predictors, suggest that fostering positive attitudes through education and increasing participation in WETA's activities could enhance support^[31]. These findings guide targeted interventions, such as training programs and community outreach, to align stakeholder expectations.

4.5. Theoretical Contributions

This study extends Stakeholder Theory by demonstrating WETA's role as a community-driven platform for integrating diverse stakeholders in ecotourism governance^[23]. By highlighting the 40% revenue loss to external operators, reported by 18% of respondents, it challenges Social Exchange Theory's assumption of equitable benefit distribution, revealing disparities that undermine community support^[25]. The findings align with Adaptive Capacity Theory, illustrating how ecotourism's sustainable practices enhance resilience against climate risks^[27]. Unlike prior studies focusing on single dimensions, such as conservation or regional tourism, this research offers a holistic framework by integrating conservation, socio-economic, and climate adaptation impacts.

This multi-dimensional approach provides a novel contribution to CBET literature^[8, 16], particularly in under-studied East African contexts like Wanchi-Dandi.

4.6. Broader Implications

The findings have broader implications for Ethiopia's ecotourism sector and global CBET practices. Wanchi-Dandi's experience highlights the importance of community-based governance in balancing conservation and development goals, offering lessons for other Ethiopian ecotourism sites like Bale Mountains and Simien National Park. The proposed interventions, such as waste management and revenue-sharing, are scalable to other biodiversity-rich, climate-vulnerable regions, contributing to global efforts to achieve SDGs 8, 13, and 15^[3]. The study also underscores the need for inclusive stakeholder engagement to address inequities, aligning with international calls for equitable tourism development^[2].

5. Conclusions

5.1. Summary of Findings

Ecotourism in Wanchi-Dandi significantly contributes to environmental conservation (58% positive perceptions), socio-economic development (53%), and climate adaptation (48%). Key achievements include planting 2000 trees, creating 65 jobs, and reducing emissions by 10 tons annually. However, challenges such as 500 kg of plastic waste, 40% revenue loss to external operators, and infrastructure gaps limit impacts. Stakeholder differences, with tourists and officials more optimistic than residents and operators, highlight the need for inclusive governance to address inequities and enhance community support.

5.2. Practical Recommendations

To maximize ecotourism's benefits, WETA and policymakers should implement the following:

- **Waste Management:** Install 50 waste bins and establish a recycling facility to reduce 500 kg of plastic waste, engaging 20 community members^[8].
- **Revenue-Sharing:** Allocate 70% of revenue to locals, redirecting \$16,000 by 2026 through a WETA-managed fund^[9].

- Infrastructure: Invest \$7500 from WETA's budget and secure \$10,000 in grants for roads and restrooms^[20].
- Training: Train 100 youth annually through workshops and school curricula to enhance employability^[17].
- Policy: Draft a 2026 ecotourism policy mandating community representation and revenue audits^[3].

These recommendations leverage WETA's community-based structure to foster sustainability and equity, aligning with Ethiopia's Tourism Development Policy (2017) and global sustainability goals.

5.3. Future Research

Future studies should:

Investigate long-term ecotourism impacts in Wanchi-Dandi, focusing on ecological and economic sustainability.

Compare Wanchi-Dandi with other Ethiopian ecotourism sites, such as Bale Mountains, to identify best practices^[31].

Address sampling biases by including more short-term visitors and marginalized groups, such as low-income women and rural residents.

Explore digital tools, such as mobile apps or online platforms, to enhance stakeholder engagement and community participation in ecotourism governance.

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Institutional Review Board Statement

The study was approved by the Institutional Review Board of Ethiopia Civil Service University (protocol code ECSU-2024-012, 10 December 2024).

Informed Consent Statement

Informed consent was obtained from all participants, with forms provided in Amharic and English and verbal explanations for participants with low literacy levels.

Data Availability Statement

Data are available on request from the corresponding author due to privacy restrictions.

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Conflicts of Interest

The author declares no conflict of interest.

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