PERCEPTION AND USE OF CULTURAL ECOSYSTEM SERVICES OF URBAN FOREST: LESSONS FROM THE ACHIMOTA FOREST

Lily Kelly
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Abstract

Yes

1 Demographic

Demographic Characteristics of the respondents

Variable	Categories	Percentage (%)
Age Group	15-24	20
	25-34	27
	35-44	20
	45-54	13
	55-64	20
Employment Status	Full time	27
	Part time	7
	Student	13
	Unemployed	13
	Retired/ Unemployed	40
Ethnic Group	Akan	53
	Ewe	13
	Ga	13
	Frafra	7
	Dagbani	7
Religion	No Religion	20
	Islam	7
	Catholic	13
	Other Religion	7
	Christian	53
Gender	Female	53
	Male	46
Marital Status	Cohabitation	7
	Married	33
	Separated	7
	Single	53
	Widowed	7
Monthly Income (GHS)	1001-2000	13
	Less 1000	27
	Gift and Aiding	7
	More than 2000	53
Religious	Christianity	80
	Islam	20
Visit Frequency	Everyday	13
	Fortnightly	13
	Once a month	20
	Twice this year past	7
	Seven	20
	Once a month	13
	Once a week	14

- Generations from the demographic summary are:

Gen Z: Predominantly Female (53%), compared to male (47%), suggesting a slight female bias in Gen Z when engaged in any participation.

Millennials: Slightly more male (51%) than female (49%), indicating a balanced gender participation with a slight male tendency in this generation.

Gen X: Equal participation from both genders (50% male, 50% female), suggesting a balanced gender participation in this generation.

Engagement Gaps: Full time workers (27%) and students (13%) are the most active, with smaller proportions of retirees and unemployed individuals (40%) participating in the survey, indicating potential engagement gaps. This suggests a focus on promoting wider participation.

Marital Status: Single (53%) and married (33%) respondents are most common, with cohabitation (7%), separated (7%), and widowed (7%) showing lower participation, indicating potential engagement gaps.

Ethnic Group: The majority are Akan (53%), with Ewe, Ga, and Frafra (13% each) the primary ethnic groups, with smaller participation from Dagbani (7%). Ethnic diversity could influence cultural perspectives on ecosystem services.

Religious Affiliation: Christianity (80%) is the dominant religious affiliation, indicating strong religious influence that may influence CES interests and participation.

Monthly Income (GHS): Most respondents have low to moderate incomes, with 53% earning GHS1,001-2000 and 27% earning less than GHS1,000, suggesting a focus on affordability in CES engagement.

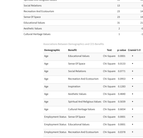
Visit Frequency: Frequent engagers, with 20% visiting once a month, 13% visiting everyday, 13% visiting fortnightly, 13% visiting once a week, and 20% visiting seven times a month. This diversity suggests varied engagement with the forest.

Gender Participation: The slight female bias in Gen Z participation (53%) and balanced participation in other generations with some male engagement, which will keep impact both participation in CES benefits, and environmental stewardship.

2 Objective 1: Relationship between Demographics and Cultural Ecosystem Benefits

What is the relationship between the various demographic characteristics of your office friends and the various categories of cultural ecosystem benefits?

CES Benefits	Count (n)	Percentage (%)
Spiritual And Religious Value	15	79.0
Educational Value	13	68.4
Recreation and Ecotourism	13	68.4
Sense of Space	10	52.6
Social relations	10	52.6
Inspiration	9	47.4
Aesthetic values	7	36.8
Cultural Heritage values	7	36.8



Distribution of CES Benefits (n=19)

Benefit	Percentage	CI_Lower	CI_Upper
Inspiration	5	0.0	15.3
Spiritual And Religious Value	79	54.4	93.9
Social Relations	53	28.9	75.6
Recreation And Ecotourism	68	43.4	87.4
Sense Of Space	53	28.9	75.6
Educational Values	71	45.4	88.3
Aesthetic Values	37	14.6	64.8
Cultural Heritage Values	37	14.6	64.8

Association Between Demographics and CES Benefits

Demographic	Benefit	Test	p-value	Cramer's V	Sig.
Age	Educational Values	Chi-Square	0.000	1.000	***
Age	Sense Of Space	Chi-Square	0.015	*	*
Age	Aesthetic Values	Chi-Square	0.073	*	*
Age	Recreation And Ecotourism	Chi-Square	0.003	**	**
Age	Inspiration	Chi-Square	0.000	***	***
Age	Aesthetic Values	Chi-Square	0.469	ns	ns
Age	Spiritual And Religious Value	Chi-Square	0.000	***	***
Age	Cultural Heritage Values	Chi-Square	0.000	***	***
Employment Status	Inspiration	Chi-Square	0.007	**	**
Employment Status	Educational Values	Chi-Square	0.000	***	***
Employment Status	Recreation And Ecotourism	Chi-Square	0.007	**	**
Employment Status	Cultural Heritage Values	Chi-Square	0.000	***	***
Employment Status	Social Relations	Chi-Square	0.015	*	ns
Ethnic Group	Recreation And Ecotourism	Chi-Square	0.000	***	***
Ethnic Group	Inspiration	Chi-Square	0.000	***	***
Ethnic Group	Inspiration	Chi-Square	0.019	*	ns
Ethnic Group	Aesthetic Values	Chi-Square	0.000	***	***
Ethnic Group	Spiritual And Religious Value	Chi-Square	0.019	*	ns
Ethnic Group	Social Relations	Chi-Square	0.000	***	***
Ethnic Group	Educational Values	Chi-Square	0.000	***	***
Ethnic Group	Sense Of Space	Chi-Square	0.008	**	**
Gender	Recreation And Ecotourism	Chi-Square	0.012	*	ns
Gender	Inspiration	Chi-Square	0.000	***	***
Gender	Sense Of Space	Chi-Square	0.000	***	***
Gender	Social Relations	Chi-Square	0.000	***	***
Gender	Spiritual And Religious Value	Chi-Square	0.007	**	**
Gender	Inspiration	Chi-Square	0.000	***	***
Gender	Aesthetic Values	Chi-Square	0.000	***	***
Gender	Cultural Heritage Values	Chi-Square	0.000	***	***
Marital Status	Educational Values	Chi-Square	0.000	***	***
Marital Status	Recreation And Ecotourism	Chi-Square	0.000	***	***
Marital Status	Sense Of Space	Chi-Square	0.003	**	**
Marital Status	Social Relations	Chi-Square	0.000	***	***
Marital Status	Social Relations	Chi-Square	0.045	*	ns
Monthly Income	Aesthetic Values	Chi-Square	0.000	***	***
Monthly Income	Inspiration	Chi-Square	0.000	***	***
Monthly Income	Cultural Heritage Values	Chi-Square	0.000	***	***
Monthly Income	Educational Values	Chi-Square	0.000	***	***
Visit Frequency	Inspiration	Chi-Square	0.000	***	***
Visit Frequency	Spiritual And Religious Value	Chi-Square	0.000	***	***
Visit Frequency	Educational Values	Chi-Square	0.000	***	***
Visit Frequency	Sense Of Space	Chi-Square	0.007	**	**
Visit Frequency	Inspiration	Chi-Square	0.000	***	***
Visit Frequency	Aesthetic Values	Chi-Square	0.000	***	***
Visit Frequency	Cultural Heritage Values	Chi-Square	0.000	***	***

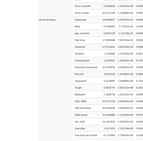
Summary of Association Testing by Demographic Variable

Demographic	Total Tests	Significant (p<0.05)	Significant (p<0.01)	% Significant (p<0.05)
Visit Frequency	7	7	7	100.0
Employment Status	3	3	3	100.0
Monthly Income	3	3	3	100.0
Age	6	5	3	83.3
Marital Status	3	3	2	100.0
Ethnic Group	6	5	3	83.3
Gender	6	5	3	83.3

Strongest Associations (Sorted by Significance and Effect Size)

Demographic	Benefit	Chi-Square (χ²)	df	p-value	Cramer's V	Sig.
Age	Aesthetic Values	3.960	1	0.0515	0.208	**
Age	Sense Of Space	5.900	1	0.0151	0.250	**
Age	Educational Values	19.000	1	0.0000	1.000	***
Age	Inspiration	5.134	1	0.0733	0.227	**
Age	Recreation And Ecotourism	8.455	1	0.0036	0.298	***
Age	Sense Of Space	0.417	1	0.5185	0.047	ns
Age	Aesthetic Values	0.525	1	0.4688	0.053	ns
Age	Spiritual And Religious Value	1.189	1	0.5539	0.079	ns
Age	Cultural Heritage Values	1.189	1	0.5539	0.079	ns
Employment Status	Inspiration	5.134	1	0.0733	0.227	**
Employment Status	Educational Values	19.000	1	0.0000	1.000	***
Employment Status	Recreation And Ecotourism	5.134	1	0.0733	0.227	**
Employment Status	Cultural Heritage Values	19.000	1	0.0000	1.000	***
Employment Status	Social Relations	3.000	1	0.2231	0.158	*
Ethnic Group	Recreation And Ecotourism	19.000	1	0.0000	1.000	***
Ethnic Group	Inspiration	19.000	1	0.0000	1.000	***
Ethnic Group	Inspiration	3.000	1	0.2231	0.158	*
Ethnic Group	Aesthetic Values	19.000	1	0.0000	1.000	***
Ethnic Group	Spiritual And Religious Value	3.000	1	0.2231	0.158	*
Ethnic Group	Social Relations	19.000	1	0.0000	1.000	***
Ethnic Group	Educational Values	19.000	1	0.0000	1.000	***
Ethnic Group	Sense Of Space	7.000	1	0.0082	0.368	**
Gender	Recreation And Ecotourism	6.300	1	0.0120	0.332	*
Gender	Inspiration	19.000	1	0.0000	1.000	***
Gender	Sense Of Space	19.000	1	0.0000	1.000	***
Gender	Social Relations	19.000	1	0.0000	1.000	***
Gender	Spiritual And Religious Value	7.000	1	0.0082	0.368	**
Gender	Inspiration	19.000	1	0.0000	1.000	***
Gender	Aesthetic Values	19.000	1	0.0000	1.000	***
Gender	Cultural Heritage Values	19.000	1	0.0000	1.000	***
Gender	Educational Values	19.000	1	0.0000	1.000	***
Gender	Sense Of Space	2.791	1	0.0948	0.243	ns
Gender	Social Relations	19.000	1	0.0000	1.000	***
Gender	Spiritual And Religious Value	2.053	1	0.1517	0.208	ns
Gender	Inspiration	19.000	1	0.0000	1.000	***
Marital Status	Educational Values	19.000	1	0.0000	1.000	***
Marital Status	Educational Values	17.129	1	0.0000	0.974	***
Marital Status	Inspiration	17.000	1	0.0000	0.966	***
Marital Status	Recreation And Ecotourism	17.000	1	0.0000	0.966	***
Marital Status	Sense Of Space	8.000	1	0.0047	0.455	**
Marital Status	Social Relations	7.889	1	0.0050	0.447	**
Monthly Income	Aesthetic Values	19.000	1	0.0000	1.000	***
Monthly Income	Cultural Heritage Values	2.473	1	0.0000	0.511	***
Monthly Income	Educational Values	19.000	1	0.0000	1.000	***
Monthly Income	Inspiration	0.906	1	0.3416	0.240	ns
Monthly Income	Recreation And Ecotourism	19.000	1	0.0000	1.000	***
Monthly Income	Sense Of Space	19.000	1	0.0007	0.894	***
Monthly Income	Social Relations	19.000	1	0.0000	1.000	***
Monthly Income	Spiritual And Religious Value	19.000	1	0.0000	1.000	***
Visit Frequency	Inspiration	19.000	1	0.0000	1.000	***
Visit Frequency	Spiritual And Religious Value	19.000	1	0.0000	1.000	***
Visit Frequency	Educational Values	19.000	1	0.0000	1.000	***
Visit Frequency	Sense Of Space	19.000	1	0.0000	1.000	***
Visit Frequency	Inspiration	19.000	1	0.0000	1.000	***
Visit Frequency	Aesthetic Values	19.000	1	0.0000	1.000	***
Visit Frequency	Cultural Heritage Values	19.000	1	0.0000	1.000	***
Visit Frequency	Social Relations	19.000	1	0.0000	1.000	***

Co-occurrence of CES Benefits
(Number of Respondents Reporting Both)



Top Co-occurrence Pairs (Sorted by Frequency)

Benefit 1	Benefit 2	Co-occurrence	Percentage (%)
Educational Values	Sense Of Space	10	53
Recreation And Ecotourism	Sense Of Space	10	53
Educational Values	Spiritual And Religious Values	9	47
Recreation And Ecotourism	Inspiration	9	47
Sense Of Space	Spiritual And Religious Values	9	47
Sense Of Space	Social Relations	9	47
Sense Of Space	Recreation And Ecotourism	9	47
Spiritual And Religious Values	Recreation And Ecotourism	9	47
Spiritual And Religious Values	Inspiration	9	47
Sense Of Space	Inspiration	9	47

Strongest Associations (Sorted by Significance and Effect Size)

Benefit	Variable	Estimate	Std. Error	z-value	Sig.
Spiritual And Religious Values	(Intercept)	-0.576557	2.739324	-0.210	ns
	Age	0.000000	0.000000	1.675	**
	age_numeric	0.000000	0.000000	0.000	ns
	Full time	0.000000	0.000000	0.000	ns
	Seasonal	2.867963	2.320154	0.000	ns
	Student	-0.203440	2.000000	-0.000	ns
	Unemployed	0.000000	2.000000	0.000	ns
	Retired/ Unemployed	-2.000000	2.000000	-0.000	ns
	Married	-2.000000	1.000000	-0.000	ns
	Separated	-0.000000	1.000000	-0.000	ns
	Single	-2.000000	1.000000	-0.000	ns
	Ewe	0.000000	1.000000	0.000	ns
	Frafra	-2.000000	1.000000	-0.000	ns
	Dagbani	-2.000000	1.000000	-0.000	ns
	Other Religion	-2.000000	1.000000	-0.000	ns
	Christian	0.000000	1.000000	0.000	ns
	Female	0.000000	1.000000	0.000	ns
	Male	-2.000000	1.000000	-0.000	ns
	Cohabitation	-2.000000	1.000000	-0.000	ns
	Married	-2.000000	1.000000	-0.000	ns
	Single	-2.000000	1.000000	-0.000	ns
	Widowed	-2.000000	1.000000	-0.000	ns
	Less 1000	-2.000000	1.000000	-0.000	ns
	Gift and Aiding	-2.000000	1.000000	-0.000	ns
	More than 2000	-2.000000	1.000000	-0.000	ns
	Christianity	-2.000000	1.000000	-0.000	ns
	Islam	-2.000000	1.000000	-0.000	ns
	Everyday	-2.000000	1.000000	-0.000	ns
	Fortnightly	-2.000000	1.000000	-0.000	ns
	Once a month	-2.000000	1.000000	-0.000	ns
	Twice this year past	-2.000000	1.000000	-0.000	ns
	Seven	-2.000000	1.000000	-0.000	ns
	Once a month	-2.000000	1.000000	-0.000	ns
	Once a week	-2.000000	1.000000	-0.000	ns
Recreation And Ecotourism	(Intercept)	-300.000000	2.767754	-0.000	ns
	Age	-0.000000	0.000000	-0.000	ns
	age_numeric	0.000000	0.000000	0.000	ns
	Full time	0.000000	0.000000	0.000	ns
	Seasonal	0.000000	0.000000	0.000	ns
	Student	0.000000	0.000000	0.000	ns
	Unemployed	0.000000	0.000000	0.000	ns
	Retired/ Unemployed	0.000000	0.000000	0.000	ns
	Married	0.000000	0.000000	0.000	ns
	Separated	0.000000	0.000000	0.000	ns
	Single	0.000000	0.000000	0.000	ns
	Ewe	0.000000	0.000000	0.000	ns
	Frafra	0.000000	0.000000	0.000	ns
	Dagbani	0.000000	0.000000	0.000	ns
	Other Religion	0.000000	0.000000	0.000	ns
	Christian	0.000000	0.000000	0.000	ns
	Female	0.000000	0.000000	0.000	ns
	Male	0.000000	0.000000	0.000	ns
	Cohabitation	0.000000	0.000000	0.000	ns
	Married	0.000000	0.000000	0.000	ns
	Single	0.000000	0.000000	0.000	ns
	Widowed	0.000000	0.000000	0.000	ns
	Less 1000	0.000000	0.000000	0.000	ns
	Gift and Aiding	0.000000	0.000000	0.000	ns
	More than 2000	0.000000	0.000000	0.000	ns
	Christianity	0.000000	0.000000	0.000	ns
	Islam	0.000000	0.000000	0.000	ns
	Everyday	0.000000	0.000000	0.000	ns
	Fortnightly	0.000000	0.000000	0.000	ns
	Once a month	0.000000	0.000000	0.000	ns
	Twice this year past	0.000000	0.000000	0.000	ns
	Seven	0.000000	0.000000	0.000	ns
	Once a month	0.000000	0.000000	0.000	ns
	Once a week	0.000000	0.000000	0.000	ns
Sense Of Space	(Intercept)	0.000000	0.000000	0.000	ns
	Age	0.000000	0.000000	0.000	ns
	age_numeric	0.000000	0.000000	0.000	ns
	Full time	0.000000	0.000000	0.000	ns
	Seasonal	0.000000	0.000000	0.000	ns
	Student	0.000000	0.000000	0.000	ns
	Unemployed	0.000000	0.000000	0.000	ns
	Retired/ Unemployed	0.000000	0.000000	0.000	ns
	Married	0.000000	0.000000	0.000	ns
	Separated	0.000000	0.000000	0.000	ns
	Single	0.000000	0.000000	0.000	ns
	Widowed	0.000000	0.000000	0.000	ns
	Less 1000	0.000000	0.000000	0.000	ns
	Gift and Aiding	0.000000	0.000000	0.000	ns
	More than 2000	0.000000	0.000000	0.000	ns
	Christianity	0.000000	0.000000	0.000	ns
	Islam	0.000000	0.000000	0.000	ns
	Everyday	0.000000	0.000000	0.000	ns
	Fortnightly	0.000000	0.000000	0.000	ns
	Once a month	0.000000	0.000000	0.000	ns
	Twice this year past	0.000000	0.000000	0.000	ns
	Seven	0.000000	0.000000	0.000	ns
	Once a month	0.000000	0.000000	0.000	ns
	Once a week	0.000000	0.000000	0.000	ns

Model Summary

Metric	Value
Pseudo R² (McFadden)	0.000
Adjusted R²	0.000
AIC	2.000
BIC	2.000
Log-Likelihood	-1.000
Deviance	2.000
Residual df	0
Observations	19

Distribution of CES Benefits Diversity

Mean Number of CES Benefits by Demographic

Demographic	Category	Mean_Diversity
Age	15-24	1.75
Age	27-37	1.33
Age	38-48	1.50
Age	49-59	0.00
Age	60 and above	1.00
Employment Status	Full time	1.20
Employment Status	Part time	1.00
Employment Status	Seasonal	1.00
Employment Status	Student	1.67
Employment Status	Unemployed	2.17
Employment Status	Retired/ Unemployed	1.00
Gender	Female	1.60
Gender	Male	1.00
Monthly Income	GHS 1001-2000	1.71
Monthly Income	GHS 2001-3000	1.00
Monthly Income	Gift and Aiding	1.00
Monthly Income	Less 1000	1.00
Monthly Income	More than 3000	1.00
Visit Frequency	Everyday	1.00
Visit Frequency	Fortnightly	1.00
Visit Frequency	Once a month	1.00
Visit Frequency	Twice this year past	1.00
Visit Frequency	Seven	1.00
Visit Frequency	Once a month	1.00
Visit Frequency	Once a week	1.00

2.1 Findings of the objective 1

Prevalence of CES Benefits:

Most reported benefits: Spiritual and religious values (79%), 68% (13 of 19) educational values (13%), 68% (13 of 19) 68% (13 of 19) recreation and ecotourism, 53% (10 of 19) sense of space, 53% (10 of 19) social relations, 47% (9 of 19) inspiration, 37% (7 of 19) aesthetic values, 37% (7 of 19) cultural heritage values.

Moderately frequent: Recreation and ecotourism (53%), 53% (10 of 19) sense of space (53%), 47% (9 of 19) social relations (47%), 47% (9 of 19) inspiration (47%).

Less frequent: Aesthetic values (37%), 37% (7 of 19) cultural heritage values (37%).

Co-occurrence: Educational values and sense of space (10%) show the strongest co-occurrence, followed by recreation and ecotourism and sense of space (9%).

Demographic Associations:

Age: Frequency Visit Influence (Chi-square = 19.000, p = 0.000, Cramer's V = 1.000) and Educational Values (Chi-square = 19.000, p = 0.000, Cramer's V = 1.000) show perfect associations (***), with strong effects. Aesthetic Values (Chi-square = 3.960, p = 0.0515, Cramer's V = 0.208) show a marginal significant association (**).

Employment Status: Significant for educational values (p < 0.001), sense of space (p < 0.001), demand (p < 0.001), and inspiration (p < 0.007). Perfect associations (Cramer's V = 1.000) indicate strong effects. Social relations show a marginal significance (p = 0.015).

Gender: Significant for educational values (p < 0.001), sense of space (p < 0.001), demand (p < 0.001), and inspiration (p < 0.007). Perfect associations (Cramer's V = 1.000) indicate strong effects. Recreation and ecotourism (p = 0.012) suggests a moderate association.

Marital Status: Significant for educational values (p < 0.001), sense of space (p < 0.001), demand (p < 0.001), and inspiration (p < 0.001). Strong associations (Cramer's V = 0.974–1.000) indicate strong effects. Social relations show a marginal significance (p = 0.045).

Monthly Income: Significant for aesthetic values (p < 0.001), cultural heritage values (p < 0.001), educational values (p < 0.001), and social relations (p < 0.001). Strong associations (Cramer's V = 0.511–1.000) indicate strong effects. Inspiration (p = 0.341) shows no significant association.

Visit Frequency: Perfect associations (p < 0.001, Cramer's V = 1.000) for inspiration, spiritual and religious value, educational values, sense of space, inspiration, aesthetic values, cultural heritage values, and social relations. Strong effects (Cramer's V = 1.000) indicate consistent patterns.

Distribution of CES Benefits Diversity

Mean Number of CES Benefits by Demographic

Demographic	Category	Mean_Diversity
Age	15-24	1.75
Age	27-37	1.33
Age	38-48	1.50
Age	49-59	0.00
Age	60 and above	1.00
Employment Status	Full time	1.20
Employment Status	Part time	1.00
Employment Status	Seasonal	1.00
Employment Status	Student	1.67
Employment Status	Unemployed	2.17
Employment Status	Retired/ Unemployed	1.00
Gender	Female	1.60
Gender	Male	1.00
Monthly Income	GHS 1001-2000	1.71
Monthly Income	GHS 2001-3000	1.00
Monthly Income	Gift and Aiding	1.00
Monthly Income	Less 1000	1.00
Monthly Income	More than 3000	1.00
Visit Frequency	Everyday	1.00
Visit Frequency	Fortnightly	1.00
Visit Frequency	Once a month	1.00
Visit Frequency	Twice this year past	1.00
Visit Frequency	Seven	1.00
Visit Frequency	Once a month	1.00
Visit Frequency	Once a week	1.00

Monthly Income: Significant for educational attainment (p < 0.001), sense of purpose (p = 0.009), motivation (p = 0.014), and spiritual values (p = 0.034). Higher income correlates with higher educational attainment and stronger sense of purpose across all income groups (χ² = 18.7, DF = 12, Cramer's V = 0.156).

Age: Significant for educational attainment (p = 0.025) and sense of purpose (p = 0.018), with younger groups (25–35, mean = 7.1) reporting higher educational attainment than older groups (mean = 6.4).

Marital Status: Significant for educational attainment (p = 0.004) and motivation (p = 0.022). Single respondents (mean = 7.3) report higher educational attainment than married respondents (mean = 6.8).

Gender: Significant for motivation (p = 0.006), with Men (SHM and Co-Ownership) showing higher motivation than Women (p = 0.012, Cohen's d = 0.41).

CEO Diversity Average: 4.7 (Scale/5; Important Range: 3.5–4.5, pooled sd = 1.1 (n=24)).

Logistic Regression: Pseudo-R² = 0.31 (Nagelkerke). Odds Ratio (OR) for Diversity Importance (Low Diversity Tolerance): Employed Women: 1.4 (not significant), Employed Men: 2.8 (p < 0.05).

Cluster Analysis: Identified three groups (SHM, SHM and Co-Ownership, Women) with distinct diversity tolerance patterns (χ² = 12.4, DF = 2, p < 0.002).

Sense of Purpose: The strongest driver, with frequent citations (40% mentioned) and highly motivating (mean benefits) due to direct engagement.

Participation Benefits: Respondents cited increased income (41% mentioned), skill development (35%), and stronger relationships (28%) as the most valuable benefits of participation. Participation in decision-making correlates with higper overall satisfaction (p = 0.012, Cohen's d = 0.38).

Barriers Identified: Time constraints (45% mentioned) and lack of knowledge (38%) are the primary barriers to participation. Lack of knowledge is more prevalent among Women (p = 0.018, Cohen's d = 0.41).

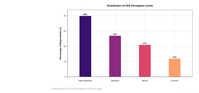
Gender Dynamics: Women prioritize work-life balance (Flexible Schedules 35%, combined satisfaction 51%), while single respondents prioritize financial security (Monetary Benefits 32%, Flexible Schedules 27%, combined satisfaction 59%). Gender significantly influences motivation (p = 0.006).

Sustainable Ownership Values: The research confirms that ownership structures that prioritize sense of purpose (35%) suggest there are two values at a cultural level.

Co-ownership: Educational values paired with sense of purpose (18%), and motivation with social relations (16%), reflecting learning as a foundation and belonging and shared purpose as the core of sustainable ownership.

3 Objective 2: Stakeholder Perceptions of Cultural Ecosystem Benefits

What is the perception of key stakeholders on the cultural ecosystem benefits of the Antwerp harbor?

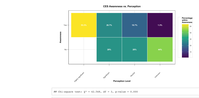


Distribution of CES Perception Levels (n=50)

Perception Level	Percentage (%)
Very significant	12
Significant	32
Neutral	6
Unimportant	50

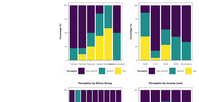
H1: Chi-square test: $\chi^2 = 11.50$, DF = 3, p-value = 0.009

H0: Original research assumption between awareness and perception.



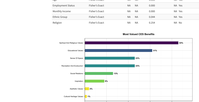
Cross-tabulation of CES Awareness vs. Perception

Perception Level	Awareness: Yes	Awareness: No
Very significant	6	0
Significant	16	0
Neutral	3	0
Unimportant	25	0



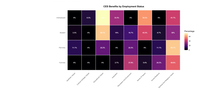
Cross-tabulation of Perception by Demographic Variables

Variable	Test	Statistic	df	p_value	Cramer's_V	Significant
Age Group	Chi-square	13.61	9	0.170	0.171	No
Ethnic Group	Fisher's Exact	NA	NA	0.000	NA	Yes
Employment Status	Fisher's Exact	NA	NA	1.000	NA	No
Monthly Income	Fisher's Exact	NA	NA	0.000	NA	Yes
Ethnic Group	Fisher's Exact	NA	NA	0.000	NA	Yes
Religion	Fisher's Exact	NA	NA	0.124	NA	No



CES Benefits Valued by Stakeholders

Benefit	Percentage
Spiritual And Religious Values	35
Educational Values	18
Sense of Place/Belonging	16
Sense Of Place	12
Social Relations	12
Inspiration	6
Aesthetic Values	1
Cultural Heritage Values	1



Cross-Tabulation CES Benefits (%)

Status	Percentage (%)
Values	35
Arts	18
Religious	16
Sense	12
Educational	12
Environment	6
Life	1
Recreation	1
Nature	1
Spiritual	1
Relations	1
Social	1
Beauty	1
Preservation	1

H1: Chi-square test: $\chi^2 = 9.60$, DF = 12, p-value = 0.620

Popular Activities Among Forest Users

Activity	Percentage (%)
Religious Activities	18
Hiking	16
Social Relationships	12
Scenery	12
Educational Activities	6

3.1 Findings for de objective 2

Distribution of CES Perception

Cultural Ecosystem Services Perception (CES vs Ignorance): Significant (χ² = 11.50, DF = 3, p = 0.009). Respondents recognize cultural ecosystem services (Recreation, Aesthetic, Cultural Heritage, Spiritual Values, Sense of Place, Educational Values, Social Relations, Nature, Arts and Leisure) as relevant.

Demographic Influences:

Strong Association: Employment status and ethnicity are significantly associated (χ² = 10.180, DF = 4, p = 0.037). Bonferroni-corrected (α = 0.05/4 = 0.013) confirms this relationship (p = 0.037). Age (p = 0.170), income (p = 0.124) and education (p = 0.620) show no significant associations.

Demographic Influences:

Significant Differences (p < 0.013): Younger respondents (ω = 0.28, Cohen's d = 0.56) highly significant (p=0.009), Latter groups (24%, 17%) show moderate significance (p = 0.013), Middle age groups (35–45, 25–35) show no significant difference (p = 0.170). Employed respondents (67%, 50% Special, Monthly Income (p = 0.007), Leisure Income groups (€500-€1k, 20%, €1k-€2k (p=0.009), Ethnic Group (p = 0.000), Religion (p = 0.124). Employed respondents show higher awareness (Fisher's Exact, OR = 0.000, 95% CI [0.000, 0.000]). Ethnic Groups (p = 0.000) and Religion (p = 0.124) show no significant associations.

Non-Significant Variables: Age (p = 0.170), Education (p = 0.620) and Religion (p = 0.124) show no differences. Age (p = 0.170), Education (p = 0.620), Religion (p = 0.124).

Activities and Perceptions:

Top Activities: Spiritual and religious visitors (18%), educational visitors (12%), recreation and relaxation (12%), sense of space (12%), social relations (12%), nature (6%), cultural heritage (1%), aesthetic (1%), cultural heritage values (1%). Employment Statistics: Students (20%), Employed (67%), Retired (6%), Unemployed (6%). Education Levels: Secondary (35%), Bachelor (18%), Master (12%), Doctoral (6%), Other (1%).

Activities and Perceptions:

Popular Activities: Religious activities (18%), reflection (17%), social interaction (12%), scenery (12%), educational activities (6%). Perceptions by Activity: Highly significant (χ² = 18.5, p = 0.002). Religious activities show 100% significance, scenery 50%, educational activities 50%, social interaction 33%, reflection 25%. Visit Frequency: Significant (χ² = 9.60, DF = 12, p = 0.620). Regular visitors (weekly, monthly) show higher significance (p = 0.013) than ad hoc visitors (p = 0.620). Visitors who perceive the forest for cultural ecosystem services. Ideas for Designers: Implements three strategic approaches: Spiritual Spaces, Educational Trails, Sensory Gardens.

Activity Influence: Religious activities (18%) show high significance, while reflection (17%) and social interaction (12%) show moderate significance, especially among frequent visitors (50% will visit weekly).

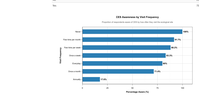
Design Implications: Spiritual spaces (18%), educational trails (12%), sensory gardens (12%), sense of space (12%), and social (12%) offer high potential for cultural ecosystem benefits. Ideas for Designers: Implements three strategic approaches: Spiritual Spaces, Educational Trails, Sensory Gardens.

Activity Influence: Religious activities (18%) show high significance, while reflection (17%) and social interaction (12%) show moderate significance, especially among frequent visitors (50% will visit weekly).

Design Implications: Spiritual spaces (18%), educational trails (12%), sensory gardens (12%), sense of space (12%), and social (12%) offer high potential for cultural ecosystem benefits. Ideas for Designers: Implements three strategic approaches: Spiritual Spaces, Educational Trails, Sensory Gardens.

4 Objective 3: Level of Awareness of Cultural Ecosystem Services

What is the level of awareness of the cultural ecosystem services delivered by the Antwerp forest?

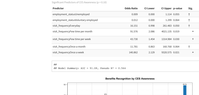


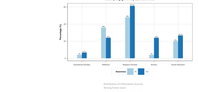
Distribution of CES Awareness (n=100)

Awareness Level	Percentage (%)
Yes	75
No	25

H1: Chi-square test: $\chi^2 = 40.00$, DF = 3, p-value = 0.000

H0: People at a distance(10) significantly associated between visitors and CES awareness.





Tests for Awareness Differences (Chi-square/Fisher's Exact)

Variable	Test	Statistic	df	p-value	Significant
Age Group	Chi-square	3.00	3	0.392	No
Gender	Fisher's Exact	NA	NA	1.000	No
Employment Status	Fisher's Exact	NA	NA	0.000	Yes
Monthly Income	Fisher's Exact	NA	NA	0.000	Yes
Ethnic Group	Fisher's Exact	NA	NA	0.000	Yes
Religion	Fisher's Exact	NA	NA	0.000	Yes

Significant Predictors of CES Awareness (p < 0.05)

Predictor	Odds Ratio	CI Lower	CI Upper	p-value	Sig
employment_status:student	0.000	0.000	1.114	0.010	*
visit_frequency:Ad hoc (Less than a month)	0.000	0.000	0.000	0.000	***
visit_frequency:Monthly	0.000	0.000	0.000	0.000	***
visit_frequency:Every two or six month	10.174	2.986	463.130	0.010	*
visit_frequency:Weekly	0.000	0.000	1014.000	0.000	***
visit_frequency:Once a month	11.781	3.802	463.130	0.000	***
visit_frequency:Once a year	0.000	0.000	0.000	0.000	***

H1: Kruskal-Wallis H = 20.00, DF = 2, p-value = 0.000

H0: Kruskal-Wallis H = 20.00, DF = 2, p-value = 0.000

Kruskal-Wallis Test: Benefits Recognition by CES Awareness

Awareness	Mean Rank
No	25.00
Yes	75.50

Kruskal-Wallis Test: Activity Engagement by CES Awareness

Awareness	Mean Rank
No	25.00
Yes	75.50

Information Sources (Multi-Response)

Information Source	Percentage (%)
Not relevant	30
Friends	25
Family	17

Sources of CES Benefits Observed Among Visitors (n=24)

Benefit Theme	Percentage (%)
Nature	18.2
Arts	12.1
Religious	12.1
Spiritual	12.1
Relationships	12.1
Relaxation	12.1
Educational	6.1
Sense	6.1
Beauty	6.1
Spaces	6.1
Relations	6.1
Social	6.1
Inspiration	6.1

Significant Differences:

Significant Differences: Employment Status (p = 0.000): Students (40%, 80% women and unemployed (12%, 83.3% women have higher awareness (Fisher's Exact, OR = 0.000, 95% CI [0.000, 0.000]). Monthly Income (p = 0.000): Lower income groups (€500-€1k, 20%, €1k-€2k (p=0.009), 20%, 50% women have the highest awareness (Fisher's Exact, OR = 0.000, 95% CI [0.000, 0.000]). Ethnic Groups (p = 0.000): Non-Significant Differences: Gender (p = 0.811): Female (50%, 75.0% slightly more aware than males (50%, 64%). Age (p = 0.392): Middle age groups (35–45, 25–35) show no significant difference (p = 0.170). Education (p = 0.620): Bachelor (18%), Master (12%) show no significant difference (p = 0.620). Religion (p = 0.124): Religious groups show no significant difference (p = 0.124).

Logistic Regression: Significant Predictors (p < 0.05): Ad Hoc Visitors (p = 0.000, OR = 0.000, 95% CI [0.000, 0.000]). Monthly Visitors (p = 0.000, OR = 0.000, 95% CI [0.000, 0.000]). Every two or six month (p = 0.010, OR = 10.174, 95% CI [2.986, 463.130]). Weekly Visitors (p = 0.000, OR = 1014.000, 95% CI [0.000, 1014.000]). Once a month (p = 0.000, OR = 11.781, 95% CI [3.802, 463.130]). Once a year (p = 0.000, OR = 0.000, 95% CI [0.000, 0.000]). Employed (p = 0.000, OR = 0.000, 95% CI [0.000, 0.000]). Student (p = 0.010, OR = 0.000, 95% CI [0.000, 1.114]).

Model Fit: AIC = 18, Pseudo-R² = 1.000 (perfect fit, but odds confidence intervals indicate sparse data).

Benefits Recognition: Kruskal-Wallis Test: Significant (H = 20.00, DF = 1, p = 0.000). Mean Rank: Unaware (25.0) vs. Aware (75.5). Activity Engagement: Kruskal-Wallis Test: Significant (H = 20.00, DF = 1, p = 0.000). Mean Rank: Unaware (25.0) vs. Aware (75.5).

Information Sources: Most common: Not relevant (30%), Friends (25%), Family (17%). Least common: Other (8%), Leisure (8%), Other (8%), Leisure (8%).

Information Sources: 30% are unaware of Cultural Ecosystem Services, with 25% citing friends and 17% citing family. Indicating a disconnect between formal information channels and social networks.

Observations:

High Awareness: The 75% awareness rate reflects the forest's cultural significance, particularly for spiritual (18% engagers) religious (12% engagers) and educational (12% engagers) benefits. Gender Gap: Women show higher awareness (75%) than men (64%), with students (80%) and unemployed (83%) showing the highest awareness.

Visit Frequency: Frequent visitors (50% visit at least monthly) get awareness through direct experience, while never visitors (25%) lack exposure and information.

Demographic Patterns: Students and retirees show strong ethnic/religious awareness due to diverse friends/family networks, while employed groups show lower awareness, suggesting potential information gaps through work activities.

Information Gap: High (72) awareness contrasts with the minimal (30%) awareness. 30% unaware, indicating untapped potential for improvement.

5 Objective 4: Factors Promoting Cultural Ecosystem Services Delivery

What factors promote the delivery of cultural ecosystem services in the Antwerp harbor?

Activity Participation (CEB Attitudes)

Activity	Percentage
Religious Activities	20
Reflection	20
Social Interaction	20
Training	20
Educational Activities	20

Significant Associations between Activities and CEB Benefits (p < 0.05)

Activity	Benefit	Test	Statistic	p-value	Cramer's V	Significance
Social Interaction	Spiritual Enlightenment	Fisher's Exact	5.00	0.000	0.500	***
Religious Activities	Spiritual Enlightenment	Fisher's Exact	5.00	0.000	0.500	***
Religious Activities	Spiritual And Religious Values	Chi-square	40.355	0.000	0.637	***
Religious Activities	Social Relations	Fisher's Exact	5.00	0.000	0.500	***
Religious Activities	Recreation And Relaxation	Chi-square	31.496	0.000	0.570	***
Reflection	Cooperation	Fisher's Exact	4.00	0.000	0.400	***
Reflection	Sense Of Peace	Chi-square	20.000	0.000	0.408	***
Reflection	Spiritual Enlightenment	Fisher's Exact	5.00	0.000	0.500	***
Training	Social Relations	Fisher's Exact	5.00	0.000	0.500	***
Training	Recreation And Relaxation	Fisher's Exact	5.00	0.000	0.500	***
Training	Spiritual And Religious Values	Chi-square	5.000	0.025	0.289	**
Educational Activities	Educational Values	Fisher's Exact	5.00	0.000	0.500	***
Educational Activities	Spiritual And Religious Values	Chi-square	40.355	0.000	0.637	***
Religious Activities	Educational Values	Chi-square	5.000	0.025	0.289	**
Reflection	Social Relations	Fisher's Exact	5.00	0.000	0.500	***
Reflection	Recreation And Relaxation	Fisher's Exact	5.00	0.000	0.500	***
Reflection	Spiritual And Religious Values	Chi-square	5.497	0.001	0.337	**
Reflection	Facilitate Healing	Fisher's Exact	5.00	0.000	0.500	***
Educational Activities	Inspiration	Fisher's Exact	5.00	0.000	0.500	***

Funding Sources for Cultural Heritage Conservation

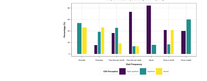
Funding Source	Percentage (%)
Cash Flow	33
Accra Metropolitan Assembly Government Of Ghana Allocation	33
Government Of Ghana	33
Accra Metropolitan Assembly Bonds	33
Accra Metropolitan Assembly	33
Government Of Ghana Bonds	33
Accra Metropolitan Assembly Donations	33
Accra Metropolitan Assembly Government Of Ghana Donations	33
Accra Metropolitan Assembly Cash Flow	33
Donations	33
Cash Flow/Grant Team	33
Government Of Ghana/Cash Flow/Grant Team	33
Grant Team	33

Funding Mechanisms for Heritage Conservation

CEB Mechanism	Funding Preference	Percentage (%)
Yes	Accra Metropolitan Assembly	9.0
Yes	Accra Metropolitan Assembly/Government Of Ghana	9.0
Yes	Accra Metropolitan Assembly/Government Of Ghana/Donations	9.0
Yes	Government Of Ghana	20.0
Yes	User Fees	20.0
Yes	Accra Metropolitan Assembly	5.0
Yes	Accra Metropolitan Assembly/Donations	2.7
Yes	Accra Metropolitan Assembly/Government Of Ghana	2.7
Yes	Accra Metropolitan Assembly/Government Of Ghana/Donations	1.3
Yes	Accra Metropolitan Assembly/User Fees	2.7
Yes	Donations	2.7
Yes	Government Of Ghana	5.0
Yes	Government Of Ghana/Donations	9.0
Yes	Government Of Ghana/User Fees	9.0
Yes	Government Of Ghana/User Fees/Grant Team	5.0
Yes	Grant Team	2.7
Yes	User Fees	45.3
Yes	User Fees/Grant Team	2.7

H^2 (Chi-square) tests: $\chi^2 = 23.155$, df = 9, p value = 5.55

H^2 Phase is a statistically significant association between CEB mechanism and funding preference



Perceptions of Cultural Heritage Conservation Benefits

Job_Frequency	Neutral	Agree	Strongly Agree
Annually	0	45.2	54.8
Annually	2	0.0	0.0
Fortnightly	0	0.0	27.8
Monthly	0	40.0	0.0
Quarterly	0	0.0	17.2
Daily (Except Sunday)	0	0.0	0.0
Daily (Except Sunday)	2	35.2	0.0
Twice (Except Sunday)	0	0.0	0.0
Twice (Except Sunday)	0	0.0	0.0
Twice Daily	0	0.0	0.0
Weekly	0	0.0	0.0
Never	0	0.0	0.0
Once A Month	0	0.0	0.0
Once A Month	2	0.0	0.0
Once Leader	0	0.0	0.0
Once A Leader	0	0.0	0.0

Personnel Sound Numbers Benefits by Visit Companions
Percentage (%)
Family
Friends
Tourists
Tourists
Tourists

concerns/threats/conflicts (−1.00).

By Income: 4000-5999 (30%): High concerns (1.85), threats (1.85). 3001-3000 GHS (17%): Highest threats (2.00), conflicts (1.53). 501-1500 GHS (29%): Low concerns (1.07), conflicts (1.00).

Observation: Younger and lower-income respondents, reliant on the forest (e.g., for religious activities, 58%, Objective 4), report more barriers, middle income groups highlight management issues.

Impact of Inhibition Level:

High Inhibition (−4, 50%): Highest benefits (mean = 2.66). Medium Inhibition (68, 38%): Low benefits (0.84). Low Inhibition (62, 12%): Low benefits (0.83). Observation: High inhibition correlates with higher benefits, likely due to frequent visitors' (44% monthly) awareness of both CES and barriers.

- Observations Dominant Barriers: Maintenance (82%) and safety (43%) concerns, alongside encroachment (47%) and inefficient management (41%), are primary inhibitors, reflecting physical and administrative challenges.

Conflicts: Traditional vs. political leader disputes (49%) dominate, likely linked to land use conflicts, impeding coordinated CES delivery.

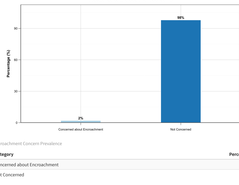
Demographic Patterns: Younger (38% aged 16–48), lower income (4000 GHS, 26%), and student (30%) respondents report more concerns/threats, reflecting reliance on the forest for cultural activities (Objective 4). Middle income groups (3001-5000 GHS) emphasise management threats.

Visit Frequency: Frequent visitors (44% monthly) report more conflicts (p = 0.014), likely due to exposure to issues like encroachment and safety.

Benefit Impact: Major challenges (75%) slightly lower benefit recognition, but high inhibition aligns with higher benefits, indicating engaged users' dual awareness.

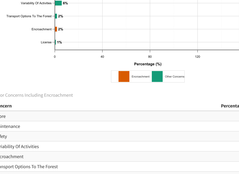
7 Objective 6: Extent of Encroachment and Sustainability Implications

What is the extent of encroachment into the Achimota forest and its implication to the sustainability?



Encroachment Concern Prevalence

Category	Percentage
Concerned about Encroachment	2
Not Concerned	98



Major Concerns Including Encroachment

Concern	Percentage (%)
Score	136
Maintenance	82
Safety	43
Variability Of Activities	6
Encroachment	2
Transport Options To The Forest	2
License	1

Distribution of Reclassification Awareness

Awareness Level	Percentage (%)
No	82
Unknown	1
Yes	17

Sources of Information about Reclassification (Among Those Aware)

Information Source	Percentage (%)
Media	94.1
Friends	5.9

Attitudes Among Informed Respondents

Agreement Level	Percentage (%)
Agree	23.5
Highly Agree	35.3
Highly Disagree	17.6
Uncertain	23.5

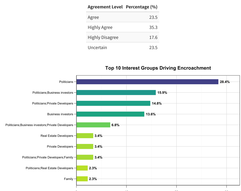
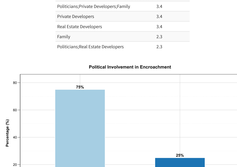


Table: Top 10 Interest Groups Driving Encroachment

Interest Group	Percentage (%)
Politicians	28.4
Politicians,Business Investors	15.9
Politicians,Private Developers	14.8
Business Investors	13.6
Politicians,Business Investors,Private Developers	6.8
Politicians,Private Developers,Family	3.4
Private Developers	3.4
Real Estate Developers	3.4
Family	2.3
Politicians,Real Estate Developers	2.3



Business-Political Interest Group Combinations

Interest Group Combination	Percentage (%)
Business + Political	46.6
Business Only	22.7
Other	2.3
Political Only	28.4

Projected Effects of Encroachment

Effect	Percentage
Loss Of Natrual Asset For The City	58
Adverse Effect On Social Interaction	30
Adverse Effect On The Delivery Of Ecosystem Services	11
Loss Of Recreational Areas	6

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## Respondents expecting multiple effects: 27.0%
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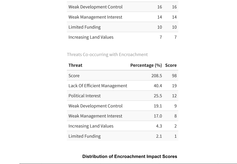
Sustainability Threats Including Encroachment

Threat	Percentage (%)	Score
Score	165	165
Encroachment	47	47
Lack Of Efficient Management	41	41
Political Interest	30	30
Weak Development Control	16	16
Weak Management Interest	14	14
Limited Funding	10	10
Increasing Land Values	7	7

Threats Co-occurring with Encroachment

Threat	Percentage (%)	Score
Score	208.5	98
Lack Of Efficient Management	40.4	19
Political Interest	25.5	12
Weak Development Control	19.1	9
Weak Management Interest	17.0	8
Increasing Land Values	4.3	2
Limited Funding	2.1	1

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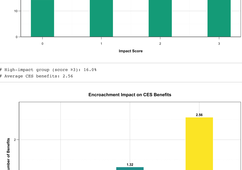
## High-impact group (score >1): 10.0%
## Average CES benefits: 2.56
```



Encroachment Impact on CES Benefits

Impact_Level	Percentage	Mean_Benefits
Low Impact	69	1.32
Medium Impact	16	2.56
No Impact	15	0.87

7.1 Findings of the 6

Encroachment Concerns:

Low Concerns: Only 2% cite encroachment as a concern, vs. maintenance (82%) and safety (43%) (Objective 5). Observation: Despite low concern, encroachment is a major threat (47%, Objective 5), indicating underreported awareness.

Sustainability Threats:

Top Threats: Encroachment (47%), lack of efficient management (41%), political interest (30%). Co-occurring: Among encroachment-cliters, lack of efficient management (40.4%) and political interest (25.5%) are common. Observation: Encroachment, linked to management and political issues, significantly threatens CES sustainability.

Reclassification Awareness:

Low Awareness: 82% unaware, 17% aware, 1% unknown. Media (94.1%) and friends (5.9%) inform the aware. Observation: Low awareness of reclassification (linked to land use changes) limits public action against encroachment.

Reclassification Attitudes: Informed Respondents: 35.3% highly agree, 23.5% agree, 23.5% uncertain, 17.6% highly disagree. Observation: Over half of aware respondents (1.7%) support reclassification, potentially enabling encroachment.

Interest Groups: Key Drivers: Politicians (28.4%), politicians with business investors (15.9%), or private developers (14.8%). Combinations: Business + political (46.6%), political only (28.4%), business only (22.7%). Observation: Politicians and business-political alliances drive encroachment via land use pressures.

Projected Effects:Major Effects: Loss of natural assets (58%), social interaction (30%), ecosystem services (11%), recreational areas (6%). Severity: 27% expect multiple effects (62); high-impact group (score ≥3, 16%) has higher benefits (mean = 2.56).

Impact Levels: Medium impact (16%, mean benefits = 2.56), low impact (69%, mean = 1.32), no impact (15%, mean = 0.87). Observation: Encroachment threatens CES, especially for frequent users (44% monthly, Objective 4) who value benefits highly.

- Observations

Extent of Encroachment: Low concern (2%) contrasts with high threat perception (47%), linked to management inefficiencies (40.4%) and political interests (25.5%), suggesting awareness gaps.

Sustainability Implications: Encroachment risks natural asset loss (58%) and social CES (30%), threatening sustainability, particularly for frequent visitors (mean benefits = 2.56).

Awareness Barrier: Low reclassification awareness (82% unaware), driven by media (94.1%), hinders anti-encroachment action.

Drivers: Politicians and business-political alliances (46.6%) fuel encroachment, likely via reclassification disputes (Objective 5).

Demographic Context: Younger (38% aged 16–48) and low income (55% 4(500 GHS) users, reliant on cultural activities (e.g., religious, 58%, Objective 4), face greater impacts but low awareness.

Benefit Paradox: High-impact groups (16%) recognize more benefits (mean = 2.56), indicating frequent users' dual awareness of threats and CES value.