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Environmental Stewardship among Beach Users and Implications for Sustainable Coastal Tourism Governance in Cox's Bazar Bangladesh

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Environmental Stewardship among Beach Users and Implications for Sustainable Coastal Tourism Governance in Cox's Bazar Bangladesh

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Abstract

This study examined multidimensional environmental stewardship among 170 beach users in Cox's Bazar, Bangladesh, and its implications for sustainable coastal tourism governance. Using an archived cross-sectional questionnaire dataset, environmental stewardship was reanalysed through a reconstructed, conceptually specified Environmental Stewardship Index (ESI) comprising behavioural orientation, attitude, environmental awareness and understanding, ethics, and willingness. Thirty-seven eligible items were transformed to a common 0–100 scale and combined using equal dimension weighting. The overall ESI mean was 74.31 (SD = 11.74). Ethics (78.82), willingness (76.03), and environmental awareness and understanding (75.70) scored higher than behavioural orientation (69.21), indicating a descriptive divergence across stewardship dimensions rather than an observed attitude-to-behaviour transition. Archived income categories showed non-monotonic heterogeneity, while the secondary physiographic comparison showed no meaningful group difference. Respondents also expressed strong support for improved waste management, implementation of environmental laws and regulations, social-awareness initiatives, and restrictions on single-use plastics. These findings inform a conceptual Green Beach Governance Framework linking stewardship orientation with enabling conditions such as environmental education, infrastructure, enforcement, institutional capacity, accessibility, and community participation. The study provides an exploratory stewardship baseline for sustainable coastal tourism and highlights the need for prospective validation and direct behavioural measurement.

Keywords: Environmental stewardship; sustainable tourism; coastal tourism; beach governance; visitor behaviour; environmental governance

1. Introduction

Coastal tourism generates substantial economic and recreational benefits, but concentrated visitor activity, transport, accommodation, consumption, and marine recreation can intensify habitat disturbance, waste generation, plastic pollution, resource use, and other pressures on coastal systems [1–4]. Sustainable tourism therefore requires more than environmental awareness alone; it depends on how visitor orientations interact with destination-level infrastructure, institutions, services, and governance arrangements [5–7].

Environmental stewardship provides a useful framework for examining these interactions because it encompasses care for environmental resources, knowledge and awareness, ethical responsibility, willingness to contribute, and environmentally relevant action [8, 9]. Environmental-behaviour research similarly shows that pro-environmental outcomes are shaped by values, attitudes, norms, perceived control, habits, and contextual opportunities [10–21]. In tourism settings, these relationships are particularly important because environmentally supportive attitudes or intentions may not translate directly into lower-impact choices when cost, convenience, service design, infrastructure, or habitual routines constrain behaviour [22–31].

For this reason, stewardship is treated in the present study as a multidimensional orientation rather than a single behavioural trait. Five complementary dimensions are considered: behavioural orientation, reflecting environmentally relevant tourism-choice preferences; attitude, reflecting concern about environmental degradation and support for protection; environmental awareness and understanding, reflecting self-reported recognition of environmental problems and sustainable-tourism principles; ethics, reflecting moral and rights-based obligations toward environmental protection; and willingness, reflecting readiness to contribute time, money, or effort. These dimensions are conceptually related but are not assumed to represent a single validated latent construct. This approach is consistent with stewardship and sustainable-tourist-behaviour literature that distinguishes values, awareness, responsibility, willingness, and action [8–11, 22–24, 32–36].

Cox's Bazar, Bangladesh, provides an important setting for applying this perspective. The destination supports intensive tourism and livelihood activity while experiencing environmental pressures associated with shoreline development, pollution, microplastic contamination, ecosystem change, and increasing demand on coastal resources [37, 38]. Within the literature cited for Cox's Bazar in this study, environmental research has documented ecosystem degradation and pollution pressures, but evidence on multidimensional environmental stewardship among beach users remains limited. This creates a need to examine not only whether beach users express environmental concern, but also how behavioural orientation, awareness, ethics, and willingness coexist within a broader stewardship profile.

A second gap concerns the relationship between visitor-level stewardship and destination governance. Sustainable-tourism governance requires institutional capacity, stakeholder

participation, environmental indicators, service infrastructure, and contextual conditions that can enable or constrain environmentally responsible action [39–41]. However, visitor stewardship and governance conditions are often examined separately. Integrating them can help distinguish what individuals report valuing or being willing to do from the institutional and infrastructural conditions needed to support realized environmental action. Accordingly, this study examines environmental stewardship among beach users in Cox's Bazar using a reconstructed multidimensional Environmental Stewardship Index (ESI) comprising behavioural orientation, attitude, environmental awareness and understanding, ethics, and willingness. The study aims to: (1) characterize the multidimensional stewardship profile of respondents; (2) examine exploratory variation across archived monthly-income and physiographic classifications; (3) identify environmental-management measures supported by respondents; and (4) develop a conceptual Green Beach Governance Framework linking stewardship orientation with enabling conditions for sustainable coastal tourism. The study contributes to sustainable-tourism research by integrating a transparent multidimensional stewardship measure with a governance-oriented interpretation while explicitly distinguishing self-reported preferences and orientations from directly observed behaviour.

2. Materials and Methods

2.1 Study Area

The study was conducted in Cox's Bazar, Bangladesh, the country's principal coastal tourism destination, where an extended sandy shoreline supports intensive visitor activity [37, 38]. The study area encompassed approximately 26 km of coastline extending from Laboni Beach to Inani Beach. Cox's Bazar was selected because of its economic importance, high visitor concentration, and environmental pressures associated with tourism development, including plastic pollution, solid-waste generation, coastal ecosystem degradation, and resource-use pressures. Survey activities were conducted at major tourism locations, including Laboni, Sugandha, Kolatoli, Himchhari, and Inani beaches, as well as adjacent commercial areas frequently used by visitors. The broader geographic context and approximate locations of the five surveyed beach areas are shown in Fig. 1. The plotted locations identify the major beach areas visited during the study and should not be interpreted as verified GPS coordinates for individual questionnaire administration points.

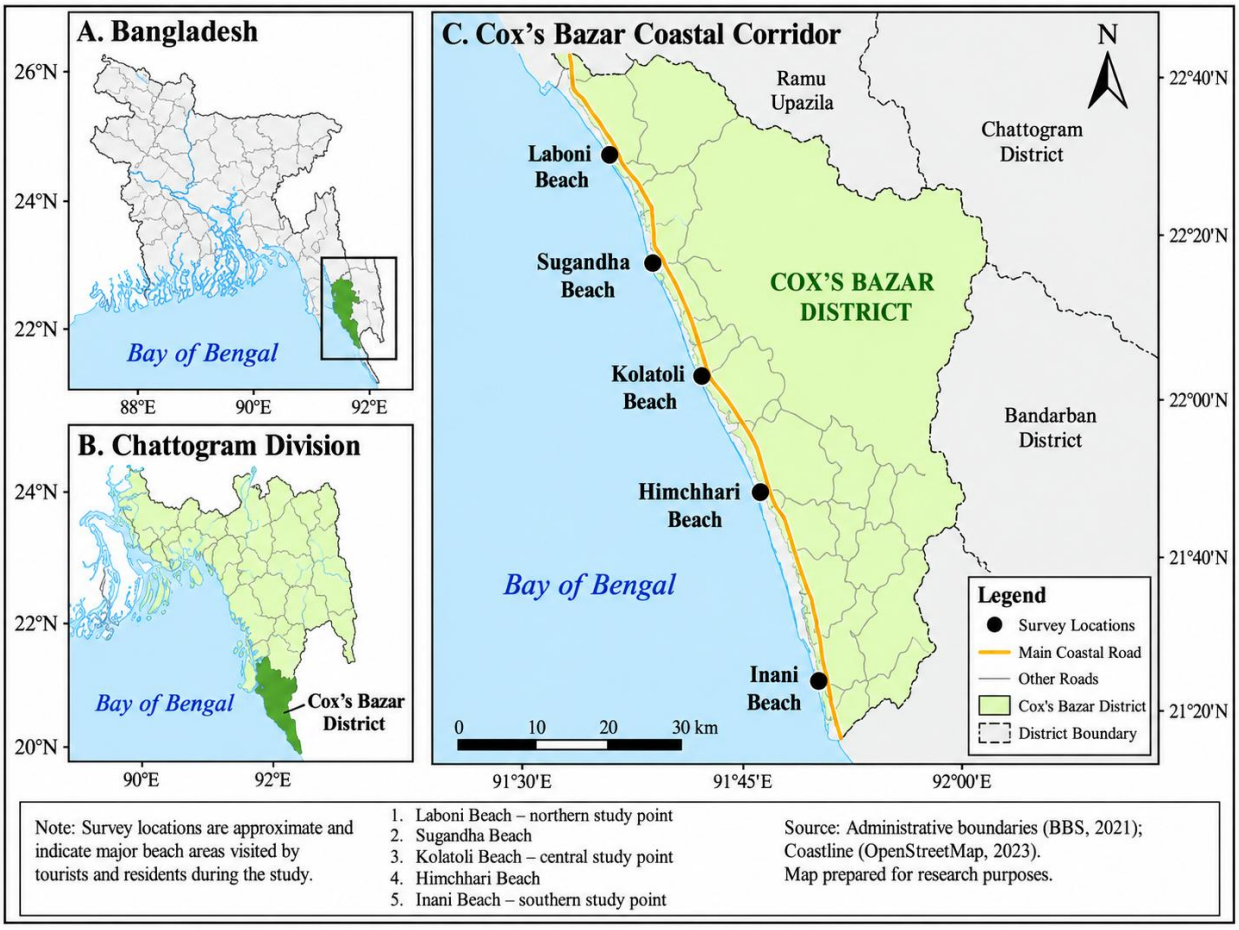


Fig. 1 Study area and survey locations in Cox's Bazar, Bangladesh. (a) Location of Cox's Bazar District within Bangladesh. (b) Location of Cox's Bazar District within Chattogram Division. (c) Cox's Bazar coastal corridor showing the approximate locations of Laboni, Sugandha, Kolatoli, Himchhari, and Inani beaches. Survey locations are approximate and indicate major beach areas visited during the study rather than verified GPS sampling coordinates. Administrative boundaries: Bangladesh Bureau of Statistics (2022). Map data © OpenStreetMap contributors; OpenStreetMap data are available under the Open Database License (ODbL).

2.2 Study Design and Data Collection

A cross-sectional questionnaire survey was conducted on 26 February 2021 among beach users encountered at major tourism locations in Cox's Bazar, Bangladesh. Data collection took place between 07:00 and 20:00 and yielded 170 analysable responses. Because visitor mobility was restricted during the COVID-19 period, convenience sampling was used at the surveyed beach locations. The resulting sample should therefore be interpreted as a site-based convenience sample rather than as statistically representative of all beach users or visitors to Cox's Bazar. The questionnaire covered travel and tourism preferences, environmental perceptions, environmental awareness and understanding, ethical orientations, willingness to participate in

environmental protection, monthly income, and place of origin. The surviving study materials do not preserve a formal age-eligibility criterion, detailed respondent-selection protocol, or a variable distinguishing tourists from local residents. These characteristics therefore cannot be reconstructed and were not inferred in the present reanalysis. The archived questionnaire template contains name and signature fields; however, the analytical dataset available for reanalysis contains questionnaire serial numbers only and no respondent names or signatures. A standalone participant-information or consent form documenting the original field procedure is not preserved in the archive. The archived dataset contained a preclassified physiographic variable comprising 52 respondents categorized as Floodplain/Delta, 71 as Hilly Terrains, and 47 as Pleistocene Uplands. Because the original mapping from respondents' reported places of origin to these physiographic classes was not preserved, analyses using this variable were treated as secondary and exploratory. Valid monthly-income classification was available for 169 respondents; one out-of-range income code was treated as missing. The archived questionnaire does not preserve the income currency, and the upper-bound notation for the sixth category is ambiguous. Income was therefore interpreted only as an ordered six-category variable. Sample distributions are summarized in Table 1.

Table 1 Analytical sample distribution

Variable	Category	n	%
Physiographic background (archived classification)	Floodplain/Delta	52	30.6
	Hilly Terrains	71	41.8
	Pleistocene Uplands	47	27.6
Monthly income (archived units; currency not preserved)	<14,600	41	24.3
	14,601–35,000	45	26.6
	35,001–55,000	45	26.6
	55,001–75,000	23	13.6
	75,001–95,000	9	5.3
	≥95,001 (category 6; upper bound unclear)	6	3.6

Note: Physiographic percentages use N = 170 and reflect an archived preclassification whose original locality-to-class mapping was not preserved. Income percentages use valid n = 169; one out-of-range income code was treated as missing. The archived questionnaire does not preserve the income currency, and the upper-bound notation for category 6 is ambiguous; income is therefore interpreted only as an ordered categorical variable.

2.3 Environmental Stewardship Indicators and Measurement

Environmental stewardship was operationalized as a multidimensional, conceptually specified construct comprising behavioural orientation, attitude, environmental awareness and understanding, ethics, and willingness. These dimensions represent complementary components of stewardship reflected in environmental-stewardship and sustainable-tourism literature, including environmentally relevant preferences, evaluative support for environmental protection, perceived environmental understanding, normative responsibility, and willingness to contribute effort or resources [8–11, 22–24, 32, 33]. They were treated as conceptually related but distinct components rather than indicators of a single latent construct; accordingly, the reconstructed Environmental Stewardship Index (ESI) is interpreted as a theory-informed composite rather than a validated psychometric scale.

Items were retained only when their response structures permitted a defensible ordering from lower to higher stewardship orientation. Nominal variables, open-ended responses, recreational preferences without a clear stewardship ordering, and COVID-19-specific health and safety items were excluded. The final ESI comprised 37 items: behavioural orientation (10), attitude (14), environmental awareness and understanding (8), ethics (2), and willingness (3). The complete item composition and scoring scheme are provided in ESM 1 (Table S1).

Response categories for Q24 and Q25 are documented in the archived data codebook but are not printed beside those questions in the archived questionnaire; sensitivity analyses therefore evaluated specifications excluding these items from the willingness dimension.

2.4 Environmental Stewardship Index Construction

All retained items were transformed to a common 0–100 metric before aggregation. Five-point Likert responses were scored as 0, 25, 50, 75, and 100 for response categories 1 through 5, respectively. The hotel item concerning daily replacement of sheets and towels was reverse-scored because greater preference for daily replacement implies greater resource use. In the primary specification, three-category No/Not sure/Yes items were scored 0/50/100, and the binary donation item was scored 0/100.

A sensitivity specification treated Not sure responses as missing rather than as the midpoint.

$$\text{Item score} = ((x - 1) / 4) \times 100$$

Dimension scores were calculated as the mean of valid item scores. Minimum valid-item requirements corresponded to approximately 80% completion within each dimension, rounded to the nearest feasible item count: 8 of 10 behavioural-orientation items, 12 of 14 attitude items, 7 of

8 environmental-awareness/understanding items, both ethics items, and 2 of 3 willingness items. Out-of-range source codes were treated as missing rather than corrected by assumption, and no item-level imputation was performed. All 170 respondents met the primary minimum-valid-item requirements.

$$ESI = (B + A + AU + E + W) / 5$$

where B, A, AU, E, and W denote the 0-100 scores for behavioural orientation, attitude, environmental awareness and understanding, ethics, and willingness, respectively. Each dimension therefore contributed 20% to the overall ESI. Equal weighting was used because no empirically defensible differential weighting scheme was available and to prevent dimensions represented by more questionnaire items from dominating the composite, consistent with established composite-indicator guidance [42]. Higher scores indicate stronger overall stewardship orientation. Because the index is intentionally multidimensional, internal consistency was evaluated within dimensions rather than by interpreting one alpha coefficient for the entire composite. The ESI construction and respondent-level analytical workflow are summarized in Fig. 2

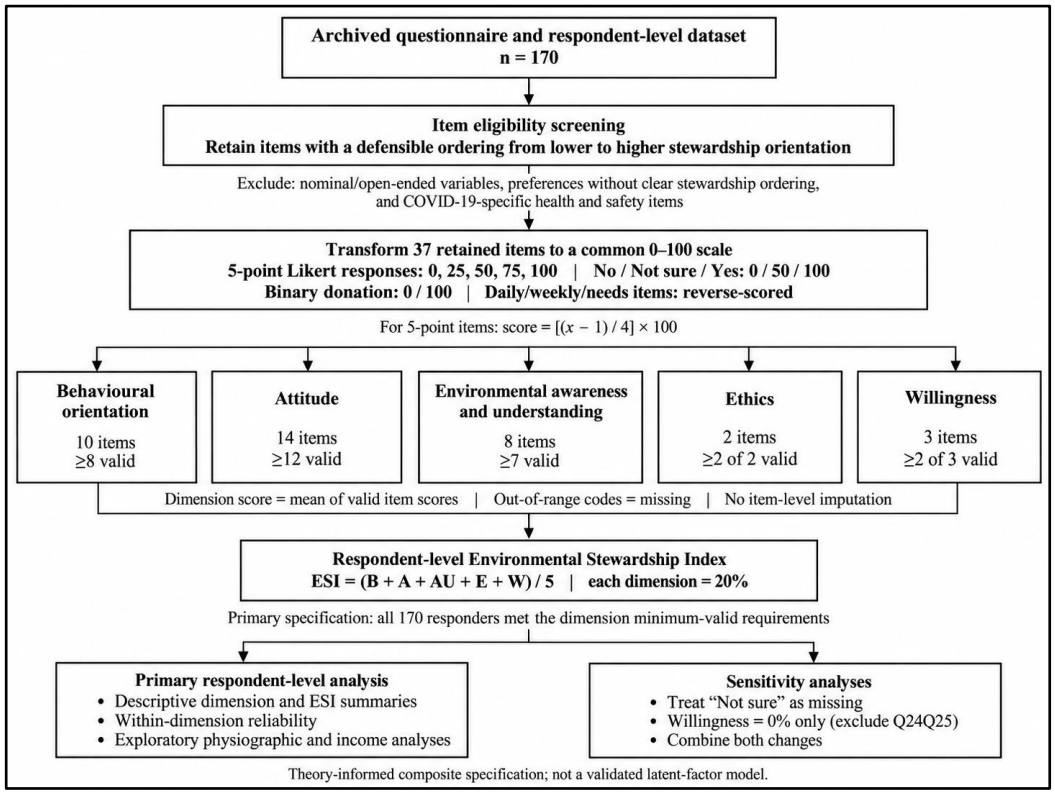


Fig. 2 Environmental Stewardship Index construction and respondent-level analytical workflow. Thirty-seven eligible items were transformed to a common 0–100 scale and aggregated within five dimensions subject to dimension-specific minimum-valid-item requirements. The five dimension scores were equally weighted to calculate the respondent-

level ESI. Sensitivity analyses evaluated alternative treatment of 'Not sure' responses and exclusion of Q24/Q25 from the willingness dimension.

2.5 Statistical Analysis and Reliability

Descriptive statistics were reported as frequencies, percentages, means, standard deviations (SD), and 95% confidence intervals (CI), as appropriate. Internal consistency was assessed separately for each ESI dimension using Cronbach's alpha; for the two-item ethics dimension, the inter-item correlation was also examined. Reliability estimates were interpreted descriptively and not as evidence of formal psychometric validation [43–45]. Dimension composition, minimum-valid-item requirements, and internal-consistency estimates are summarized in ESM 1 (Table S2).

As a secondary analysis, ESI scores were compared across the archived Floodplain/Delta, Hilly Terrains, and Pleistocene Uplands classifications using one-way ANOVA. Variance homogeneity was assessed with a median-centered Levene test, and eta squared (η^2) was reported as the effect-size estimate. Because the original locality-to-physiographic mapping was not preserved, this analysis was treated as exploratory.

Monthly income was analysed as an ordered six-category variable among 169 respondents with valid data. Because variances differed across groups, income-category heterogeneity was evaluated using Welch's ANOVA with Games–Howell post hoc comparisons. Kruskal–Wallis analysis provided a robustness check, with epsilon squared (ε^2) as the effect-size estimate, while Spearman's rank correlation assessed monotonic association between income category and ESI.

Sensitivity analyses examined alternative treatment of Not sure responses, exclusion of Q24 and Q25 from the willingness dimension, and the combination of both specifications. Analyses were conducted in Python 3.13 using SciPy 1.17.0 and statsmodels 0.14.6.

2.6 Development of the Green Beach Governance Framework

The Green Beach Governance Framework was developed by integrating the empirical stewardship profile with environmental-stewardship, responsible-tourism, and sustainable-tourism governance literature [8–11, 22–24, 39–41]. Empirical patterns in the ESI dimensions and respondents' support for environmental-management measures were interpreted alongside destination-level conditions that may enable or constrain environmentally responsible action.

Six enabling domains were identified: environmental education, waste and service infrastructure, rules and enforcement, institutional capacity, economic incentives and accessibility, and community participation. These domains were organized conceptually to link stewardship orientation with realized environmental action, improved environmental quality, and sustainable coastal tourism outcomes.

The framework is conceptual rather than predictive. The proposed pathways were not causally tested in the cross-sectional survey and should therefore be interpreted as hypotheses for prospective evaluation rather than demonstrated mechanisms.

Because the attitude dimension of the ESI includes respondents' evaluations of several environmental-management measures (Q28.1–Q28.6), the ESI profile and the governance-support responses are not treated as independent lines of evidence. The governance framework therefore uses these responses descriptively alongside the broader stewardship profile and relevant literature rather than as independent validation of the framework.

2.7 Study Limitations

Several limitations should be acknowledged. The use of convenience sampling and one-day data collection during the COVID-19 period limits generalisability and may have influenced sample composition. The archived materials do not preserve participant ages, an adult-only eligibility criterion, tourist-versus-local-resident status, or complete documentation of the original consent and ethics procedures. These characteristics therefore cannot be reconstructed. In addition, the cross-sectional design precludes causal inference and assessment of behavioural change over time, while most behavioural indicators reflect self-reported preferences rather than directly observed actions and may be subject to self-report bias.

The ESI was reconstructed from an existing questionnaire, and its five-dimensional structure is conceptually specified rather than psychometrically validated. Response categories for Q24 and Q25 are documented in the archived data codebook but are not printed on the archived questionnaire; sensitivity analyses therefore examined alternative treatment of these items and of "Not sure" responses. The archived physiographic classification lacks a preserved locality-to-class mapping, while the income variable lacks a preserved currency label and has ambiguous upper-bound notation for the highest category. Some income groups were also small. These issues are documented in ESM 1 (Table S3).

Accordingly, the ESI and subgroup analyses should be interpreted as exploratory and hypothesis-generating. ESM 1 provides the item-coding, data-quality, and sensitivity analyses, while ESM 2 reproduces the archived questionnaire. The respondent-level dataset is not publicly deposited because consent for public data sharing cannot be verified from the surviving records. Future research should use larger and more representative samples, prospectively validated measures, longitudinal designs, and direct behavioural observation to evaluate the robustness and predictive utility of the ESI and to test the proposed governance framework across coastal tourism settings.

3. Results

3.1 Environmentally Relevant Tourism Preferences

Environmentally relevant tourism preferences varied across decision contexts. Energy-efficient lighting (87.6%) and eco-friendly building materials (81.2%) were among the most frequently valued hotel attributes, while 68.2% also considered daily replacement of sheets and towels important. Lower-polluting options (77.1%) and avoidance of environmental pollution (75.9%) were frequently prioritized in product and service choices. Transport decisions were dominated by practical considerations, particularly seating, travel time, and fare. Detailed item-level distributions are provided in ESM 1 (Figs. S1–S6).

3.2 Environmental Attitudes and Governance Perceptions

Environmental attitudes were generally supportive of protection. Among valid responses, 72.2% reported that environmental pollution had affected the recreational value of coastal tourism, while 53.3% considered existing laws insufficient to reduce beach pollution. Support was particularly high for improved waste management (96.5%), implementation of laws and regulations (90.6%), social-awareness initiatives (87.1%), and restrictions on single-use plastics (81.8%). Detailed response distributions are reported in ESM 1 (Figs. S7, S8, and S13).

3.3 Environmental Awareness and Understanding

Environmental awareness and perceived understanding were generally high. Among valid responses, 88.8% reported awareness of littering or plastic-pollution issues. Respondents also frequently recognized impacts of plastic pollution on land, marine biodiversity, the food chain, and groundwater. Agreement with environmentally friendly tourism principles was similarly high, particularly for minimizing environmental impacts, sustainable use of natural resources, and nature conservation. These measures represent self-reported awareness and perceived understanding rather than objective knowledge. Detailed item-level results are provided in ESM 1 (Figs. S10–S12).

COVID-period responsibility-change items were analysed separately and are reported in ESM 1 (Fig. S9); they were not incorporated into the ESI because they reflect pandemic-specific retrospective perceptions rather than core stewardship indicators.

3.4 Environmental Stewardship Index Profile

The reconstructed ESI had an overall mean of 74.31 (SD = 11.74; 95% CI 72.53–76.09). Ethics had the highest mean dimension score (78.82), followed by willingness (76.03), environmental awareness and understanding (75.70), attitude (71.80), and behavioural orientation (69.21) (Table 2; Fig. 3). Dimension-specific Cronbach's α values ranged from .628 to .783; for the two-item ethics dimension, the inter-item correlation was $r = .458$.

The dimension scores represent self-reported stewardship orientation and should not be interpreted as directly observed behaviour or longitudinal behavioural change.

Table 2 Environmental Stewardship Dimension Scores and Internal Consistency

Dimension	Retained items	Mean	SD	95% CI	Cronbach's α
Behavioural orientation	10	69.21	11.68	67.44–70.97	.722
Attitude	14	71.80	10.51	70.21–73.39	.720
Environmental awareness and understanding	8	75.70	13.39	73.67–77.72	.743
Ethics	2	78.82	13.33	76.81–80.84	.628
Willingness	3	76.03	33.30	70.99–81.07	.783
Overall ESI	37	74.31	11.74	72.53–76.09	—

Note: Scores range from 0 to 100, with higher scores indicating stronger stewardship orientation. Dimension means and the overall ESI use the prespecified minimum-valid-item rules; all 170 respondents met these requirements. Cronbach's α used complete cases within each dimension: behavioural orientation n = 170, attitude n = 167, environmental awareness and understanding n = 169, ethics n = 170, and willingness n = 168. Because the ESI is deliberately multidimensional, an overall α is not reported. For the two-item Ethics dimension, the inter-item correlation was r = .458. The overall ESI is calculated from the five equally weighted dimension scores rather than by directly averaging all 37 items.

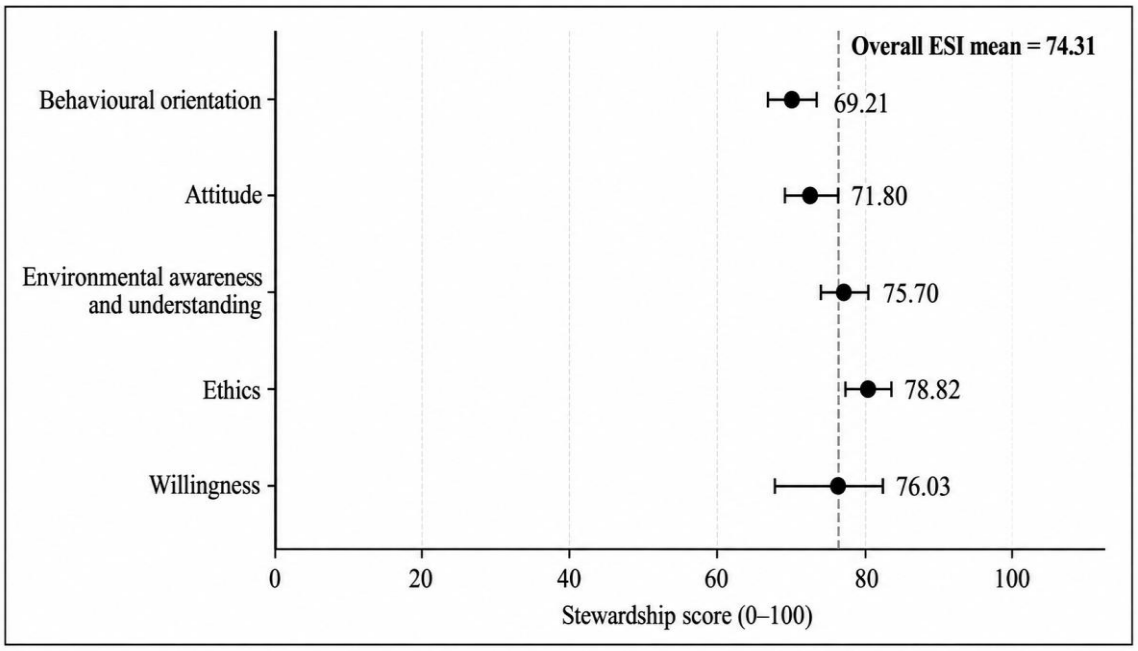


Fig. 3 Mean environmental stewardship dimension scores with 95% confidence intervals. Scores range from 0 to 100, with higher values indicating stronger stewardship orientation. The dashed vertical line represents the overall Environmental Stewardship Index mean (74.31). Environmental awareness and understanding reflects self-reported awareness, perceived environmental impacts, and recognition of sustainable-tourism principles rather than an objective knowledge test; behavioural orientation reflects reported preferences rather than directly observed behaviour.

3.5 Secondary Analysis by Archived Physiographic Classification

Mean ESI scores were 75.41 (SD = 12.07) for Floodplain/Delta, 73.62 (SD = 11.64) for Hilly Terrains, and 74.14 (SD = 11.69) for Pleistocene Uplands (Table 3; Fig. 4). Variances were comparable (median-centered Levene $p = .997$), and no group difference was detected, $F(2, 167) = 0.352$, $p = .704$, $\eta^2 = .004$. Because the original locality-to-physiographic-class mapping was not preserved, this comparison is treated as secondary and exploratory.

Table 3 Secondary Environmental Stewardship Index Comparison by Archived Physiographic Classification

Physiographic group	n	Mean ESI	SD	95% CI
Floodplain/Delta	52	75.41	12.07	72.05–78.77
Hilly Terrains	71	73.62	11.64	70.87–76.38

Pleistocene Uplands	47	74.14	11.69	70.70–77.57

Note: One-way ANOVA: F(2, 167) = 0.352, p = .704, η^2 = .004. Median-centered Levene test: p = .997. The original locality-to-physiographic-class mapping was not preserved in the archived materials; therefore, this comparison is secondary and exploratory.

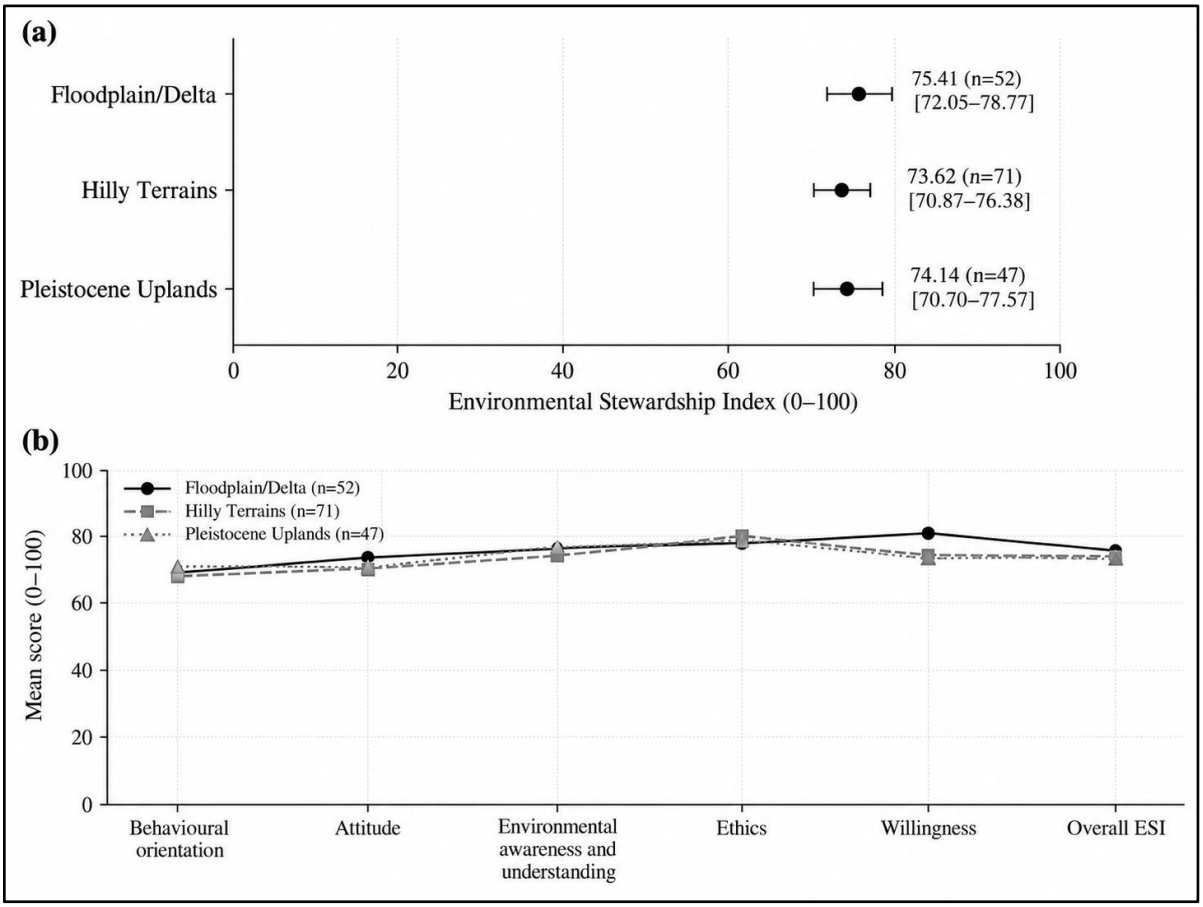


Fig. 4 Environmental stewardship across the archived physiographic classifications. (a) Mean respondent-level Environmental Stewardship Index (ESI) scores with 95% confidence intervals. (b) Descriptive mean profiles for the five stewardship dimensions and overall ESI. Overall ESI did not differ across Floodplain/Delta, Hilly Terrains, and Pleistocene Uplands, F(2, 167) = 0.352, p = .704, η^2 = .004. Dimension profiles are descriptive only. The analysis is secondary because the original locality-to-physiographic-class mapping was not preserved.

3.6 Environmental Stewardship and Archived Monthly-Income Category

Valid income data were available for 169 respondents. ESI scores differed across the six archived income categories, Welch $F(5, 33.26) = 4.391$, $p = .0035$, with the Kruskal–Wallis robustness analysis yielding a similar result, $H(5) = 16.89$, $p = .0047$, $\varepsilon^2 = .073$ (Table 4; Fig. 5). Games–Howell comparisons identified differences between category 2 and categories 4 and 5; other adjusted pairwise comparisons were not significant.

The monotonic association between ordered income category and ESI was weak and did not reach the .05 threshold in the primary analysis (Spearman ρ = .144, p = .061). Sensitivity analyses preserved overall income-group heterogeneity but did not demonstrate a stable monotonic association (ESM 1, Table S4). Overall, the analyses indicated income-group heterogeneity without a stable monotonic income–ESI association.

Table 4 Environmental Stewardship Index Across Archived Monthly-Income Categories

Monthly income category	n	Mean ESI	SD	95% CI
<14,600	41	74.25	14.03	69.82–78.67
14,601–35,000	45	69.39	11.03	66.08–72.71
35,001–55,000	45	76.00	11.32	72.60–79.40
55,001–75,000	23	78.31	8.32	74.71–81.91
75,001–95,000	9	80.85	6.22	76.07–85.63
≥95,001 (category 6; upper bound unclear)	6	73.21	10.90	61.77–84.65

Note: Valid income n = 169. The archived questionnaire does not preserve the income currency, and the upper-bound notation for category 6 is ambiguous; the categories are therefore treated only as ordered groups. Variances differed across categories (median-centered Levene p = .031). Welch's ANOVA indicated overall heterogeneity, F(5, 33.26) = 4.391, p = .0035. The Kruskal–Wallis robustness analysis was also significant, H(5) = 16.89, p = .0047, ε^2 = .073. The primary monotonic association was weak, Spearman ρ = .144, p = .061.

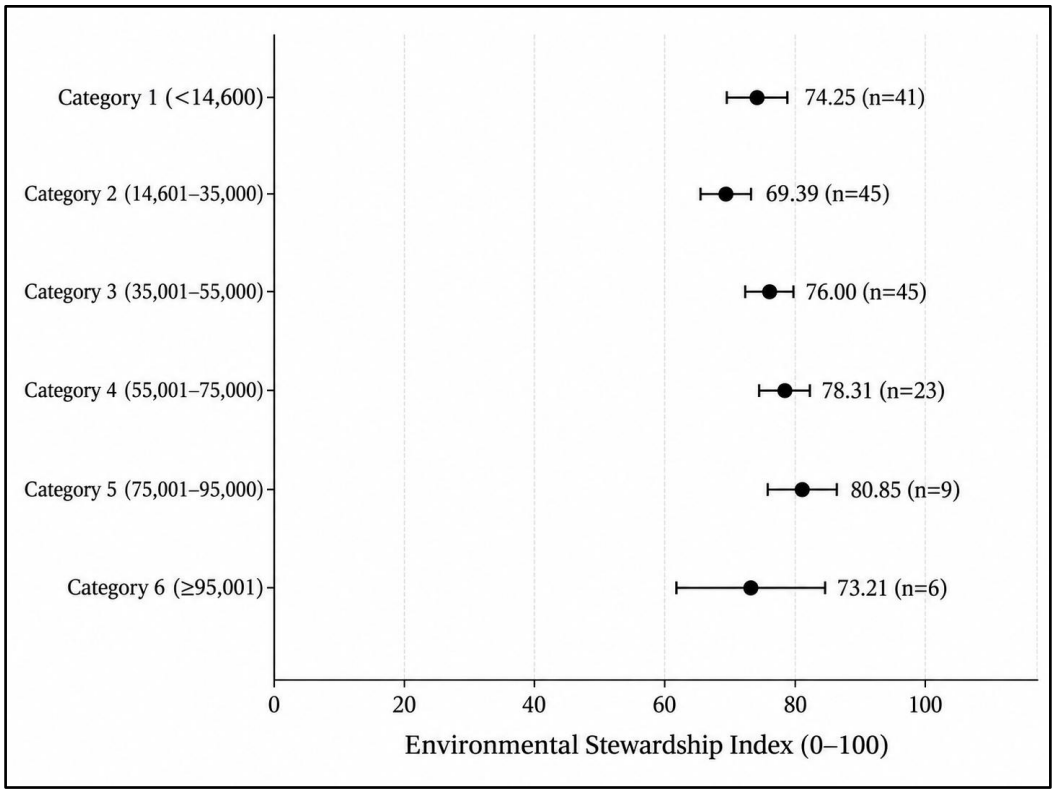


Fig. 5 Mean Environmental Stewardship Index scores across archived monthly-income categories with 95% confidence intervals. Valid income data were available for 169 respondents. The archived questionnaire does not preserve the income currency, and the upper-bound notation for category 6 is ambiguous; the categories are therefore interpreted as ordered groups only. Income-category means differed overall, Welch $F(5, 33.26) = 4.391$, $p = .0035$, whereas the monotonic association between income category and ESI was weak, Spearman $\rho = .144$, $p = .061$.

4. Discussion

4.1 Multidimensional Stewardship and Descriptive Dimension Divergence

The respondent-level analysis indicates that environmental stewardship in Cox's Bazar is characterized by higher mean scores for ethics, environmental awareness and understanding, and willingness than for behavioural orientation. The overall ESI mean was 74.31 on the 0–100 scale, while the dimension profile shows that environmental values, awareness, and readiness to support protection were not expressed equally across tourism-choice preferences. This multidimensional pattern is consistent with stewardship and sustainable-tourist-behaviour literature that distinguishes values, awareness, responsibility, willingness, and realized behaviour rather than treating environmental responsibility as a single trait [8–11, 22–24, 32, 33]. It is best understood here as a descriptive cross-dimensional pattern rather than a demonstrated attitude-to-behaviour gap.

The present data warrant a cautious formulation of this divergence. Behavioural orientation is

based on reported preferences rather than directly observed behaviour, and the cross-sectional design does not track whether willingness subsequently becomes action. The data therefore support only a descriptive difference among stewardship dimensions. This distinction keeps the empirical evidence separate from the conceptual governance pathways proposed later in the paper.

4.2 Tourism Choices, Convenience, and Environmental Orientation

The detailed preference patterns help explain why behavioural orientation scored below the other dimensions. Respondents strongly valued energy-efficient hotel lighting and eco-friendly building materials, and many preferred low-polluting options and avoidance of environmental harm when purchasing services. At the same time, 68.2% rated daily sheet/towel replacement as important, and transport decisions were dominated by seating, travel time, and fare. These findings illustrate how environmental orientation operates alongside service quality, convenience, affordability, habits, and situational constraints rather than replacing them.
Tourism and environmental-behavior research similarly shows that pro-environmental intentions and appeals do not automatically produce lower-impact behaviour and that holiday settings, perceived control, incentives, and habitual routines can materially shape choices [12–21, 23, 25–29].

4.3 Environmental Awareness, Understanding, and Demand for Governance

The survey revealed a strong informational and normative foundation for environmental management. Nearly nine in ten respondents reported awareness of beach-pollution issues, and majorities agreed with statements linking plastic pollution to land, marine biodiversity, the food chain, and groundwater. These items capture self-reported awareness and perceived understanding rather than objective knowledge. Support was particularly high for waste management, implementation of environmental laws, social-awareness initiatives, and restrictions on single-use plastics.
At the same time, more than half of valid respondents considered current laws insufficient to reduce beach pollution, suggesting demand for stronger implementation as well as awareness-building. This combination of individual support and perceived institutional insufficiency aligns with responsible-tourism and governance research emphasizing the need to connect visitor responsibility with credible destination-level systems and indicators [30, 31, 39–41]. This interpretation is consistent with stewardship perspectives that emphasize interactions between individual capacities and enabling social or institutional conditions [8–11]. In a coastal tourism setting, environmental education may reinforce awareness and understanding, while waste-management infrastructure, accessible low-impact services, enforcement, and community participation may shape whether stewardship orientation can be expressed in routine tourism choices [22–24, 39–41].

4.4 Secondary Physiographic Analysis and Income Heterogeneity

The secondary analysis using the archived physiographic classification showed no meaningful relationship with ESI. Mean scores differed by less than two points across the three archived groups and the effect size was negligible. However, because the locality-to-classification mapping was not preserved, this result should be interpreted only as a descriptive check within the archived coding rather than evidence about reproducible physiographic effects. The income findings require similarly cautious interpretation.
Respondent-level category means differed overall, but the pattern was non-monotonic, category 6 was small, the questionnaire did not preserve the currency label, and the upper-bound notation of the sixth band is ambiguous. Primary and sensitivity specifications also produced somewhat different Spearman p-values. The data therefore do not support a simple claim that stewardship rises steadily with income; they instead identify exploratory heterogeneity across the archived ordinal categories.

4.5 Governance Implications for Sustainable Coastal Tourism

The findings point to a governance approach in which environmental stewardship is supported by conditions that make lower-impact tourism choices feasible. Priorities identified by respondents included reliable waste management, effective implementation of environmental regulations, social-awareness initiatives, and restrictions on single-use plastics. These measures may be complemented by environmental information at tourism facilities, accessible recycling and waste services, lower-impact transport options, and participation mechanisms that do not depend strongly on ability to pay. Such an approach is consistent with evidence that sustainable tourist behaviour is shaped by the interaction of individual orientations with information, services, incentives, infrastructure, and institutional context [22–24, 28–33, 39–41].
The Green Beach Governance Framework (Fig. 6) brings together three analytical levels: multidimensional stewardship orientation, destination-level enabling conditions, and potential sustainability outcomes. Previous research has developed substantial but partly distinct strands concerned with sustainable tourist behaviour and its antecedents, responsible-tourism practices and indicators, and tourism governance and stakeholder capacity [22–24, 32, 33, 39–41]. The framework connects these strands by using the empirically reconstructed ESI as the visitor-level starting point and positioning environmental education, waste and service infrastructure, rules and enforcement, institutional capacity, economic incentives and accessibility, and community participation as conditions that may support the expression of stewardship orientation in practice.
The contribution of the framework therefore lies in its cross-level integration rather than in proposing a new general theory of sustainable-tourism governance. It distinguishes what beach users report valuing or being willing to support from the destination-level conditions that may facilitate realized environmental action and, ultimately, improved environmental quality and sustainable coastal tourism outcomes. These relationships are conceptual hypotheses derived from the empirical findings and relevant literature; they were not causally tested in the present cross-sectional study.

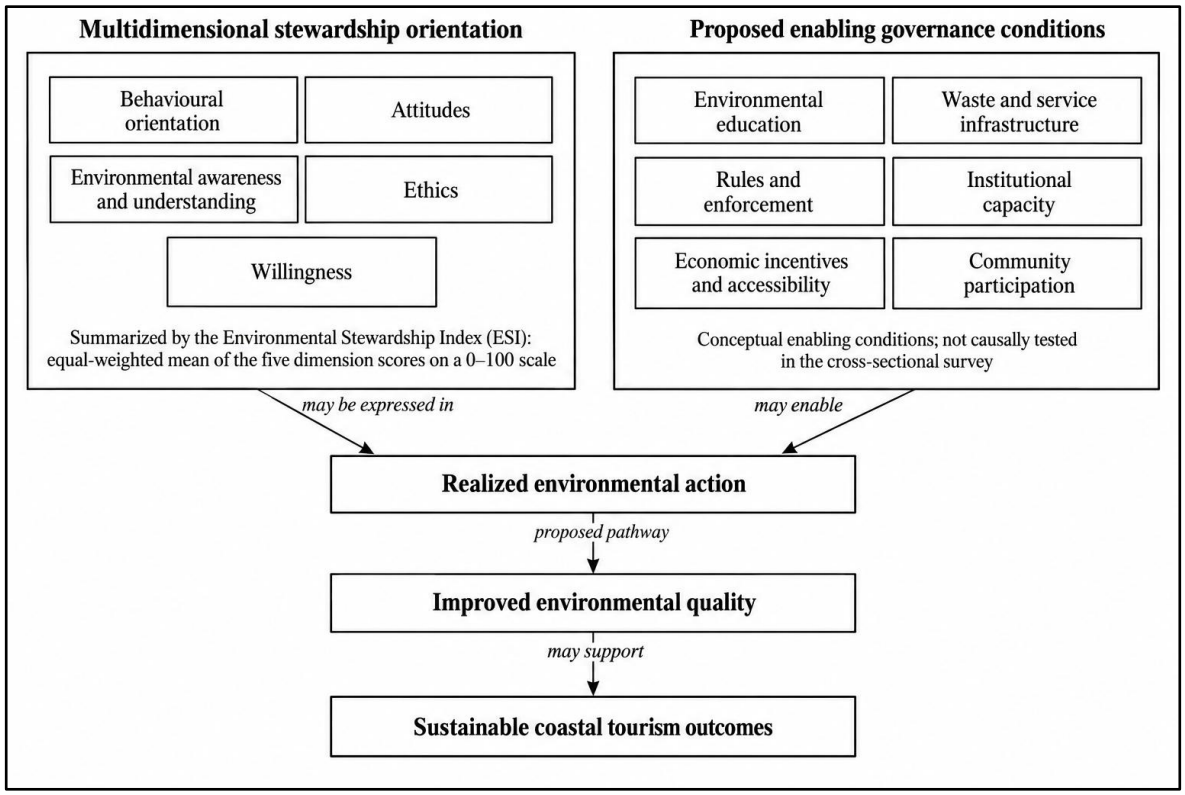


Fig. 6 Green Beach Governance Framework integrating multidimensional stewardship orientation, destination-level enabling conditions, and potential sustainability outcomes. Stewardship orientation is summarized by the Environmental Stewardship Index (ESI), comprising behavioural orientation, attitude, environmental awareness and understanding, ethics, and willingness. Proposed enabling conditions include environmental education, waste and service infrastructure, rules and enforcement, institutional capacity, economic incentives and accessibility, and community participation. The framework distinguishes respondent-level stewardship from the governance conditions that may support realized environmental action and from potential downstream environmental and tourism outcomes. Dashed arrows represent proposed pathways and should not be interpreted as causally demonstrated relationships.

4.6 Contemporary and Broader Relevance

Although the survey was conducted in 2021, the dataset provides a stewardship-orientation baseline that can be interpreted alongside subsequent sustainable tourism planning in Cox's Bazar. The Destination Development Plan for Cox's Bazar (2025–2027) emphasizes sustainable and inclusive tourism, environmental stewardship, institutional coordination, and community participation [46], while recent research continues to identify environmental degradation, community engagement, and sustainability planning as important destination-management concerns [47]. The present findings provide respondent-level evidence that can be considered in

relation to these later planning priorities.
The analytical approach may also have relevance beyond Cox's Bazar, particularly in coastal destinations where environmentally favourable orientations coexist with constraints related to infrastructure, affordability, service design, or institutional capacity [5–7, 32]. However, transferability of both the ESI and the Green Beach Governance Framework should be established prospectively rather than assumed from a single-site study.

4.7 Research Priorities

The ESI should be treated as an exploratory multidimensional composite requiring prospective validation rather than as a validated psychometric scale. Future studies should examine its construct validity and dimensional stability, test measurement invariance across relevant visitor groups and destinations, and use larger and more representative samples. Longitudinal designs and direct behavioural observation are also needed to determine whether stewardship orientations predict subsequent tourism behaviour.

The proposed governance framework similarly requires empirical testing. Future research should evaluate whether interventions involving environmental education, waste and service infrastructure, enforcement, incentives, accessibility, or community participation influence observed environmental behaviour and destination-level outcomes. Larger samples would also allow more robust examination of socioeconomic heterogeneity and interactions among affordability, access, education, visitor status, and environmental preferences.

5. Conclusions

This study identified a multidimensional environmental stewardship profile among beach users in Cox's Bazar, with ethics, willingness, and environmental awareness and understanding showing higher mean scores than behavioural orientation. The findings indicate that stewardship is better understood as a multidimensional profile than as a single measure of environmental responsibility and should not be interpreted as directly observed behaviour.

For sustainable coastal tourism governance, the results highlight the importance of complementing individual stewardship with enabling conditions such as environmental education, effective waste and service infrastructure, implementation of environmental regulations, accessible lower-impact choices, and community participation. The proposed Green Beach Governance Framework integrates these visitor-level and destination-level dimensions within a conceptual pathway toward improved environmental quality and sustainable tourism outcomes.

Because the ESI was reconstructed from an archived questionnaire and the study was cross-sectional, both the composite measure and the proposed governance framework require prospective validation. Future research should use larger and more representative samples,

validated measurement approaches, longitudinal designs, and direct behavioural observations to test their robustness, transferability, and practical relevance across coastal tourism settings.

Declarations

Ethics approval and consent to participate: All methods used in the present retrospective secondary analysis were performed in accordance with relevant ethical guidelines and regulations, including the applicable principles of the Declaration of Helsinki concerning participant privacy and confidentiality. From 11 October 2026 onward, continued secondary analysis and associated scholarly activities were conducted in accordance with the applicable requirements of the Bangladesh Health Research & Implementation Initiative Ethics Review Committee (BHRI ERC; Conditional Ethical Approval, Reference No. BHRI/ERC/2026/593, dated 11 October 2026). This determination applies prospectively and does not constitute retrospective approval of the original 2021 survey or analyses completed before the Committee's review.

Consent to participate: The Bangladesh Health Research & Implementation Initiative Ethics Review Committee (BHRI ERC) waived the requirement to obtain additional informed consent for the present retrospective secondary analysis and associated scholarly dissemination (Reference No. BHRI/ERC/2026/593; 11 October 2026), subject to the conditions of its approval. The waiver was based on retrospective analysis of existing data, no new participant recruitment or contact, the impracticability of obtaining additional consent from historical respondents, and the Committee's determination of no more than minimal risk under the specified safeguards. This waiver does not retrospectively apply to consent requirements governing the original 2021 survey.

Consent for publication: Not applicable. The manuscript contains no identifiable individual information, images, or case-level material.

Clinical trial number: Not applicable.

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Competing interests: The authors declare no competing interests.

Data availability: Aggregate results, item-coding decisions, data-quality notes, and sensitivity analyses supporting the findings are provided in ESM 1, and the archived questionnaire is provided in ESM 2. The respondent-level dataset is not publicly available because the surviving records do not establish participant consent for public data sharing and the original questionnaire template contained name and signature fields. A de-identified respondent-level dataset may be made available to editors or qualified reviewers for verification and, where ethically and legally permissible, to qualified researchers upon reasonable request to the corresponding author.

Author contributions: Mohammad Ariful Hoque: Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Visualization, Writing - original draft, Writing - review & editing, Project administration. Afroja Afrin: Validation, Interpretation of behavioural findings, Writing - review & editing.

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