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# Gender perspectives on coastal and marine ecosystems services flow in Kwale County, Kenya

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**Introduction:** The continuous flow of ecosystem services (ESs) within coastal and marine ecosystems supports communities' well-being and security by harnessing required resources such as seafood that address food security. The overexploitation of these coastal resources places communities at risk of losing ES. This study assesses how preference for the ES flow from these ecosystem types (i.e., mangrove forests, coastal lagoons, seagrass beds, coral reefs, and the deep sea) vary by gender in Diani Chale and Kisite-Mpunguti Marine Protected Areas in Kwale County, Kenya. Specifically, the objective of this article was to assess the pattern and variation in mean scores of ES flow across coastal and marine ecosystem types by gender.

**Methods:** A total of 148 respondents (87 men and 61 women) aged 20-72 years participated in describing ES through focus group discussions and the Delphi technique. Respondents were engaged in a participatory activity that involved filling of perceived ES flow scores using a 6-point Likert-type scale in the lookup tables (also known as matrix). Data were analyzed using descriptive statistics for mean scores of ES flow across coastal and marine ecosystem types as perceived by men and women. One-way MANOVA was used to test for the significant differences between mean scores of men and women in ES flow across ecosystem types.

**Results:** The aggregate scores for non-use values, regulating services, and cultural services, were scored higher than provisioning services by ecosystem service flow. The overall ES flow scores were higher in the mangrove forests 52/90 and least in the coastal lagoon 39/90. There was a significant variation ($p < 0.05$) of ES flow by gender: the mean score of men was significantly higher than women for most ES flow in cultural, regulating, and provisioning services across some coastal and marine ecosystem types. However, there was no significant variation ($p > 0.05$) in the flow of non-use values by gender across ET.

**Conclusion:** The findings of this study highlight the importance of understanding gender views in ES access and use at local levels to support food security. Including gender perspectives in coastal and marine ecosystem governance is critical, especially toward achieving sustainable development goals.

KEYWORDS

**ecosystem services flow, Kwale County, matrix approach, gender, food security, coastal and marine ecosystems, Kenya, lookup table**

## 1. Introduction

Ecosystem services (ESs) provide ecosystem benefits that actively or passively support human wellbeing (Fisher et al., 2009). The productive coastal and marine ecosystems,[1] which include the mangrove forests,[2] seagrass beds,[3] coastal lagoons,[4] coral reefs,[5] and the deep sea,[6] provide various ESs including provisioning, regulating, supporting, and cultural. These ESs support access to food security, income, and the wellbeing of coastal communities (Millennium Ecosystem Assessment, 2005; Painter et al., 2022). Globally, coastal and marine ESs support over 3.3 billion people who rely on fish as their primary source of animal protein, which is crucial in meeting their dietary nutritional needs, and this population is bound to rise (FAO, 2020). Hence, the coastal and marine ESs are vital to the achievement of sustainable development goal 2, which aims to achieve food security and improved nutrition by 2030 for most global nations.

Several regional assessments have identified the Eastern African coast as one of the most environmentally threatened coastal regions (Cinner et al., 2012; Hinkel et al., 2012; Brown and Fortnam, 2018; Bullock et al., 2021). Consequently, the benefits of ES from the Western Indian Ocean (WIO) worth US$ 20.8 billion are bound to diminish (UN, 2021). As a result of the threats, there is a high demand for coastal and marine ecosystem services, consequently increasing the risks of coastal communities suffering higher food insecurity, income losses, resource use conflicts, and high vulnerability to natural disasters such as flooding, tsunamis, exposure to waterborne diseases, and reduced tourism revenue (Hernández-Delgado, 2015; McClanahan et al., 2015).

Due to the lack of a clear distinction between coastal and marine ES flows across the ecosystem types, few ES studies have focused on non-use values (intrinsic, existence, and bequest) (Haines-Young et al., 2007). Additionally, from the systematic literature review of marine ES flow by Chalkiadakis et al. (2022), only 5.4% of the 54 publications reviewed on marine ES flows considered the participation of local communities in identifying marine ES under their custody. This article aims to fill the gap in assessing the ES flow in coastal and marine ecosystems as perceived differently by the local communities who live closer to these ecosystems. Ecosystem service flow refers to the current or future benefits of using ES for human wellbeing (Burkhard et al., 2014). One of the approaches that has been adopted to assess the ES flow is the matrix approach, and it uses the lookup tables consisting of ecosystem types (ET) and sets of selected ES in a specific area (Campagne and Roche, 2018). The lookup table is also known as the matrix of land cover class/types used as proxies for ES provision, for more information on categories of ES mapping approaches refer to Burkhard and Maes (2017). The advantage of the matrix approach is that it is highly flexible in assessing and mapping ES flow using numerous data from ET in each area (Burkhard et al., 2009, 2012b, 2014).

Evidence shows that the application of the matrix approach has mainly focused on ES supply, followed by provisioning, cultural, and supporting, but less focused on ES flow and utilization with very few studies focusing on ES demand and ES flow/use (Campagne et al., 2020). Again, these studies were mostly in developed countries in Europe, with few studies reported in East Asia and the Pacific (Kandziora et al., 2013b; Campagne et al., 2020; Chalkiadakis et al., 2022). In a review by Campagne et al. (2020), of 109 studies that applied, the ES matrix approach showed that a mean of 15.6 ± 1.9 ES classifications was assessed. Hence, the justification for settling on assessing 18 classes/categories of ES in this present study.

Moreover, in the application of the matrix approach for ES flow assessment, few studies have considered gender dimensions in their analysis (Cruz-Garcia et al., 2016; Lau et al., 2019). These few studies show that gender influences knowledge, perceptions, and preference for ES within a given context (Cruz-Garcia et al., 2017; Lawless et al., 2017, 2019; Yang et al., 2018). Therefore, in this study, gender is considered a key variable to contribute to filling this gap in ES flow for coastal and marine ETs in Kenya. In this article, gender refers to the societal and cultural roles of men and women in coastal and marine ecosystem service flows. Evidence shows that women are not always given the platforms in key environmental decision-making processes due to their low socio-economic status (Sunderland et al., 2013; Cruz-Garcia et al., 2016). Additionally, other social factors that contribute to gendered variation in ES preferences include women's limited access to information (Allendorf and Allendorf, 2013) and high illiteracy (Yang et al., 2015). According to Pearson et al. (2019), men are more likely to be knowledgeable about provisioning and regulating ES than women. Therefore, addressing the inequalities in the ES benefits is a daunting task, which may require a holistic understanding of gender views and ecosystem service interactions or improvements on the existing inequalities in coastal and marine ecosystem services. Again, understanding the flow of ecosystem services from the different coastal and marine ecosystem types is key to sustainable and equitable resource use for human wellbeing (Millennium Ecosystem Assessment, 2005; Sukhdev et al., 2014; Owuor et al., 2017).

In the wake of the dwindling fish harvests, increasing threats to coastal and marine ecosystems including ever-rising global temperatures, the increase in poverty level, and food insecurity in the area is an issue of concern to the government of Kenya. The need to uplift the livelihood of the coastal communities in Kenya especially women who are the majority of the oppressed should be given the priority it deserves. Typically in the coastal community, women are further marginalized from access to coastal and marine ecosystem services by cultural norms, taboos, and societal

Abbreviations: ES, Ecosystem Services; ET, Ecosystem Types; FAO, Food and Agricultural Organization; FGDs, Focus Group Discussions; IUCN, International Union for Conservation of Nature; KM, Kilometers; KNBS, Kenya National Bureau of Statistics; MPAs, Marine Protected Areas; US$, United States dollar; WIO, Western Indian Ocean; WWF-EFN, World Wildlife Fund Education for Nature.

1 https://www.sciencedirect.com/topics/earth-and-planetary-sciences/coastal-ecosystem

2 https://www.sciencedirect.com/topics/earth-and-planetary-sciences/mangrove

3 https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/seagrass

4 https://www.sciencedirect.com/topics/earth-and-planetary-sciences/coastal-lagoon

5 https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/coral-reefs

6 https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/deep-sea-species

expectations (Fröcklin et al., 2013; Yang et al., 2018). For example, in a study on the gendered nature of ES in Mozambique and Kenya, it was evident that men were allowed to go fishing in the deep sea. Women were confined to the land area, shoreline, and closer to their homes to take care of house chores. In contrast, it is evident that men play the roles that require wealth in the form of capital investment such as scuba diving equipment, fishing nets, and boats to exploit the deep sea ecosystems, which is often not within reach of most women (Matsue et al., 2014; Fortnam et al., 2019; Lawless et al., 2019, 2021).

This article thus explores the differences in the perceived ES flow in coastal and marine ecosystems as impacted by access, use, and socio-cultural practices among men and women living around Diani Chale and Kisite Mpunguti Marine Protected Areas, Kwale County, Kenya. Specifically, this article aims to answer the following questions: (1) Does the pattern of ES flow of use values and non-use values vary across coastal and marine ecosystems by gender; and (2) Does views on ES flow of the use and non-use values across coastal and marine ecosystems vary by gender? Understanding gender views on the patterns of coastal and marine ES flows is important for informing policies on integrated coastal and marine ecosystem management programs. The findings from this study seek to provide recommendations geared toward the achievement of sustainable development goals 2 on food security, goal 5 on gender equality, and goal 14 on life below water (Griggs et al., 2017; Agarwal, 2018).

# 2. Materials and methods

## 2.1. Study area

The study area lies within the Transboundary Marine Conservation Areas between Kenya and Tanzania (Tanzania and Unit, 2017). The study area runs from Likoni to Vanga, covering 255 km, and consists of a narrow strip of land 3–10 km wide. The area is generally low-lying at an average of 30 m above sea level. The area has a diversity of natural ecosystems such as mangrove forests, and marine resources such as sandy beaches, coral reefs, open waters, and coastal plains occasionally referred to as the "coral rag" with alluvial deposits (Kwale County Integrated Development Plan, 2018). The coastal waters in Kwale county comprise 12 identified seagrass species in the Gazi bay and Shimoni areas (Githaiga et al., 2019). The region lies within the most productive inshore fishing grounds in Shimoni and Funzi Islands, with over 40 fish landing sites. Diani and Shimoni areas where the two MPAs are found are classified as pristine areas for recreational and sports fishing activities (Tanzania and Unit, 2017). The region is classified as a tourist site with favorable warm coastal climatic conditions, long stretches of sandy beaches, coral reefs, mangroves, riverine systems, wetlands, and MPAs.

Many families in these areas are highly dependent on the coastal and marine ES, especially artisanal fisheries for food, income from employment in fisheries and tourism sectors, and protection of coasts from storms and waves as well as flooding (McClanahan et al., 1997; Fisher et al., 2009; Samoilys et al., 2015, 2017; Obura et al., 2017; McClanahan, 2019; Taylor et al., 2019) (Figure 1). Furthermore, it is important to note that Kwale County is among the poorest counties in Kenya, with over 71% of its population living below the poverty line (Kenya National Bureau of Statistics, 2018). It is characterized by high unemployment and underemployment rates: 30% of the total labor force ranges between ages 5 and 64 years (Kwale County Integrated Development Plan, 2018). Some community members are engaged in establishing and managing community-managed marine protected areas locally referred to as "*tengefu*" to support dwindling artisanal fisheries (McClanahan et al., 2016). The area also experiences seasonal droughts characterized by unreliable rainfall of about 800 mm annually (Kwale County Integrated Development Plan, 2018; Ambrosino et al., 2020).

## 2.2. Selection and definition of ecosystem services and ecosystem types

The study made use of the socio-cultural method in identifying and classifying provisioning, regulating, and cultural ESs based on the existing literature on coastal and marine ES in the study area, which was carried out during a reconnaissance survey in December 2019. For a detailed description of ES classification, refer to Emerton and Tessema (2001) and Burkhard et al. (2014). Concerning the definition of ES categories used in the study, each ES was defined in a simple description that was easy to interpret by the local resource users, following a similar approach used by Kandziora et al. (2013a). The flows of non-use values were separated from cultural services to provide a baseline for identifying future ES benefits to human wellbeing as recommended by Fisher et al. (2009), Burkhard et al. (2012b), Burkhard and Maes (2017), and Yang et al. (2018). To ensure the validity and reliability of selected ES of the study areas, we used three local research assistants who assisted in the identification of ES to be included as per the local context in the lookup table. The research assistants (RAs) have been born and lived in the area and were also working in coastal and marine resource use sectors, and we believed that they were familiar with ES in the study area. The RAs who identified the ES were not the ones used during the FGDs and during the survey to avoid biases. We ensured that the selection of the ES was in line with the survey objectives and strictly relevant to the local context, for detailed recommendations on ES selection, refer to Campagne and Roche (2018). Overall, this present study assessed a total of 18 ES (refer to Table 1), against five coastal and marine ETs (mangrove forests, coastal lagoons, seagrass beds, coral reefs, and the deep sea).

## 2.3. Study design and sampling procedure

In this study, we used a cross-sectional design to collect data at one point in time on the ES flow across coastal and marine ETs, using descriptive qualitative (focus group discussions—FGDs) inquiry that was designed to assess the perspectives of men and women on the preference for ES flow in five coastal and marine ETs. To invite FGD participants, we used the local group leaders to provide a list of currently existing groups (fisher or community marine conservation groups) who were directly dependent on coastal and marine ecosystems in the study area. From this list, we purposively selected 16 groups comprising eight groups from each site. In Diani Chale MPA of the eight groups, only two were women groups while six were men groups. In Kisite Mpunguti MPA, of the eight groups, four were women groups and four were men groups. In each of the 16

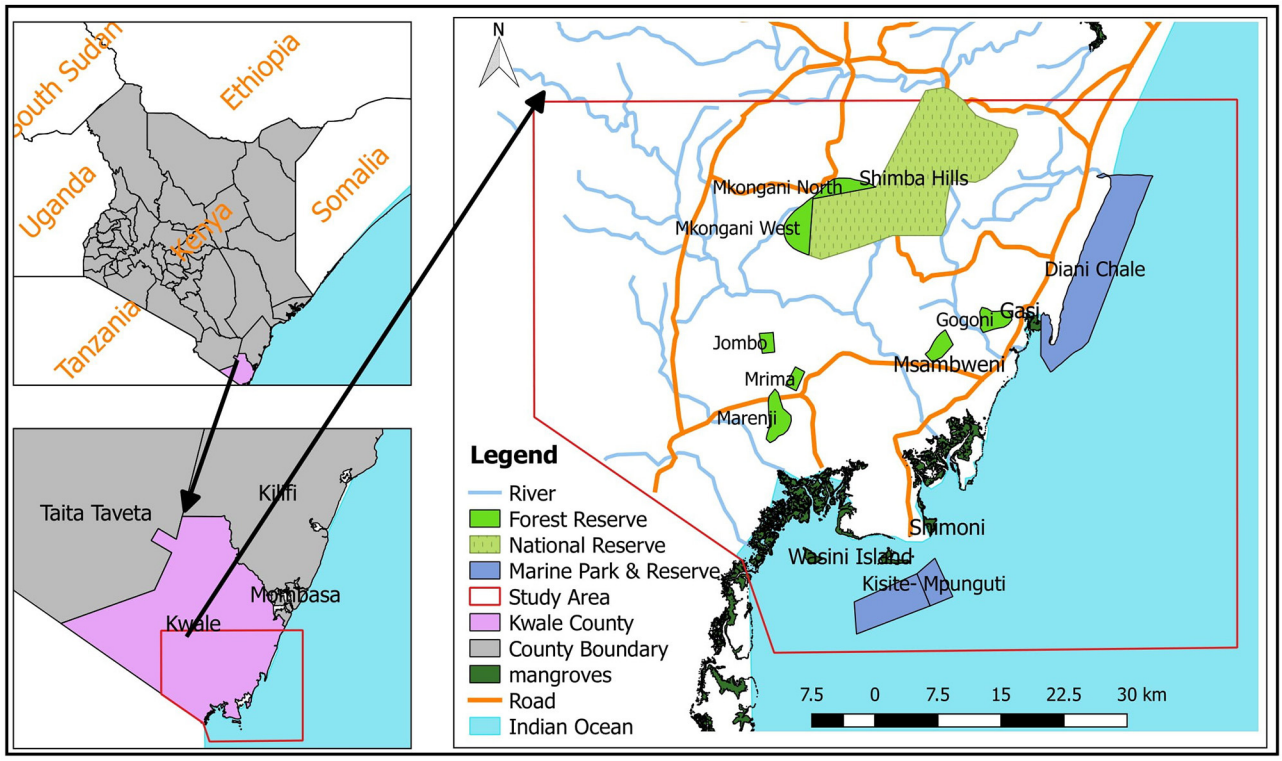


FIGURE 1
The map of the study area that show the location of the nearest marine protected areas and the mangrove forest areas within the proposed transboundary biodiversity conservation area between Kenya and Tanzania in the Western Indian Ocean waters in Kwale County, Kenya.

groups, we purposively selected a maximum of 12 participants who were deemed fit based on their experiences and ability to engage in a discussion, to address the study objectives by providing relevant information in relation to the survey themes. We administered 16 FGDs comprising of 8–10 participants each, 8 ($n = 67$) in Diani Chale MPA and 8 ($n = 81$) in Kisite Mpunguti MPA. FGD sample size determination was based on the recommendations of Nyumba et al. (2018). The FGD participants were then reached *via* phone calls to confirm their availability to participate in the discussion. Out of the initial 192 expected participants, 42 declined to participate in the survey due to personal commitments.

## 2.4. Data collection

Focus group discussion data were collected from May to July 2021 using an FGD guide developed in English and translated into Swahili (a language commonly spoken in the study area). The purpose of the FGDs was to derive the perceived benefits and ES flow (utilization) concerning coastal and marine ecosystem types (mangrove forests, coastal lagoons, seagrass beds, coral reefs, and the deep sea). To enable the comparison of ideas and perspectives of men and women based on their experiences in the coastal and marine ES flows, FGDs with predetermined questions (refer to Supplementary Appendix 1) on preference assessment and participatory mapping assessment were administered to the selected groups with similar experiences in deriving benefits from coastal and marine ES. FGD participants' demographic data were captured at the registration point, where all the participants were requested to enter their details in a well-designed form.

The discussions were conducted in designated quiet places and comprised of groups sitting in circular arrangements guided by the moderators, following a sequential flow of ideas in the perceived knowledge of ES flow for access and use. At first, all FGD participants were allowed to jointly indicate their perceived knowledge of the visual location of coastal and marine ETs based on a projected 2-dimensional map of the study area (attached as Supplementary Figure 1) as previously used in the studies of (Lau et al., 2019). Participants were allowed to engage in the discussion and finally mark the agreed location of the perceived ET using different colors of marker pens. Upon the identification of the ET, participants were asked to elaborate on the possible uses (ES flow) of each ET by men and women. After exhausting all the possible perceived and known uses of the coastal and marine ETs, participants were separated from each other at a distance of ~2 m apart to embark on a lookup table scoring exercise. This followed a similar approach by Raymond et al. (2009) and Sherrouse et al. (2011) where there is a strong emphasis that local communities' preference for ES is vital in the matrix assessment of ES flow.

The second activity involved all FGD participants indicating their perceived scores of ES flow across coastal and marine ETs on the provided lookup tables based on the ratings. The scoring was based on a 6-point Likert-type scale (0 = no relevant ES flow, 1 = very low relevant ES flow, 2 = low relevant ES flow, 3 = medium relevant ES flow, 4 = high relevant ES flow, and 5 = very high relevant ES flow) as previously used in the study by Burkhard et al.

TABLE 1 Definition of selected coastal and marine ES adapted from Kandziora et al. (2013a) as cited in Owuor et al. (2017).

| Ecosystem services | Definitions of ES categories |
|---|---|
| **Provisioning** | |
| Medicinal | Ability to extract traditional medicine from the ecosystem for therapeutic purposes |
| Artisanal fishing | Practicing subsistence fishing in the area using mostly traditional fishing methods |
| Commercial fishing | Practicing modern fishing for commercial purposes using modern fishing gears |
| Aquarium fishing | Fishing purposely for aquarium/ornamental fishes, for commercial purposes |
| Building materials | Extracting building materials from the ecosystem for use in the area by themselves or by other persons |
| **Regulating** | |
| Carbon sequestration | The ability of the ecosystem to reduce the atmospheric carbon dioxide gas/ reduce air pollution |
| Coastal protection from waves and storms | The ability of the ecosystem to reduce the non-desirable impacts of waves and storms on the local communities |
| Sand re-generation | The ability of the ecosystem to support the production of sand resulting in sandy beaches |
| Flood protection | The ability of the ecosystem to reduce and control flooding incidences in the area |
| Nutrient regulation | The ability of the ecosystem to reduce the impact of water-based chemical pollutants to maintain the balance of important nutrients in the ecosystem. |
| Nutrient processing | The ability of the ecosystem to aid in the production and conversion of the desired nutrients for marine organisms (fishes) use for growth |
| **Cultural** | |
| Recreation | Deriving ES from the ecosystem for personal relaxation and enjoyment |
| Tourism | The ecosystem acts as a tourist attraction site, hence, bringing in visitors to the area |
| Research | The ecosystem is used for research purposes either by Colleges, Universities, local NGOs, and Government Institutions |
| Education | The ecosystems provide a learning avenue for students (school-going children at kindergarten, primary, secondary, and colleges or universities) |
| **Non-use value** | |
| Existence value | The ability of the ecosystem to be present as part of God's/Allah's creation |
| Intrinsic value | The personal desire to know that the ecosystem exists even if they have not seen or used it, nor do they intend to use it. |
| Bequest value | The inheritance value of the ecosystem is transferred in a good and productive state to the younger generations and the future generations to come for them to enjoy similar benefits of ES or even better. |

(2012b). ES scoring table (lookup table) was designed based on the ET of coastal and marine ecosystems on rows and the ES on the columns, and a similar approach has been used by Jacobs et al. (2015). Respondents independently scored their lookup tables based on their perceived benefits from ES categories (refer to Table 1). The local research assistants assisted the respondents who could not read and write. At the end of the matrix scoring exercise, participants were randomly given a chance to justify their scores. We used the Delphi technique to get the most comprehensive results on ES flows from selected coastal and marine ETs by gender while keeping respondents' confidentiality. A similar approach was recommended by Yousuf (2007) and Nahuelhual et al. (2013). Finally, the participants were asked to justify their scores based on their experiences, knowledge, and socio-cultural practices. However, during the debriefing exercise post-filling the matrix table, a section of the respondents stated that they considered present ES access and used it to inform their choice of scores while filling in the matrix table. In contrast, other respondents provided scores based on the present and future access of ES flow, an element of limitation to this study.

In addition, we conducted separate FGDs with men and women grouped by age groups (young 18–35 years and old 36 or more years). The categorization was necessary to capture the experiences and views of men vs. women and young vs. older people regarding ES flow. Young respondents tend to feel inferior while discussing with older respondents, and this approach of separating FGD participants by gender and age has been observed by other researchers such as Hollander (2004), Eriksson and Kovalainen (2008), and Cislaghi and Heise (2020). The discussions were conducted in the Swahili language (a local and widely spoken language in the area) and audio recorded after seeking permission of the respondents' consent. FGD participants were each assigned a unique identifying number to use when contributing their views instead of names to enhance confidentiality. FGD sessions lasted on average of 2–3 h.

## 2.5. Data analysis

Audio-recorded discussions were transcribed verbatim and translated into English. We did not back-translate transcripts into Kiswahili to check whether any meaning was lost. Data were analyzed using the content analysis approach to extract

TABLE 2 Distribution of FGD respondents by socio-economic and demographic characteristics: chi-square has been used to test for the significant difference in socio-economic and demographic characteristics by gender.

| | Men *n* (%) | Women *n* (%) | All *n* (%) | $\chi^2$; *p*-value |
|---|---|---|---|---|
| **Age** | | | | |
| 20–35 years | 50 (57.5) | 31 (50.8) | 81 (54.7) | $\chi^2 = 0.640$; 0.424 |
| 36 or more | 37 (42.5) | 30 (49.2) | 67 (45.3) | |
| Mean age (SD; min–max) | 35.3 (12.4; 20–76) | 39.1 (14.2; 22–75) | | |
| **Education level** | | | | |
| No education | 9 (10.3) | 14 (23.0) | 23 (15.5) | $\chi^2 = 15.980$; 0.000* |
| Primary | 35 (40.2) | 36 (59.0) | 71 (48.0) | |
| Secondary and above | 43 (49.4) | 11 (18.0) | 54 (36.5) | |
| **Distance from the household to the shoreline** | | | | |
| <10 km | 54 (62.1) | 36 (59.0) | 90 (60.8) | $\chi^2 = 0.1402$; 0.708 |
| >10 km | 33 (37.9) | 25 (41.0) | 58 (39.2) | |
| Mean (SD) | 10.2 (9.3) | 11.6 (10.5) | | |
| **Duration of Stay in the study area** | | | | |
| <30 years | 37 (42.5) | 19 (31.2) | 56 (37.8) | $\chi^2 = 2.228$; 0.328 |
| 30–49 years | 38 (43.7) | 30 (49.2) | 68 (46.0) | |
| 50 or more years | 12 (13.8) | 12 (19.7) | 21 (16.2) | |
| Mean (SD; min–max) | 34.5 (12.9; 10–76) | 38.5 (14.0; 20–75) | | |
| **Migration status** | | | | |
| Native dweller | 80 (92.0) | 61 (100) | 141 (95.3) | $\chi^2 = 5.152$; 0.023* |
| Migrant | 7 (8.1) | 0 (0.0) | 7 (4.7) | |
| **Source of livelihoods** | | | | |
| Fishing | 34 (39.1) | 17 (27.9) | 51 (34.5) | $\chi^2 = 10.986$; 0.089 |
| Small scale business | 27 (31.0) | 29 (47.5) | 56 (37.8) | |
| Others (tourism, farming, formal, and informal employment) | 17 (9.2) | 6 (9.8) | 23 (15.5) | |
| Unemployed | 9 (10.3) | 9 (14.8) | 18 (12.2) | |

*Results statistically significant.

comparable and valid statements from the transcripts as previously used by Erlingsson and Brysiewicz (2017). The analysis focused on the themes of perceptions of men and women of the ES flow across the ecosystem types and the justification for scoring the ES flows in each ET. To support the findings on the participants' mean scores, we used quotes from the transcribed data.

The quantitative data on respondents' socio-economic and demographic background characteristics and scores of the ES flow were organized and entered into SPSS version 20. These data were analyzed using descriptive statistics (percentages, frequencies, and mean scores) to analyze ES flow across the ET. An inferential statistics chi-square test was used to test for statistical significance variation between men and women by socio-demographic and economic characteristics (age, marital status, household size, level of education, livelihood source, distance from the shoreline, and migration status). Average scores were calculated for each ET as recommended by Kandziora et al. (2013b). The results were then incorporated into a matrix model (Table 4) to show the visual pattern of relationships between ET and their ability to provide ES flow as perceived by men and women. For each ES assessed, the aggregate mean score of the respondents ranged from 0 (no) flow to 5 (very high) flow across ET. Therefore, the possible overall aggregate mean scores of all the assessed 18 ES flow across each ET ranged from 0 to 90. Furthermore, we conducted a one-way multivariate analysis of variance (MANOVA) test to assess statistically significant differences between the means scores of men and women in each of the perceived/preferred ES flow within ET. To avoid biases by the respondents' sites, we combined the analysis from all study areas and differentiated by gender to provide a general view of gendered perceptions on ES flow across the different coastal and marine ecosystems in the study area. The differences by sites were catered for by the assumption of MANOVA that the study samples are independent and completely random (Smith et al., 2020).

TABLE 3 Assessment matrix illustrating the mean scores of ecosystem service flows in different ecosystem types as perceived by communities in the study area.

| | Provisioning services | | | | | Regulating services | | | | | | | Cultural services | | | | Non-use values | | | Sum of scores out of possible score (90) i.e., 18 ES ∗5 highest |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Medicinal | Artisanal fishing | Commercial fishing | Aquarium fishing | Building materials | Carbon sequestration | Coastal protection from storms and waves | Sand re-generation | Flood protection | Nutrient regulation | Nutrient processing | Recreation | Tourism | Research | Education | Existence Value | Intrinsic value | Bequest value | |
| Mangrove forests | 2 | 2 | 1 | 1 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 4 | 4 | 3 | 4 | 4 | 4 | **52** |
| Coastal lagoons | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 3 | 3 | 2 | 3 | 4 | 4 | 4 | **39** |
| Seagrass beds | 2 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 2 | 3 | 3 | 3 | 4 | 4 | 4 | **43** |
| Coral reefs | 0 | 3 | 3 | 4 | 2 | 1 | 2 | 2 | 1 | 3 | 2 | 3 | 4 | 4 | 3 | 4 | 4 | 4 | **49** |
| Deep sea | 1 | 2 | 4 | 4 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 2 | 4 | 4 | 4 | **42** |

The scores were calculated based on the average mean scores of all FGD respondents as per the data in each of the anonymous respondent's lookup tables. The colors indicate the following: 0, rosy = no relevant ES flow, 1, gray green = very low relevant ES flow, 2, light green = low relevant ES flow, 3, yellow green = medium relevant ES flow, 4, blue green = high relevant ES flow, and 5, dark green = very high relevant ES flow adapted from Burkhard et al. (2012a, 2014). These results are rounded off scores to the nearest whole number to illustrate the ES flow patterns across the ecosystem types. The bold values are the aggregate sum of the possible scores of each of the 18 ES across Coastal and marine Ecosystem Types. Assuming the aggregate mean score was 5 across each of the 18 ES, the highest possible score would be 90. Hence the aggregate score out of 90.

# 3. Results

## 3.1. Background characteristics of the FGD respondents

Table 2 presents the distribution of the respondents by background (socio-demographic and socio-economic) characteristics. There were 148 respondents, 59% ($n$ = 87) were men, and 41% ($n$ = 61) women. Overall, more than half 57% ($n$ = 50) (of respondents were young, i.e., aged 20–35 years) and a third 37% ($n$ = 54) had secondary or higher education. The majority 95% ($n$ = 141) of respondents were indigenous, 62% ($n$ = 89) had lived in the study area for 30 years or more, and about 61% ($n$ = 90) lived within 10 km of distance from the shoreline. The proportion of men with secondary or higher educational attainment was significantly ($\chi^2$ = 15.980; $p < 0.05$) higher than women [49% ($n$ = 43) vs. 18% ($n$ = 11)]. Regarding the source of livelihood, more men, 39.1% ($n$ = 34), than women, 27.0% ($n$ = 17), were engaged in fishing activities. In contrast, more women, 47.5% ($n$ = 29), than men, 31.0% ($n$ = 27), engaged in small-scale businesses (selling clothes and food). All women were indigenous 92% ($n$ = 80) compared to men ($\chi^2$ = 5.152; $p < 0.05$). However, the results show no significant variation between men and women by age, distance from the household to the shoreline, duration of stay in the study area, and main source of livelihood.

## 3.2. Ecosystem service flow patterns across ecosystem types

Table 3 compares the overall pattern of ES flow for provisioning services, regulating services, cultural services, and non-use values across coastal and marine ecosystem types for all the respondents. The findings indicate a variation in the patterns of use between the assessed ET and the perceived ES flow scores by local communities. Respondents' perceived mean score of ES flow for non-use values (existence, intrinsic, and bequest) was high flow (4) across all ET. However, the perceived mean score of ES flow for cultural services (recreation, tourism, research, and education) ranged from low flow (2) to high flow (4) across ET. Tourism and research services scored high flow (4) in the mangrove forest and coral reef ecosystems.

For regulating services (carbon sequestration, sand re-generation, coastal protection from storms and waves, flood protection, nutrient regulation, and nutrient processing), respondents' perceived ES flow mean score ranged from very low flow (1) to medium flow (3) across all ET. Except for sand re-generation, all regulating services were scored medium (3) for mangrove forest ecosystems. Finally, for provisioning services (medicinal, artisanal fishing, commercial fishing, aquarium fishing, and building materials), respondents' perceived mean score for ES flow ranged from no flow (0) to high flow (4) across all ET. Medicinal services had no flow (0) for coral reef ET. On the other hand, aquarium fishing had a high flow (4) for coral reefs and deep-sea ET. In summary, the sum of the mean score of all ES flow was highest for the mangrove forest ET (52 out of 90). However, the coastal lagoon ecosystem had the least overall sum of the mean score (39 out 90) for ES flow.

## 3.3. Ecosystem service flow across coastal and marine ecosystem types by gender

Table 4 shows a comparison in the pattern of ES flow for provisioning services, regulating services, cultural services, and non-use values across coastal and marine ETs by gender. The results show a slight difference in the pattern of perceived mean score of ES flow within the ET by gender. For example, men had higher average mean scores in the mangrove forest ecosystems than women in the flow of carbon sequestration (4 vs. 3). However, in the coastal lagoon, women had higher average mean scores than men in the flow of recreation (4 vs. 3) and educational services (4 vs. 3).

In the seagrass bed ecosystems, women's average score was higher than men's in the flow of building material services. In contrast, men's average score was higher than women's in the flow of medicinal services, commercial fishing, protection of coasts from storms and waves, sand re-generation, recreation, and research. Men had higher average mean scores in coral reef ecosystems than women in aquarium fishing (4 vs. 3), recreation (4 vs. 2), tourism (4 vs. 3), research (4 vs. 3), and education (4 vs. 3). In the deep-sea ecosystem, men had higher average scores of ES flow than women in the following in commercial (4 vs. 3).

## 3.4. The proportion of respondents scoring high (4) or very high (5) for the ES flow across coastal and marine ecosystem types by gender

Table 5 shows the proportion (%) of men and women who on a scale of no ES flow (0) to very high ES flow (5), scored high (4) or very high (5) ES flow across ET. For example, in the flow of provisioning services, the proportion of respondents scoring high/very high perceived flow of medicinal services was in seagrass beds (25%), artisanal fishing in coral reefs (46.6%), aquarium fishing in coral reefs (74.8%), commercial fishing in deep-sea (67.8%), and building materials in mangrove forests (38.5%). More women than men scored high/very high ES flow of provisioning services in ET closer to the shoreline areas (i.e., mangrove forests, coastal lagoons, and seagrass beds).

In regulating services, mangrove forest ecosystems had more than half of the respondents scoring high/very high flow of carbon sequestration (59.4%), coastal protection from storms and waves (53.1%), flood protection (50.4%), and nutrient regulation (53.1%). Again, more women than men scored high/very high flow of most regulating ecosystem services in the mangrove forests. However, more men than women scored high/very high flow for most regulating ecosystem services across other ET.

In cultural services, coral reef ecosystems scored high/very high for the flow of tourism services (72.7%), research (65.7%), and education (59.4%) services compared to other ET. Furthermore, the flow of tourism services was equally scored high/very high in mangrove forest ecosystems. More men than women scored higher in flow for all the highest cultural services by ET except for recreation services from the coastal lagoon, where more women (70.6%) scored higher than men (57.7%). Furthermore, more men than women scored high/very high flow for all cultural ES in coral reef ecosystems.

TABLE 4 Assessment matrix illustrating the mean scores of ecosystem service flows in different ecosystem types as perceived by men (♂) $n = 87$ and women (♀) $n = 61$.

| | | Provisioning services | | | | | | | | | | Regulating services | | | | | | | | | | Cultural services | | | | | | | | | | Non-use values | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Medicinal | | Artisanal fishing | | Commercial fishing | | Aquarium fishing | | Building materials | | Carbon sequestration | | Coastal protection from storms and waves | | Sand re-generation | | Flood protection | | Nutrient regulation | | Nutrient processing | | Recreation | | Tourism | | Research | | Education | | Existence value | | Intrinsic value | | Bequest value | |
| | | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ |
| Mangrove forests | | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | 4 | 3 | 3 | 3 | 2 | 1 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 4 | 4 | 4 | 2 | 3 | 3 | 4 | 4 | 4 | 4 | 4 |
| Coastal lagoons | | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 1 | 2 | 1 | 3 | 4 | 3 | 3 | 3 | 2 | 3 | 4 | 4 | 4 | 4 | 4 | 4 |
| Seagrass beds | | 2 | 1 | 3 | 3 | 2 | 2 | 3 | 0 | 1 | 1 | 1 | 1 | 0 | 2 | 1 | 1 | 1 | 3 | 3 | 3 | 2 | 1 | 3 | 3 | 4 | 3 | 2 | 3 | 3 | 4 | 4 | 4 | 4 | 4 |
| Coral reefs | | 1 | 1 | 3 | 3 | 4 | 3 | 3 | 2 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 3 | 3 | 2 | 2 | 2 | 4 | 3 | 4 | 3 | 3 | 2 | 4 | 3 | 4 | 4 | 4 | 4 |
| Deep sea | | 1 | 0 | 2 | 1 | 4 | 3 | 4 | 4 | 1 | 1 | 0 | 0 | 1 | 2 | 0 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 4 | 4 | 4 | 4 |

The scores were calculated based on the average mean scores of all FGD respondents and later by gender as per the data in each of the anonymous respondents' lookup tables. The colors show the following: 0, rosy = no relevant ES flow, 1, gray green = very low relevant ES flow, 2, light green = low relevant ES flow, 3, yellow green = medium relevant ES flow, 4, blue green = high relevant ES flow, and 5, dark green = very high relevant ES flow. These results are round off scores to the nearest whole number to illustrate the ES flow patterns across the ecosystem types.

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TABLE 5 Percentages (%) of men (♂) and women (♀) showing highest score (% sum of respondents scoring high or very high) for ES flow by ecosystem types (ET).

| | Mangrove forests | | | Coastal lagoons | | | Seagrass beds | | | Coral reefs | | | Deep sea | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ♂% | ♀% | Total % | ♂% | ♀% | Total % | ♂% | ♀% | Total % | ♂% | ♀% | Total % | ♂% | ♀% | Total % |
| **Provisioning services** | | | | | | | | | | | | | | | |
| Medicinal | 10.3 | 17.9 | 17.6 | 6.8 | 29.6 | 16.2 | 26.4 | 23.0 | 25.0[a] | 14.9 | 21.3 | 17.6 | 14.9 | 4.9 | 9.5 |
| Artisanal fishing | 10.0 | 29.9 | 21.0 | 16.1 | 32.8 | 23.0 | 40.2 | 49.2 | 43.9 | 44.8 | 49.2 | 46.6[a] | 18.3 | 9.8 | 14.9 |
| Commercial fishing | 5.9 | 10.3 | 7.7 | 14.1 | 24.2 | 18.2 | 42.3 | 46.6 | 44.1 | 50.6 | 44.8 | 48.3 | 77.6 | 53.4 | 67.8[a] |
| Aquarium fishing | 18.8 | 6.9 | 14.0 | 11.7 | 25.9 | 14.0 | 16.5 | 34.5 | 23.8 | 87.0 | 56.9 | 74.8[a] | 57.6 | 70.7 | 62.9 |
| Building materials | 38.8 | 37.9 | 38.5[a] | 11.8 | 17.2 | 17.5 | 3.6 | 23.8 | 7.7 | 40.0 | 17.2 | 30.8 | 10.6 | 13.8 | 11.9 |
| **Regulating services** | | | | | | | | | | | | | | | |
| Carbon sequestration | 64.7 | 51.7 | 59.4[a] | 7.1 | 6.9 | 7.0 | 17.7 | 6.9 | 13.3 | 22.4 | 12.0 | 18.2 | 13.0 | 5.1 | 9.8 |
| Coastal protection storms and waves | 50.6 | 58.7 | 53.9[a] | 10.6 | 6.9 | 9.1 | 10.6 | 10.3 | 7.0 | 36.4 | 15.5 | 28.0 | 14.1 | 0.0 | 8.4 |
| Sand re-generation | 19.4 | 22.4 | 26.6 | 30.6 | 37.9 | 33.6[a] | 21.2 | 15.5 | 14.0 | 27.0 | 12.0 | 21.0 | 33.0 | 5.1 | 21.7 |
| Flood protection | 43.5 | 60.3 | 50.4[a] | 15.3 | 17.2 | 15.4 | 8.4 | 6.9 | 7.8 | 18.8 | 3.4 | 12.6 | 11.8 | 10.3 | 11.2 |
| Nutrient regulation | 45.9 | 63.8 | 53.1[a] | 28.3 | 12.0 | 21.7 | 48.2 | 43.1 | 46.2 | 44.8 | 51.8 | 47.6 | 23.5 | 20.6 | 22.4 |
| Nutrient processing | 31.8 | 53.4 | 40.6[a] | 23.5 | 22.4 | 23.1 | 31.7 | 41.4 | 35.7 | 29.4 | 29.3 | 29.4 | 18.9 | 20.7 | 19.6 |
| **Cultural services** | | | | | | | | | | | | | | | |
| Recreation | 54.2 | 60.3 | 56.7 | 57.7 | 70.6 | 62.9[a] | 21.2 | 10.3 | 16.8 | 68.3 | 42.7 | 53.9 | 38.9 | 29.3 | 35.0 |
| Tourism | 74.1 | 70.7 | 72.7[a] | 58.8 | 67.2 | 62.2 | 34.1 | 36.2 | 35.0 | 81.1 | 60.3 | 72.7[a] | 47.1 | 44.8 | 46.2 |
| Research | 62.3 | 62.1 | 62.2 | 32.9 | 36.2 | 34.3 | 47.1 | 39.6 | 44.1 | 75.3 | 51.7 | 65.7[a] | 51.8 | 32.7 | 44.1 |
| Education | 53.0 | 62.1 | 56.6 | 32.2 | 58.6 | 43.0 | 47.1 | 50.0 | 48.3 | 64.7 | 51.7 | 59.4[a] | 24.7 | 34.5 | 28.7 |
| **Non-use value** | | | | | | | | | | | | | | | |
| Existence value | 80.0 | 84.5 | 81.8[a] | 76.4 | 82.8 | 79.6 | 64.1 | 77.6 | 75.5 | 78.9 | 84.5 | 81.1 | 68.2 | 70.7 | 69.2 |
| Intrinsic value | 76.5 | 81.1 | 78.3 | 70.6 | 82.7 | 79.0[a] | 64.3 | 59.0 | 62.2 | 78.9 | 77.6 | 78.3 | 63.6 | 65.5 | 64.3 |
| Bequest value | 78.8 | 87.9 | 82.5 | 72.9 | 89.5 | 75.5 | 65.5 | 75.4 | 69.6 | 89.4 | 81.1 | 86.0[a] | 73.5 | 82.8 | 77.3 |

[a]Ecosystem type that was scored highest for the flow for specific ES.

The scores were calculated based on the average mean scores of all FGD respondents and later by gender as per the data in each of the anonymous respondents' lookup tables used during the survey. Scale ranged from 0, no relevant flow; 1, very low relevant flow; 2, low relevant flow; 3, medium relevant flow; 4, high relevant flow; 5, very high relevant flow ($n = 148$).

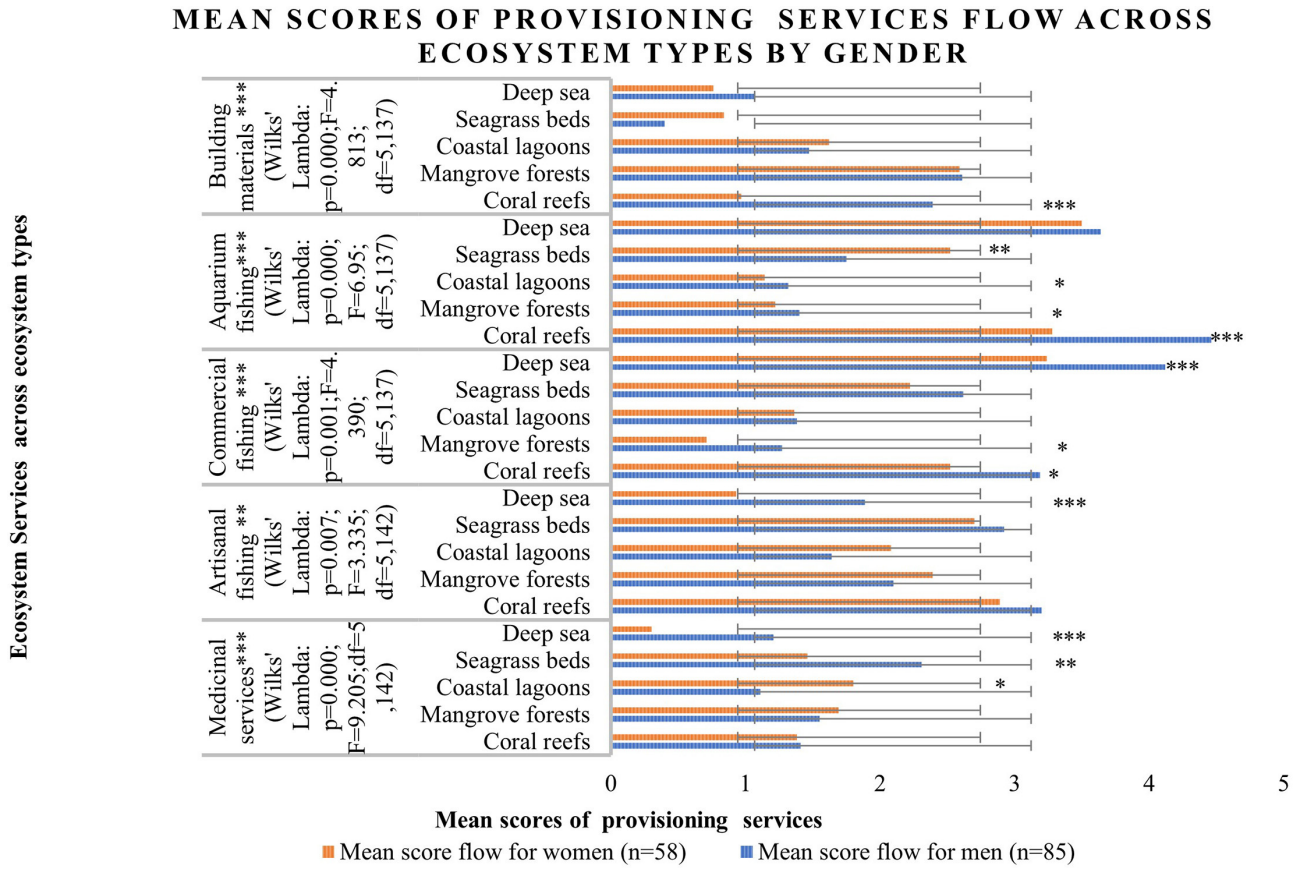


FIGURE 2
Comparing the mean scores of the one-way MANOVA test of men and women in the scores of provisioning service flow across selected coastal and marine ecosystem types. Results statistically significant at *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

On the other hand, more women compared to men scored high/very high for cultural ES in coastal lagoon ecosystems.

Non-use (bequest and existence) values had a high proportion of respondents scoring high or very high for all ES flow across all the ET. Except for intrinsic value, which had 64.3% compared to the flow for commercial fishing (67.8%) in the deep-sea ecosystems, the proportion of respondents scoring high/very high perceived flow of existence value was in mangrove forests (81.1%), intrinsic in coastal lagoons (79.0%), and bequest in coral reefs (86.0%). More women than men perceived a high/very high flow of non-use values in mangrove forests, coastal lagoons, and the deep sea.

Overall, more women than men scored high/very high ES flow of most ES in ecosystem types closer to the shoreline areas (i.e., mangrove forests, coastal lagoons, and seagrass beds). Refer to Supplementary Table 10 for verbatim quotes and Supplementary Tables 5a–e on the proportionate scores for the ES flow across coastal and marine ETs by gender.

## 3.5. Provisioning ecosystem service flow across ET by gender

Figure 2 presents the provisioning ecosystem service flow mean score across ET by gender. Gender was statistically significant in determining the difference in some ES flow across ET (Wilks' Lambda $p$-value $< 0.001$). For example, men had statistically significantly [$F_{(5,137)} = 9.205$; $p = 0.000$, partial eta squared $= 0.25$] higher mean scores in the perceived flow of medicinal services than women in seagrass beds and deep-sea ecosystems. In contrast, the mean score of women was statistically significantly higher than men in coastal lagoon ecosystems.

In the perceived flow of artisanal fishing services, men had a statistically significantly higher mean score than women in the deep-sea ecosystem [$F_{(5,142)} = 3.335$; $p = 0.007$; partial eta square $= 0.105$]. In commercial fishing, men had statistically significantly higher mean scores in coral reefs, mangrove forests, and deep-sea ecosystems, [$F_{(5,137)} = 4.390$; $p = 0.000$; partial eta square $= 0.138$]. In the perceived flow of aquarium fishing services, men had statistically significantly higher mean scores than women in coral reefs, mangrove forests, and deep-sea ecosystems [$F_{(5,137)} = 6.495$; $p = 0.000$; partial eta square $= 0.192$]. In contrast, the mean score of women was statistically significantly higher than men in seagrass bed ecosystems. In the perceived flow of building materials services, men had a statistically significantly higher mean score than women in the coral reef ecosystems [$F_{(5,137)} = 4.813$; $p = 0.000$; partial eta square $= 0.149$].

The qualitative data analysis highlights men's and women's sentiment supporting their ES flow scoring in the study area. For instance, during discussions, many respondents referred to coral reefs as "*nyumba ya Samaki" or "Makao ya Samaki*", loosely translated in English as "fish dwelling place". One old fisherman remarked, "*the fishers from Shimoni always get many fish within a short time. The*

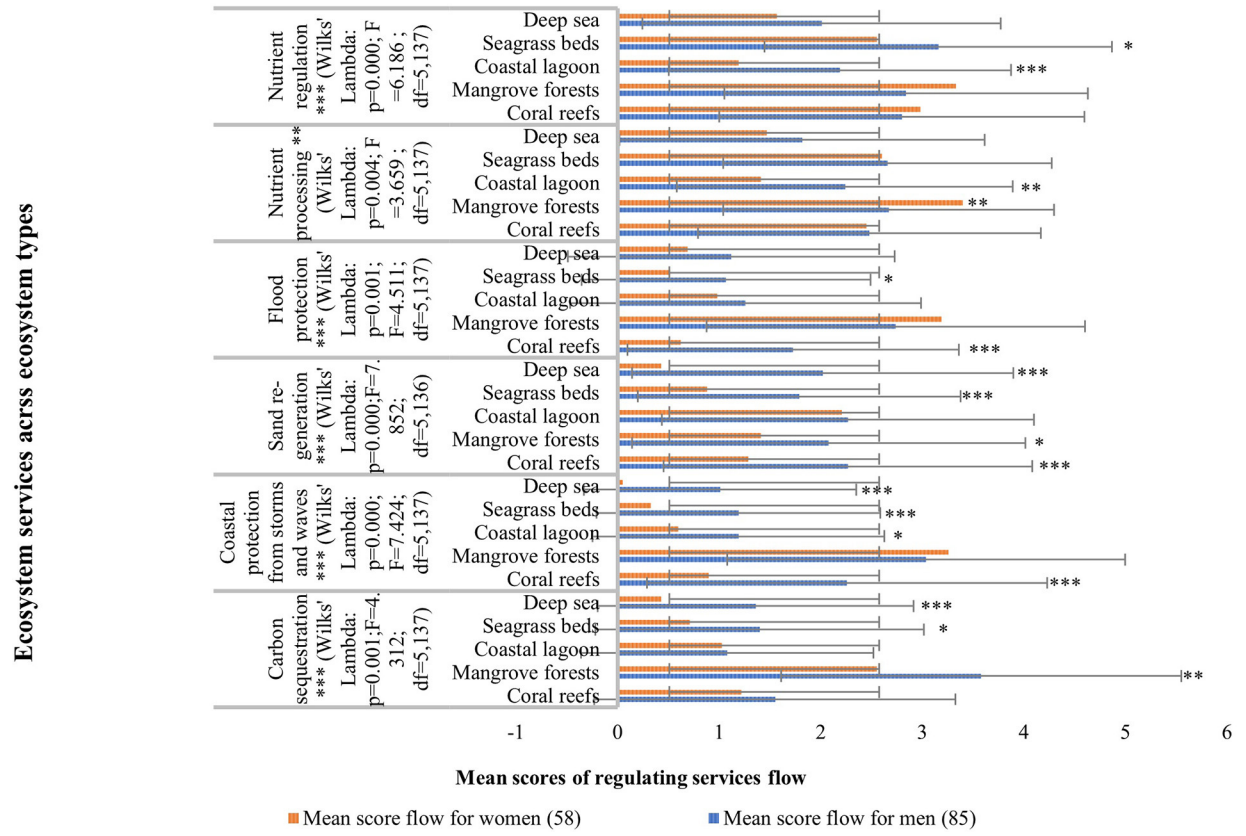


FIGURE 3
Comparing the mean scores of the one-way MANOVA test of men and women in the scores of regulating service flow across selected coastal and marine ecosystem types. Results statistically significant at *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

*area is protected/secluded, with many corals that protect fish. However, we do not have that here in Diani area. Sometimes, we can spend over 8 hours in the ocean and return with no fish*".

Another old woman said, "These *ecosystems sustain our livelihood in terms of income from fishing. We eat [fish] in our homes most of the days. Our husbands work in fisheries; it is all about fishing, nothing else; the ocean is our farm.*"

For additional verbatim quotes, refer to Supplementary Tables 6, 10 for detailed results of verbatim quotes and the one-way MANOVA test, respectively.

## 3.6. Regulating ecosystem service flow across ET by gender

Figure 3 presents regulating ecosystem service flow mean scores across ET and gender. The results show that gender determines the difference in regulating ecosystem service flow across ET (Wilks' Lambda $p$-value $< 0.001$). For example, in the perceived flow for carbon sequestration, men had statistically significantly higher mean scores than women in the mangrove forests, seagrass beds, and deep-sea ecosystems [$F_{(5,137)} = 4.312$; $p = 0.001$; partial eta square $= 0.136$]. Similarly, men had significantly higher mean scores than women in coastal lagoons, seagrass beds, and deep-sea ecosystems for the perceived flow of coastal protection from storms and waves [$F_{(5,137)} = 7.424$; $p = 0.000$; partial eta square $= 0.213$]. In the perceived flow of sand re-generation, men had significantly higher mean scores than women across all ET except coastal lagoons [$F_{(5,137)} = 7.852$; $p = 0.000$; partial eta square $= 0.223$].

The results further show that men had significantly higher mean scores than women in coral reefs and seagrass bed ecosystems in the flow of flood protection [$F_{(5,136)} = 4.511$; $p = 0.001$; partial eta square $= 0.142$]. In nutrient processing, men had significantly higher mean scores than women in coastal lagoons ecosystems [$F_{(5,137)} = 3.659$; $p = 0.004$; partial eta square $= 0.118$]. In the perceived flow of nutrient regulations, men had statistically significantly higher mean scores than women in coastal lagoons and seagrass bed ecosystems [$F_{(5,137)} = 6.186$; $p = 0.000$; partial eta square $= 0.184$]. There was no statistically significant difference for most regulating ES flow in the mangrove forests by gender except for carbon sequestration. From FGDs, most respondents perceived that mangrove forest ecosystems provided ES with protection from storms, waves, and flooding due to their highly branched roots, which reduce the speed or flow of water.

Refer to Supplementary Table 10 for detailed verbatims and Supplementary Table 7 for detailed results of the one-way MANOVA test.

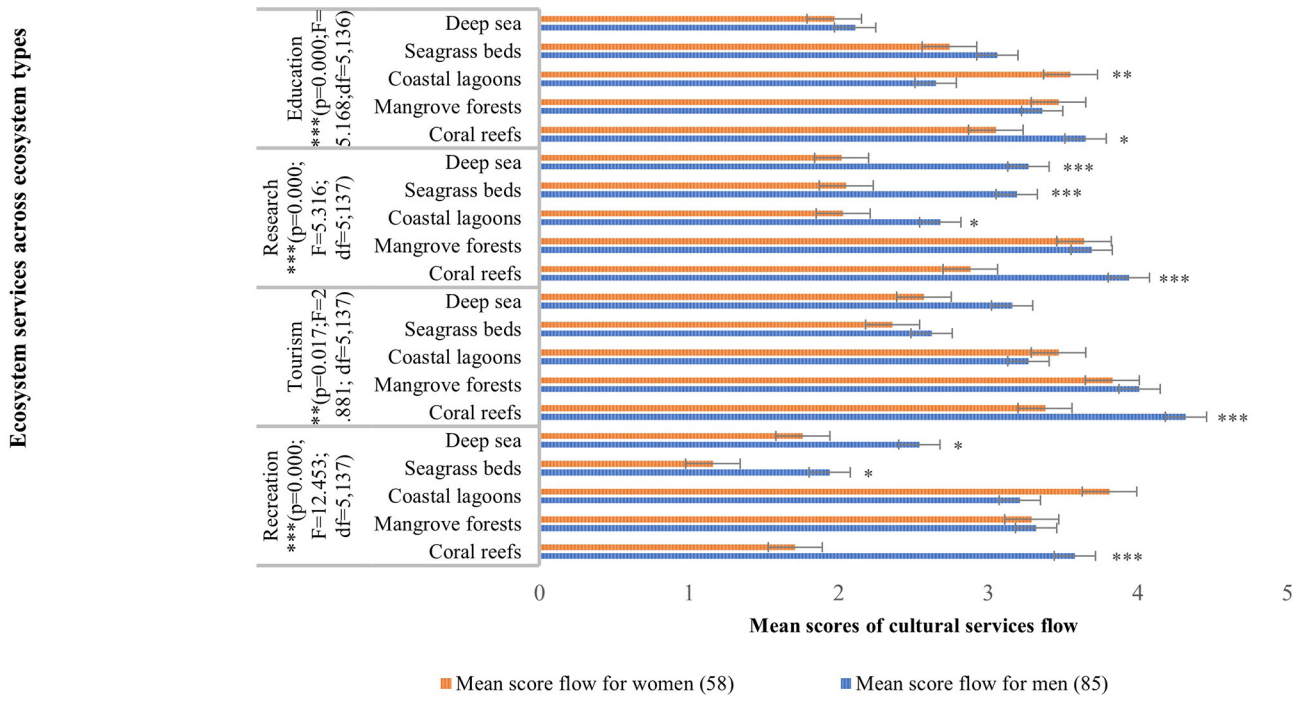


FIGURE 4
Comparing the mean scores of the one-way MANOVA test of men and women in the scores of cultural service flows across selected coastal and marine ecosystem types. Results statistically significant at *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

## 3.7. Cultural ecosystem services and non-use values flow across ET by gender

Figure 4 shows a statistically significant variation ($p < 0.01$) in the mean scores of men and women in the flow of cultural services across all the ET. In the perceived flow of recreation services, men had significantly higher mean scores than women in coral reefs, seagrass beds, and deep-sea ecosystems [$F_{(5,137)} = 12.453$; $p = 0.000$; partial eta square = 0.312]. In the perceived flow of tourism ecosystem services, a significant difference in the mean scores between men and women was noted in coral reef ecosystems [$F_{(5,137)} = 2.881$; $p = 0.017$; partial eta square = 0.095]. In the perceived flow of research services, there was a significant variation in the mean score between men and women across all ET except for mangrove forests [$F_{(5,137)} = 5.316$; $p = 0.000$; partial eta square = 0.162].

In the perceived flow of education services, men had significantly higher mean scores than women in coral reef ecosystems while in comparison, women had significantly higher mean scores than men in coastal lagoon ecosystems [$F_{(5,136)} = 5.168$; $p = 0.000$; partial eta square = 0.160]. Figure 5 shows the perceived non-use value flow mean score across ET and gender. Compared to other ES, gender was not statistically significant in determining the difference in intrinsic and existence value flow across ET. However, gender had a weak (Wilks' Lambda $p$-value $< 0.02$) association with the flow of bequest value across ET. The $p$-values across ET for bequest value by gender were not statistically significant. For example, the $p$-value for the flow of bequest value by gender for coral reefs was 0.059, the $p$-value for mangrove forests was 0.187, the $p$-value for seagrass beds was 0.954, the $p$-value for coastal lagoons was 0.191, and the $p$-value for deep sea was 0.942. Hence, we did not include the Asterix* in Figure 5 to indicate the significant difference in the flow of bequest value by gender across ET.

# 4. Discussions

Support for the livelihood of coastal communities is an issue of concern due to the coastal and marine ecosystems' threats from major stressors, including climate change, pollution, and over-harvesting from fisheries (Roberts Callum et al., 2017). These stressors undermine ecosystem services, which consequently affect many coastal communities' livelihoods, food security, and social wellbeing (McDonald et al., 2020). Women and men are affected differently by coastal and marine ecosystem threats. Similar to the study of Daw et al. (2011), on the exploitation of coastal and marine ecosystem services, our study found that perceived use and access to coastal and marine ecosystems to support wellbeing varied by gender. Women were mainly restricted from accessing the deep sea due to socio-cultural expectations and the fear that the deep sea is life-threatening and has demons. On the other hand, men had prominent roles in exploitation of coastal and marine ecosystem services due to their ability to own sophisticated tourism and fishing equipment. The variation in the preference of ES flow by gender across ecosystem types may be attributed to the socio-cultural roles and beliefs of the

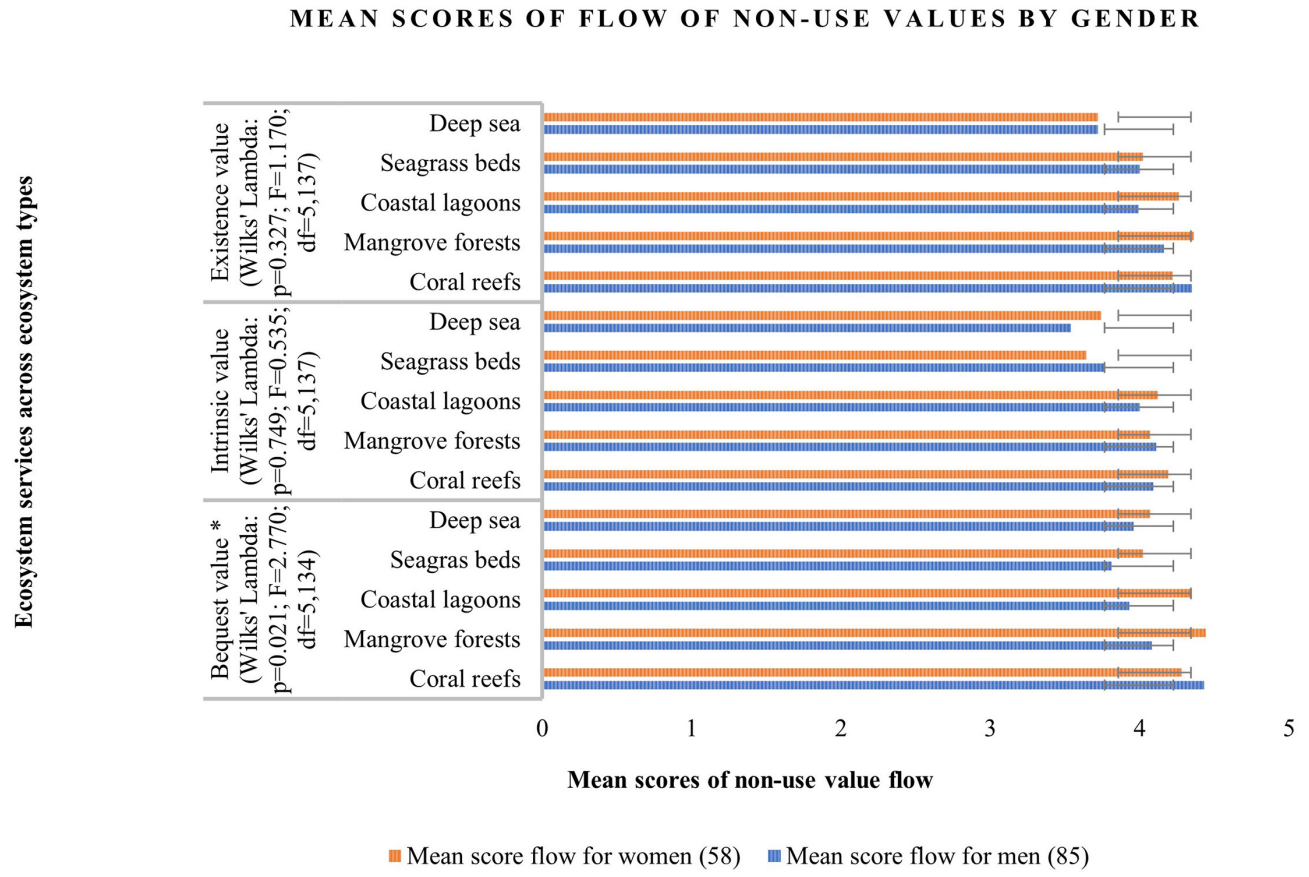


FIGURE 5
Comparing the mean scores of the one-way MANOVA test of men and women in the scores of non-use values flow across selected coastal and marine ecosystem types. Results statistically significant at *$p < 0.05$.

communities, identity and rights about properties, and the tenure system as echoed in a study by Lau et al. (2019).

The findings from our study in Diani and Kisite MPAs indicate that significantly more men than women had higher levels of formal education from chi-square test results. In the study of Hopkins and McKeown (2002), they showed that from an international perspective, respondents' level of formal education might impact the perception of ecosystem service flow they consider essential. Education level directly influences the exposure to knowledge of bundles of ecosystem services perceived as important. For example, respondents with a higher level of formal education are likely to perceive ES flow that is more complex to visualize (i.e., nutrient regulation and carbon sequestration) than those with a lower level of education. It is important to note that knowledge of such ES may require a solid scientific background to understand. We further support the argument by Bennett (2016), that perceptions are influenced by knowledge, experience, and motivations toward a resource. Therefore, in our study, men were more likely to perceive higher mean scores in the flow of most regulating services across all ET than women. The perceived flow of carbon sequestration in seagrass beds, mangroves, and deep-sea ecosystems was higher in men than women. This might be because most men in our study area were dependent on fishing as their main source of livelihood; hence, they valued the role of these ecosystems in reducing the impact of climate change on coastal and marine ecosystems to support artisanal fisheries for household food and income. This concurs with similar findings in the studies of Allendorf and Yang (2013), Allendorf and Yang (2017), and Yang et al. (2018) who found that men tended to be more aware of regulating services relevant to extreme weather mitigation such as carbon sequestration and flood protection than women.

On the other hand, our study found that women had higher scores for ES flow in the ETs used mainly by women and closer to the shoreline such as the mangrove forests and coastal lagoons. This may be due to the fact that women were constrained by the social norm restrictions barring their movements beyond specific spaces such as the deep sea and coral reef areas. Our findings corroborate the findings of Kleiber et al. (2015) in their review of 106 case studies on small-scale fishers for the past 20 years on the importance of gender to the understanding of marine ecology, and they found that women mainly exploited the mangrove and estuaries for fisheries in the marine ecosystems while both men and women shared the intertidal zone. Additionally, our findings also concur with the study of Arce-Ibarra and Charles (2008) in Mexico, where women were found to prefer fishing closer to their homes. Also, according to Pearson et al. (2019), women favored mangroves and coral reefs close to shoreline due to their proximity and ecosystem benefits, such as fuelwood from mangroves, crabs, and shells in coral reefs. Similarly, in the Democratic Republic of Congo, studies have shown that compared to women, men fished in the deeper waters (Béné et al., 2009).

Both genders had high scores for the ES flow for non-use (existence and bequest) values across all the coastal and marine ecosystems in Diani and Kisite Mpunguti MPAs. Qualitative data revealed that most respondents gave high mean scores to non-use values due to the perceived future benefits. The high mean scores in the flow of existence and bequest values imply that sustainable coastal and marine resource use benefits everyone in the community. In the qualitative explanation of respondents in this study, the benefits were perceived to support food security, income, and wellbeing. These findings concur with those of Raymond et al. (2009) in a study on mapping community values for natural capital and ecosystem services in South Australia, where bequest, intrinsic, and existence values associated with cultural ecosystem services were highly valued. Similarly, a study by O'Garra (2009) established the high importance of bequest value to indigenous communities in Fiji who were willing to pay a higher premium from their household income to protect the fisheries' value of coral reef ecosystems. Likewise, Madagascar's bequest value had a high priority compared to other beneficial ecosystem services in communities' livelihoods (Oleson et al., 2015). In our study, respondents showed a sense of stewardship in their obligation to preserve all coastal and marine ecosystems for sustainable use.

More women than men scored high/very high for bequest value flow across all ETs except in the coral reefs, although the association was not statistically significant. The high scores of bequest values by women may be related to women's roles in the family, such as being responsible for nurturing children. Thus, women may be the best champions to preserve coastal and marine ecosystems for future use by their children. This argument is supported by the sentiments of Leach (2007), who echoed the mythical statement that women have the inborn desire to conserve nature; therefore, they are the desired custodians of conservation matters, while women's qualitative explanation for low scores for bequest value in coral reef ecosystems was evident in dwindling fish harvests. In addition, they perceived the dwindling fish harvests to relate to high degradation in coral reef ecosystems due to overfishing and unsustainable fishing practices such as the use of dragnet and blast fishing. Hence, they believed that ES flow for future generations is limited in coral reef ecosystems.

Regarding the flow of cultural services (recreation, tourism, research, and education services), our findings show a significant variation in the mean scores of men and women across some ETs. The mean scores for men were significantly higher than women in the perceived flow of all the cultural services in coral reef ecosystems, especially for tourism ES. This high mean score of the flow of tourism services in coral reef ecosystems was because men are mostly engaged in coral reef tourism, which attracts many foreign and local tourists. These tourists participate in snorkeling and diving in the coral reef sites or use glass boat tours in the area, thereby a source of income for tour operators, tour guides, educators, and research assistants or translators. However, these findings are contrary to the study of O'Garra (2009), who found that the Fijian communities were unwilling to forego traditional fishing grounds to give way for future tourism investments, which was perceived as a major risk to their livelihood. In Diani and Kisite MPAs, artisanal fishing for household consumption and small-scale fish trading is practiced. Furthermore, the studies of Petrosillo et al. (2007), Martín-López et al. (2012), and Mensah et al. (2017) noted that there was no variation in the perception of the use or importance of tourism and recreation services by gender across the various ecosystem types.

In regard to the importance of provisioning services in supporting coastal communities' livelihoods for their wellbeing, lower mean scores were recorded in the perceived flow of provisioning services compared to the flow of regulating services, cultural services, and non-use values across all ET. This was associated with the perceived and actual low productivity of the coastal and marine ecosystems in supporting fisheries and seafood. Due to high community dependence on shallow water artisanal fishing, the upcoming Shimoni fishing port was perceived as a threat to household income and food security in the area, for peaceful co-existence and potential for increased pollution on coastal and marine ecosystems. These findings are contrary to a study by Lau et al. (2019) in Papua New Guinea, who found that the provisioning services that directly provide benefits and support to communities' wellbeing received high scores for importance compared to cultural and regulating ES.

Our findings report high mean scores for women in Diani and Kisite MPAs in the flow of artisanal fishing in ecosystems closer to the shoreline (such as the mangroves, coastal lagoons, and seagrass beds). This is because artisanal fishing supported household subsistence and boosted household income. Most women participated in small-scale fisheries trade closer to their homes as "mama Karanga" (women in fish frying). Similar to the study of Matsue et al. (2014), our study found that women commonly sold small fish species gleaned from mangrove and coastal lagoon ecosystems to support household food security. Women's effort to support food security in this study corresponds to the findings of Quiros et al. (2018).

In terms of gender and provisioning ecosystem services across ET, there were significant differences in the perceived mean scores, with men having high mean scores. This was attributed to their awareness of the benefits, especially fishing, through their experience in fisheries and the seafood trade. Compared to women, men are more likely to access sea fishing equipment that can be used to exploit deep-sea, coral reef, and mangrove ecosystems. These findings concur with the study of Martín-López et al. (2012), who noted that men had a preference for provisioning services that yielded higher profits, such as charcoal production, timber harvesting, and fuel wood harvesting. These findings are also similar to a study on the coast of Kenya and Mozambique by Fortnam et al. (2019), who found that men traders had access to better equipment to exploit deep-sea fishing. In our study, women perceived the deep sea as a life-threatening and scary place that needed courage and strength for ES exploitation. Thus, most of the women based their scoring on the ES flow from deep sea on acquired knowledge from their relatives who were fishermen. It is vital to acknowledge that socio-cultural and behavioral expectations shape the role of men and women in resource use patterns.

Regarding the perceived flow of medicinal services, the study found that this remained under-explored. Most respondents doubted medicinal derivatives from these ecosystems and primarily relied on conventional medicine. On average, respondents perceived the flow of medicinal services in coral reef ecosystems to have no ES flow. These findings are contrary to the scientific evidence of potential bio-prospecting in coral reefs for cancer pain treatment (UNEP, 2006). However, men's mean scores were significantly higher than women's in the flow of medicinal services, especially in seagrass beds and deep-sea ecosystems. Most men stated that they usually use the milky sap from seagrass for analgesic properties to injured tissues while out on fishing activities. According to Schlernitzauer et al. (2013), seagrass has anti-inflammatory potential in relieving

muscular pain. For example, an endemic seagrass species found in the Mediterranean Sea known as *Posidonia oceanica* (L) Delile has been traditionally used to treat inflammation and lower limb pain (Degl'Innocenti and Vasarri, 2021). Interestingly, in Diani and Kisite MPAs, women were of the view that some shellfish species found in the coastal lagoon were used to boost children's intelligence and enhance aphrodisiac properties. Additionally, most women believed that the muddy debris in the coastal lagoon cures skin diseases such as scabies and chicken pox when smeared on the affected individuals' bodies. A study in Bangladesh on ethno medicinal uses of fish, shellfish, and other aquatic animals had similar findings (Deb and Emdad Haque, 2011).

On the role of men and women in the extraction of provisioning ecosystem services (building materials), the high mean scores in coral reefs were attributed to the role of men in securing dead coral stones and sand harvesting as building materials. Additionally, men's involvement in live coral extraction and ocean sand harvesting trade supports household income. In contrast, women perceived the extraction of building materials from coral reefs as destructive and threatening to marine biodiversity in supporting food security. Likewise, Kamau et al. (2009) found that the impacts of sand mining and picking of corals in Kwale County are among the destructive activities threatening the viability of marine fisheries. In contrast, the study by Lau et al. (2019) in Papua New Guinea noted that men perceived fuelwood collection by women as destructive because they (men) were not directly involved in its collection. Therefore, from the findings of this study, we concur that men and women have different perceptions and preferences of ES flow across coastal and marine ecosystem types.

### 4.1. Study limitations

The study had some limitations. First, the results were based on the views of focus group discussion respondents who were members of existing groups. Therefore, their views may not represent the views of individuals who do not belong to any group. Furthermore, the results may not be generalized to other settings. Second, some respondents may have indicated high or low scores on some ESs due to experiential benefits or the lack of awareness of the ES flow. In addition, the ES flow scores of the respondents may be influenced by the cognitive dissonance effect (the state of having inconsistent thoughts, beliefs, or attitudes, especially about behavioral decisions and attitude change) as explained by Festinger (1957) and Bem (1967). Finally, it is also possible that people's perceptions may change over time. Despite these limitations, our results confirm most of the findings from other studies on similar topics.

## 5. Conclusion

The analysis for this article focused mainly on the gendered dimension in coastal and marine ES flows informed by an individual's experience, norms, responsibilities, and opportunities in resource use and access. The study findings show that respondents perceived ES flows varied by coastal and marine ecosystem types. Additionally, gender (i.e., being a man or a woman) was significantly associated with the perceived ES flow in some coastal and marine ecosystems and not significantly associated with others. Furthermore, men's mean scores were significantly higher than women's in most ES flows across all ET, except in the mangroves. The average mean scores of ES flows for women were high in ecosystems commonly exploited by women, characteristically closer to the shoreline in the areas of mangroves, seagrass beds, and coastal lagoons. The differences in the perceived ES flow between men and women were influenced by perception, knowledge, use, and access to the ET.

Qualitative data revealed that most respondents appreciated the importance of the interconnectedness of coastal and marine ecosystems as vital areas for fish habitats and providing a sense of belonging to the coastal communities. The respondents' higher mean scores for the non-use values across all the ET resulted from the respondents' belief that these ecosystems have an intrinsic value as part of God's or "Allah's" creation. Furthermore, the respondents stated that they bequeathed the ocean from their parents and hoped to pass the same as an inheritance to their children (bequest value) in a better and more productive state. Hence, they showed great concern for the threats to these ecosystems. Most respondents mentioned climate change and overfishing as the most worrying threats to the flow of coastal and marine ecosystem services in the area.

## 6. Recommendations

### 6.1. Policy recommendation

The inclusion of gender perspectives in coastal and marine ecosystem-based approaches is key, and women should be facilitated to an enabling environment for accessing equal opportunities to participate in key roles and responsibilities to spearhead sustainable resource exploitation in coastal fisheries and tourism in Kenya and the larger WIO region.

The government and donor agencies should explore more blue carbon financing projects to support the replication of blue carbon credit projects such as "Mikoko Pamoja, South coast Gazi Bay, Kenya" across the southern coastline. Such a project will reduce over-reliance on provisioning ES, such as fishing and extraction of mangrove poles for building. It will also support biodiversity conservation while improving livelihoods and food security in the region.

There is a need for the collaboration of coastal and marine stakeholders to support the establishment of Locally Managed Marine Protected Areas and designate them as Man and Biosphere reserves to move toward the achievement of 30% ocean coverage under MPAs by 2030 in the region. This will in turn support coral reef and interrelated blue carbon ecosystems of mangroves and seagrass bed restoration projects in the Kenyan Coastline and increase fish spillover in highly overfished areas.

Social and environmental safeguard regulations have to be formulated in the blue economy to ensure there are enough safeguards concerning the protection of income and food sources for communities involved in artisanal fishing. Investments in coastal and marine ecosystem management should aim to achieve sustainable development goals and strengthen the local government and people's capability to plan for mitigation measures and be resilient to threats.

Direct financial facilitation to local community groups to enable them to supplement artisanal fishing by acquiring sea equipment that would enable them to exploit deep seas and engage in alternative livelihood programs such as crabs, prawns, and shrimp farming to reduce pressure on shallow waters capture fisheries.

### 6.2. Governance recommendation

The findings underscore the need to consider the perceptions of men and women in the ES flow in decision-making and planning processes in coastal and marine resource use and governance.

Community engagement strategy: Greater focus should be on the gendered lens of ecosystem-based management and integrated coastal management for sustainable food security by addressing social norms that suppress women's full participation in exploiting ES across ET. There is a need to engage local resource users in ocean governance and management with great consideration of equitable gender representation.

Coastal and marine ecosystem stakeholders should strive to improve the flow of provisioning ES by supporting local communities to be the front runners in adopting nature-based solutions to address anthropogenic and natural threats that affect ES flow to improve food security. For example, coral reef and seagrass restoration projects and seaweed farming can reduce climate change-related pressure on artisanal fisheries and interrelated coastal and marine ecosystems.

On ES resource extraction, the relevant institutions should engage local communities in the plantation of short-maturing trees for building materials and fuelwood to reduce pressure on mangrove forests. Trees such as casuarina, which is well-adapted to the area, could be useful.

### 6.3. Research and training

Finally, there is a need for further research to understand the ES flow among policymakers and program implementers across coastal and marine ecosystems in the study area for better decision-making and planning.

## Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

## Ethics statement

The study was approved by National Commission for Science and Technology (NACOSTI) under license number NACOSTI/P/21/9705. The participants provided their verbal and written informed consent to participate in this study.

## Author contributions

CN contributed to the conceptualization of the idea, designing the survey tool, data collection, processing, and analysis as well as writing the first draft of the original manuscript. MO contributed to the review of the survey tools (ES matrix assessment tool and focus group discussion guide) and the review of the manuscript. TT took part in the guidance of the development of the survey idea, review of the survey tool, and the review of the manuscript, while FM participated in the overall technical guidance of the idea in project development and review of the manuscript. All authors contributed to the article and approved the submitted version.

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## Conflict of interest

CN was employed by Kenya Wildlife Service and was granted permission to participate in fieldwork.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## Publisher's note



## Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fsufs.2022.787476/full#supplementary-material

SUPPLEMENTARY FIGURE 1
Study area map developed during reconnaissance in December 2019.

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