Delineating expert mangrove stakeholder perceptions and attitudes towards mangrove management in Sri Lanka using Q methodology

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ABSTRACT

Effective decision-making is key to the successful conservation and management of natural resources. Mangrove ecosystems all over the world provide an array of ecosystem goods and services and are managed by a wide range of stakeholders representing various sectors. The position of mangroves in the land-sea interface and the rapid development of coastal areas in the Global South make mangrove conservation and management more challenging than the management of other coastal ecosystems. Sri Lankan mangroves are degrading due to numerous natural and anthropogenic causes in recent years. Mangrove degradation in Sri Lanka is further exacerbated by the economic crisis following the COVID-19 pandemic. The coastal communities near mangroves in Sri Lanka heavily depend on mangrove goods and services (more than before, due to a lack of livelihood alternatives), despite formal *"no entry"* rules by the government. This study's objectives are to delineate the viewpoints of mangrove management experts to understand current mangrove management in Sri Lanka and to provide baseline data for effective decision-making. We used Q methodology, during which 71 mangrove experts representing 21 stakeholder groups were asked to individually rank statements regarding mangrove management. These rankings were subsequently clustered using Principal Component Analysis, allowing the identification of clusters of opinions regarding mangrove management. Stakeholder's perceptions were clustered into three discourses: community-oriented management, government-oriented management, and management in synergy between government and communities for effective mangrove conservation. Our findings emphasize the multifaceted nature of mangrove management in Sri Lanka, revealing diverse perspectives among stakeholders. Our results further highlight the need for a collaborative approach to the co-management of mangroves in Sri

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Lanka. We recommend that mangroves be co-managed by the government and local communities ensuring environmental sustainability in Sri Lanka and beyond.

1. Introduction

Mangrove ecosystems provide a wide range of goods and services for coastal communities adjacent to mangroves and other surrounding areas in tropical and subtropical regions and beyond. These goods and services include timber, fuelwood, and charcoal, as well as fisheries, coastal protection, and carbon sequestration (Dahdouh-Guebas et al., 2021). Despite positive mangrove conservation efforts around the world, these ecosystems are continuously degraded due to urbanization, coastal pollution, conversion to aquaculture facilities, and mismanagement (Friess et al., 2020). Mangrove ecosystems are in constant interaction with humans and can be considered as mangrove social-ecological systems (MSES) (Dahdouh-Guebas et al., 2021). MSES consists of ecological components, including mangrove flora, fauna, and other biophysical components, and social components such as communities, policies, governance systems, and stakeholders of mangrove management. Mangrove management stakeholders are an integral part of MSES because they are directly involved in managing and regulating mangrove goods and services and have long-standing expertise in the field (Martínez-Espinosa et al., 2020). Studies show that diverse stakeholder views and feedback are, generally not sufficiently integrated into mangrove management regimes around the world. This is believed to be one of the major reasons for mangrove mismanagement (Golebie et al., 2021) Thus, incorporating perceptions, opinions, interests, and values of diverse mangrove management stakeholders into decision making can improve sustainable mangrove management (Arumugam et al., 2021; Forrester et al., 2015).

Understanding the perspectives of a diverse array of stakeholders and the underlying rationale for resource management is necessary for effective natural resource management (Mace, 2014; Tallis and Lubchenco, 2014). Research in the Sundarbans region of Bangladesh revealed the significance of considering both the formal and informal interests of stakeholders in mangrove management (Khan et al., 2020). Additionally, examining stakeholder views on mangrove management in Senegal highlighted the potential for improving mangrove management through clearly defined responsibilities and equitable benefit sharing (Arumugam et al., 2021). An evaluation of stakeholders' perspectives on mangrove management in Matang, Malaysia, showed the importance of local stakeholder support and active participation in enhancing existing mangrove management frameworks (Hugé et al., 2016) Martínez-Espinosa et al., 2020). Furthermore, Su and Gasparatos (2023) stressed the necessity of understanding how stakeholders and communities perceive mangrove ecosystem management and its associated benefits, as stakeholder perceptions are critical for shaping effective and equitable mangrove management strategies. Perceptions of mangrove managers on the South American Pacific coast suggest the need for tailored governance mechanisms that align with specific stakeholder needs and the necessity to provide adequate training and awareness to stakeholders about the vital role of mangroves in sustaining these ecosystems (Villanueva et al., 2023). A similar study conducted in Thailand underscores the importance of prioritizing community-based mangrove restoration, with a focus on addressing the root cause of failure in restoration practices, which often stems from insufficient technical knowledge according to stakeholder perceptions (Lhosupasirirat et al., 2023). Consequently, it is imperative to incorporate stakeholder perspectives in mangrove and other natural resource management, facilitating the development of informed policies and the allocation of adequate funding for effective mangrove management (Pham et al., 2022; Sarker et al., 2017).

Mangrove ecosystems in Sri Lanka are degraded at an alarming rate despite government-led conservation efforts (Wickramasinghe et al.,

2022). There are government, non-government and private stakeholders[2] involved in mangrove management in Sri Lanka. Coastal communities living adjacent to Sri Lankan mangroves are often not adequately formally integrated in mangrove management decision-making (Nijamdeen et al., 2022). Most coastal communities in Sri Lanka adjacent to mangroves live below the poverty line (Gunawardena and Rowan, 2005). Poverty induces the coastal community to move towards utilizing mangrove goods and services. If this increased demand for mangrove goods and services is not managed properly, mangrove ecosystems may become more vulnerable to both encroachments and destruction than before the present economic crisis in Sri Lanka. Therefore, in order to design solutions and management alternatives, it is crucial to understand the viewpoints of a diversity of mangrove management stakeholders. The opinions of mangrove management stakeholders from all coastal provinces of Sri Lanka, when analyzed together, may provide a clear and holistic view of prevailing situations. The input of mangrove management stakeholders may help to assess current mangrove management methods, measure the impacts of conservation actions, as well as foster learning, and improve current mangrove management practices.

1.1. Mangrove management in Sri Lanka

Mangrove forests in Sri Lanka are managed by the divisional, district, provincial, and national authorities. The decentralized governance system of Sri Lanka has provincial councils with the responsibility of the "*protection of the environment*" (Herath, 2009). Still, all laws are enacted by the National Parliament of Sri Lanka where provincial officers do not play an active role in decision-making or funding allocations. According to Saito (2008), the "*Provincial council system has failed to achieve regionally balanced development in the country*" and the provincial councils do not have sufficient autonomy nor revenue in Sri Lanka (Saito, 2008, P 20.). The ministries of the central government are involved in policymaking for their respective departments regarding mangrove management (Nijamdeen et al., 2023). Local authorities such as municipal councils do not have sufficient capacity (in staff, power, financial resources, infrastructure etc.,) for managing forests. Apart from reaching out to the urban councils, local communities or community-based organizations do not have the possibility to connect to an elected local authority to discuss issues related to mangrove management (Nijamdeen et al., 2022; Herath, 2009). On the other hand, ministers are at times directly involved with the local authorities to support certain development projects (including in mangrove areas), especially when politically beneficial.

The Northern and Eastern parts of Sri Lanka were not accessible to researchers until 2009 and there are still ambiguities about the total extent of mangroves in the country (Arulnayagam et al., 2021) and their ownership. Mangrove forests come under the jurisdiction of the Forest Department of Sri Lanka except for privately owned mangrove forests. According to the Forest Department, the present mangrove cover is estimated to be 15,670 ha nation-wide (Perera and Amarasinghe, 2019). However, the International Union for Conservation of Nature (IUCN) estimated 12,000 ha as the total mangrove cover in Sri Lanka (Mombauer, 2019). At the same time, The Global Mangrove Watch estimated 19,874 ha of mangroves in Sri Lanka (GMW, 2022). Thus, a clear disparity in mangrove forest cover estimation is seen in Sri Lanka. Shrimp farming which is considered as a major threat to mangroves is prevalent in all coastal provinces of Sri Lanka (Ofori et al., 2022) and the ownership of most shrimp farms remains with private enterprises. There are several other governmental departments that partially manage mangroves in river catchments and urban areas in Sri Lanka (i.e.,

Mahaweli Authority of Sri Lanka) (Nijamdeen et al., 2022). Moreover, due to the ethnic diversity of people from different cultural and religious backgrounds in coastal mangrove regions, a uniform mangrove management regime has not been observed in Sri Lanka (Nijamdeen et al., 2023; Dayananda, 2004)

In recent years (2019–2022) Sri Lanka has been on the brink of bankruptcy and has struggled to fulfill the basic needs of its people. In 2022, with a soaring inflation rate of more than 50%, the Sri Lankan government does not have sufficient foreign revenue or foreign currency to import essential goods such as fuel, medicine, or food (Sultana, 2022). Frequent power outages have been observed in all provinces. According to the Sri Lankan government, the main reasons for this crisis included the COVID-19 pandemic along with the 2019 Easter attack, which adversely affected the tourism industry. The tourism industry is one of the main revenue-generating industries in Sri Lanka and is primarily based in coastal regions (De Silva, 2021). Economic experts believe that another major reason for the economic crisis in Sri Lanka is economic mismanagement after the end of the civil war in 2009 (Sharma et al., 2022; Bhowmick, 2022; Perera, 2022). As a consequence of recent negative economic prospects, coastal communities living closer to mangroves have been adversely affected by food insecurity, lack of access to essential services, and limited or no economic opportunities. With the increasing demand for essential goods and services at subsistence levels, communities living below the poverty line are now falling back on natural resources when other sources of income fail. Poverty is frequently linked with heavy dependence on natural resources at subsistence levels in developing countries (Bruce and Mearns, 2002). Mangroves are highly productive ecosystems with numerous social, economic and environmental values and are in close vicinity to poor communities that depend on mangrove goods and services where the communities try to encroach mangroves for subsistence level uses.

Even though mangroves have been fully protected by legislation since 2020 (Wickramasinghe et al., 2022), only about 4.71% of the mangroves have been included in the Protected Areas of the country. Protected Areas in Sri Lanka are administered by the Department of Wildlife Conservation. Declaring an area as a Protected Area helps to "*protect ecosystem services and cultural and historical significance of areas*" (DWC, 2022). It is still unclear how the rest of the mangroves will be fully protected in practice, without a clear conservation status. Defining a clear conservation status for all mangrove forests in Sri Lanka would help to understand the level of interaction people should ideally have with mangroves. Clear mangrove management and conservation rules would help us answer the following questions: whether communities need to fully stay away from mangroves, whether communities would be punished if they enter mangroves, or to which extent the communities can utilize mangrove resources and co-manage mangrove ecosystems.

Even though there are numerous policies in practice, it is still unclear how the mangrove stakeholders throughout the country view the current management of Sri Lanka's mangroves. We argue that mapping the diverse viewpoints of these expert stakeholders would help to assess how these stakeholders perceive current management practices. Our first objective was to identify expert stakeholders in mangrove management in Sri Lanka in all five coastal provinces and the second objective was to identify diverse perspectives among stakeholders and investigate any disparities. Through this study, we expect to provide baseline data that can be adopted by policymakers to develop sustainable mangrove management plans in Sri Lanka. Perspectives and methods from this island wide survey may also be used in other countries with similar mangrove management regimes and economic situations.

2. Methods

2.1. Study area

Sri Lanka is a tropical island situated in the Indian Ocean, between latitudes 5°550–9°510 North and longitudes 79°410–81°540 East with a land area of 65,610 km^2 (Karunathilake, 2003). Mangroves consist of 197.16 km^2, and line 18.21% of the coastline (2461.60 km) as isolated patches in all five coastal provinces (GMW, 2022; Ellepola and Ranawana, 2015). These coastal provinces have considerable differences in population density, mangrove area, and Gross Domestic Product (GDP) (Table 1).

2.2. Q methodology

Q methodology is a systematic semiquantitative procedure to delineate stakeholder perspectives on a topic of interest. Q methodology offers a systematic means to solicit and organize stakeholder perspectives. Through Q methodology we can organize individual viewpoints into clusters of value positions, belief systems, or mental models (McKeown and Thomas, 2013). Researchers can leverage the Q methodology to disentangle a spectrum of viewpoints, irrespective of the prevalence of viewpoints within a given population (Stenner and Watts, 2012). What sets Q methodology apart from other similar methods is the ability of Q methodology to merge quantitative and qualitative data along with analytical techniques, while also encouraging researchers to rely on their intuition and creativity. This approach enables researchers to actively shape the entire process, making it a valuable tool for understanding the diversity of perspectives (Mukherjee et al., 2018; Zabala et al., 2018) It is also important to note that Q methodology "*is not a purely quantitative or positivist methodology*" and is "*subjective to some extent*" (Zabala et al., 2018). Underrepresented and hidden perspectives of stakeholders that are otherwise neglected can be brought about to discussion through Q methodology (Ockwell, 2008; Mazur, and Asah, 2013; Zabala, 2018).

The first step in the Q methodology is to collect a comprehensive list of statements that encourage the personal opinions of the stakeholder about a topic. This comprehensive list is called a "*concourse*" (Zabala et al., 2014). The concourse is then reduced with the help of selected experts (on the topic) to a manageable number of statements. After selecting a manageable number of statements (Q set), a preliminary round of discussions about the clarity of statements is carried out with selected experts, and statements are modified in such a way as to be readily understood by the stakeholders. Then stakeholders are requested to individually rank the statements over a ranking grid with rows and columns (Fig. 1). This individual ranking is called "*Q sort*". Each statement of the Q set is ranked on the ranking grid according to the personal opinion of the stakeholder (Zabala et al., 2014; Stenner and Watts, 2012). The ranking varies from the most agreed to the most disagreed views. After obtaining all the responses, Q sorts are compared and clustered according to similarity where each cluster represents a specific perspective (Brown 1980). These perspectives are then developed into shared clusters of similar perspectives. In addition to ranking statements, stakeholders are asked to explain their views on each statement in the post-sorting interviews. Factor Analysis is used to cluster and summarize Q statements into specific perspectives. Factors are explained according to scores obtained, additional interpretations from the stakeholders about statements during the interview, and the knowledge of the researcher regarding the perspectives explained (Zabala et al., 2014). Distinct viewpoints of stakeholders can be delineated through Q methodology, which in turn helps support decision-making regarding the ecosystem of interest (Sandbrook et al., 2011). According to Sneegas et al. (2021), only 9 studies have been carried out in Southern Asia, applying the Q methodology in environmental sustainability research, and non-have been carried out in Sri Lanka.

2.3. Data collection

2.3.1. Mangrove stakeholder identification

A stakeholder identification survey was developed to identify

Table 1

Estimated mangrove cover, population, land area, population density, and the contribution of each coastal province to the national in Sri Lanka (adapted from CBS, 2017; Wickramasinghe et al., 2022).

Province	Mangrove forest cover (ha)	Mid-Year Population '000 (2018)	Land Area (km^2)	Density of Population per km^2	GDP Contribution-2015 (%)
Northern	6782	1131	8290	136	5.4
Eastern	2689	1710	9361	183	6.0
Southern	1137	2637	2637	490	10.4
Western	709	6129	6129	1706	41.2
North-western	2300	2536	2536	338	10.9
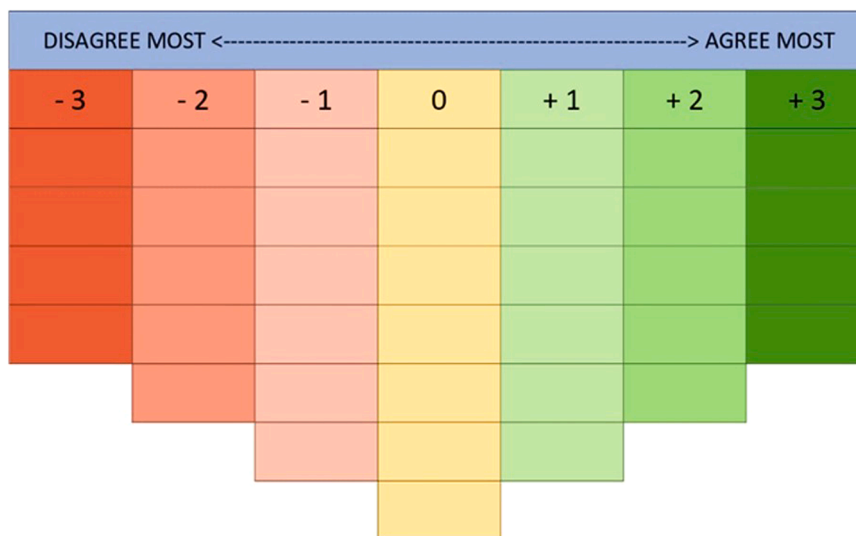
Fig. 1. Ranking grid of the Q methodology, representing a simplified bell-shaped distribution. − 3 represents the most disagreed statements whereas + 3 represents the most agreed statements. All other statements fall in between the two extremes (−3 and +3). Statements placed in the same column have the same ranking score. Stakeholders are asked to rank statements to fit all in the slots within the grid (forced distribution).

stakeholders that are considered experts in mangrove management in Sri Lanka (Fig. 2). Stakeholders were selected through four steps: (i) six organizations/departments (stakeholders) were selected according to their jurisdiction related to mangrove management (Appendix 1) along with researchers and university academics who work with mangroves in Sri Lanka, (ii) selected stakeholders (n = 12) were contacted in each province and were asked to recall other mangrove stakeholders they knew (snowballing approach). Then additional stakeholders were added and a mangrove stakeholder list was prepared (red list), (iii) by combining red lists from all provinces, a new stakeholder a new list was prepared (green list), (iv) each stakeholder group (government organization, NGO, university, private organization) related to mangrove conservation (from the green list) was contacted in each province (blue list) and they were asked to recommend 2–3 stakeholders (employee of the stakeholder group) who are experts in mangrove management. The major stakeholder groups were government, non-government, private sector, researchers, and mangrove-fringing community members who work with mangroves for prolonged periods of time (i.e., fishing in mangroves for the past 40 years). Seventy-two expert stakeholders participated in the Q methodology from 2020 August to 2022 May (Table 2). Then the recommended stakeholders were contacted and questioned about their expertise in mangrove management and were then invited to participate in the Q methodology. Researchers were selected according to the research publications related to mangroves in Sri Lanka and/or expertise in the field for prolonged periods of time. Apart from that, all Sri Lankan university websites were checked to identify academics who work on mangrove ecosystems in Sri Lanka.

2.3.2. Concourse and Q set development

Concourse is the background information which is a collection of subjective statements regarding the topic of interest in the Q methodology to create the "*Q set*" (McKeown and Thomas, 2013). The concourse of our study was prepared through a scientific literature review and from grey literature[2] (i.e., non-governmental organization (NGO) reports, annual and community reports, websites, newspapers, etc.,). The scientific literature search was carried out on Web of Science, Google Scholar, and Research Gate by using the following keywords: Mangrove, Conservation, Management, Stakeholders, and Sri Lanka under four themes as follows.

1. Legal, policy, institutional framework, and governance of mangroves in Sri Lanka
2. Involvement of stakeholders in mangrove management
3. Mangrove conservation needs based on socio-economic needs
4. Mangrove conservation needs based on threats to mangroves

Following this, the concourse was put through a structured filtering process to reduce it to a manageable set of statements (as in Benitez-Capistros et al., 2016). 37 statements were selected for our Q study (Table 4) . Subsequently, these statements were presented to the respondents to score on a 7-point Likert scale (−3, −2, −1, 0, 1, 2, 3), whereas − 3 means complete disagreement and + 3 for complete agreement. To increase the participation of stakeholders and to prevent misunderstandings, the Q statements were initially written in English and then translated to Sinhala and Tamil Languages (following e.g., Converse and Presser, 1986; Loyau and Schmeller, 2017;

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[2] Grey literature: information that is available outside of traditional publishing and distribution channels
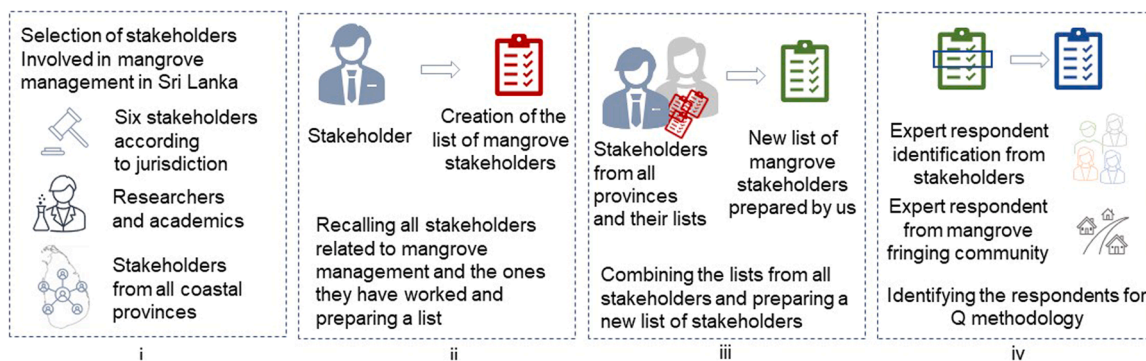
Fig. 2. Initially we selected stakeholders according to the mangrove management Jurisdiction of Sri Lanka (Appendix 1) and interviewed respondents who were involved in mangrove management as instructed by the stakeholder and asked them to recall possible mangrove management stakeholders according to their experience (red list). Once they listed the stakeholders with whom they are working/worked together regarding mangrove management, we prepared a list of possible mangrove management stakeholders (green list) by combining their answers. Then the mangrove management experts were identified for Q methodology (blue list) according to the instruction by the stakeholders followed by interviewing them regarding their mangrove-related work in Sri Lanka.

Table 2

Mangrove management stakeholder groups of Q participants and the number of participants for each stakeholder group in five coastal provinces of Sri Lanka.

Stakeholder Group	Number of participants
Army, Navy, Special Task Force	2
Central Environmental Authority	9
Coast Conservation and coastal resource management Department	2
Department of Fisheries and Aquatic Resources	3
Department of Wildlife Conservation	3
Development agencies	2
Expert Fisherman	4
Forest Department	3
Irrigation Department	2
Land Commission	1
Land use and Policy Planning Department	2
Mahaweli Authority of Sri Lanka	2
Marine Environment Protection Authority	5
National Aquaculture Development Authority of Sri Lanka	2
National Aquatic Resource and Development Agency	2
Non-Governmental Organizations	6
Private enterprise	2
Provincial Social Service Department	4
Road Development Authority	2
Sri Lanka Tourism Development Authority	2
University (academia and researchers)	11

Martínez-Espinosa et al., 2020).

2.3.3. Conducting the interviews

Due to the COVID 19-pandemic, all respondents were asked through telephone calls whether they like to participate in an online Q interview using adapted software (q-assessor). But 90% preferred to have a hard copy of the questionnaire instead of using the software. Therefore, it was made sure that the respondents were provided with a hard copy of the ranking grid and Q set (Fig. 3). The interviews were pilot tested with university students in Sinhala and Tamil and with a selection of community members (Village Council, Fisherman). These pilot tests were used to make sure that the message in each statement was clearly understood and aimed to minimize the errors in translation. The respondents were asked to choose their preferred language (English, Tamil or Sinhala) to conduct the interviews.

Stakeholders were requested to fill each position on the ranking grid and were instructed to fill the whole Q grid through a forced distribution. Stakeholders were given time to rethink their arrangement of statements on the grid and they were given the opportunity to make changes and were asked to fill the whole grid (emphasizing that each box on the grid could be filled once). After ranking the statements in the ranking grid, a post-sorting interview was carried out during which the stakeholders were asked to explain their views on each statement. More emphasis was given to the statements from two extreme ends of the ranking grid (+3 and −3).

3. Data analysis

The Q-sorts[3] gathered were separately inserted in PQMethod software (Hugé et al., 2016; Schmolck, 2014) for each province and analysed in R, through the 'qmethod' package (v1.8; Zabala, 2014). After that a correlation matrix was generated, using Pearson coefficient. Multivariate analysis for factor extraction was performed using Principal Component Analysis (PCA), with the extraction of three factors (eigenvalues >3.95, 46.84% of the variance explained). Factor rotation was performed with varimax rotation including the three factors extracted, and automatic flagging was performed on the outcome. Q-sorts with significant factor loading[4] (p-value <0.05) were attributed to the three factors according to their loadings, which represent significant correlation coefficients of the participant with one of the factor (Zabala et al., 2018). Z-scores were calculated and plotted to compare opinions and consensus about each statement in the different factors (Hugé et al., 2016; Zabala, 2014). A crib sheet was created in R to identify statements that were given the highest and the lowest values (+3 and − 3) for each factor and to determine the main differences among factors. A crib sheet was created in Rstudio, which results in the identification of the differences among factors, including a significant highest and lowest rated statement for each factor, and for each factor the statements that received higher (or lower) value compared to the other two factors. The process that led to the elaboration of the cluster of perspectives is largely based on factor interpretation, performed using results from the crib sheet, factor rounded scores and z-score values (Zabala et al., 2018). Finally, three clusters of participants' perspectives corresponding to the three factors were identified. Additional qualitative information from the post sorting interview were included at this stage to further validate the disciursesespecially for significant Q-sort loadings (Hugé et al., 2016)

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[3] Q sort: Each respondent's rank-ordered set of perceptions.

[4] Factor loading: Each respondent's correlation with each of the identified clusters or factors.

Table 3

Flagged Q-sorts: asterisks identify q-sorts with significant loading (p < 0.05) to one of the three factors (Q respondents are listed in column one, using this code: EP: Eastern Province, NWP: North-Western Province, SP: Southern Province, WP: Western Province, NP; Northern Province). Significant loadings represent the participants that are grouped together in one of the three clusters (factors), allowing the identification of participants that can be significantly attributed to one of the three perspectives emerging by the three factors.

	Factor_1	Factor_2	Factor_3
EP_1	-0.02	* 0.48	0.33
EP_2	0.19	* 0.69	0.26
EP_3	0.15	* 0.63	0.13
EP_4	-0.14	0.37	* 0.63
EP_5	* 0.51	0.2	0.28
EP_6	* 0.52	0.25	0.34
EP_7	0.17	* 0.8	0.13
EP_8	0.26	* 0.67	0.27
EP_9	-0.02	* 0.8	0.03
EP_10	0.21	* 0.55	0.43
EP_11	0.18	* 0.74	0.21
EP_12	* 0.5	0.13	0.17
EP_13	* 0.63	0.01	0.4
NWP_1	* 0.63	0.01	0.4
NWP_2	-0.03	0.43	* 0.53
NWP_3	0.18	* 0.75	0.07
NWP_4	-0.16	* 0.4	0.32
NWP_5	0.23	* 0.72	0.2
NWP_6	0.21	* 0.54	0.38
NWP_7	0.03	* 0.53	0.27
NWP_8	0.34	* 0.71	0.03
NWP_9	0.2	0.43	* 0.51
NWP_10	0.29	* 0.56	0.24
NWP_11	-0.02	* 0.42	0.11
NWP_12	* 0.62	0.25	-0.01
NWP_13	0.23	0.17	* 0.49
SP_1	* 0.57	-0.05	0.3
SP_2	0.15	* 0.49	0.06
SP_3	0.21	-0.1	-0.25
SP_4	0.23	* 0.58	0.06
SP_5	* 0.55	0.03	0.13
SP_6	* 0.43	0.3	-0.15
SP_7	* 0.47	0.02	-0.21
SP_8	* 0.76	0.32	0.11
SP_9	* 0.56	0.21	0.19
SP_10	* 0.47	0.16	0.22
SP_11	* 0.59	0.47	-0.08
SP_12	0.39	0.42	0.34
WP_1	* 0.62	-0.04	0.44
WP_2	0.25	* 0.74	0.04
WP_3	* 0.5	0.14	0.36
WP_4	* 0.64	0.21	0.13
WP_5	* 0.78	0.23	0.15
WP_6	* 0.83	0.23	0.12
WP_7	* 0.68	0.19	0.25
WP_8	* 0.65	0.08	0.15
WP_9	* 0.52	0.44	0.03
WP_10	* 0.57	0.11	0.14
WP_11	* 0.61	0.08	0.21
WP_12	* 0.63	0.21	0.13
WP_13	0.34	0.38	0.34
NP_1	0.31	* 0.51	0.2
NP_2	0.26	0.51	* 0.64
NP_3	0.11	0.23	* 0.67
NP_4	* −0.47	-0.43	-0.15
NP_5	0.18	0.17	* 0.6
NP_6	-0.19	* −0.39	-0.05
NP_7	0.3	0.23	* 0.51
NP_8	0.13	0.11	* 0.69
NP_9	0.1	* 0.42	0.32
NP_10	-0.06	* −0.76	0.09
NP_11	0.35	0.11	* 0.63
NP_12	* 0.68	0.43	0.23
NP_13	* 0.76	0.06	0.09
NP_14	* 0.55	0.17	0.46
NP_15	0.34	0.22	* 0.62
NP_16	0.28	-0.11	* 0.54
NP_17	0.25	-0.06	* 0.57

Table 3 (*continued*)

	Factor_1	Factor_2	Factor_3
NP_18	0.36	0.28	* 0.49
NP_19	0.21	0.2	* 0.55
NP_20	0.21	0.09	* 0.72
NP_21	* 0.61	0.36	0.28

4. Results

4.1. Factor analysis

Factor analysis allows, through correlation coefficients, to find similarities of perspective among participants, which can be grouped in a certain number of clusters according to the number of factors included in the analysis (Walker et al., 2018). 72 Q-sorts were entered and 46.84% of the total variance was explained using a three-factor analysis. In this case, analysis at 3 factors was preferred because of the low number of loadings in the 4-factor analysis compared to the 3-factor analysis. Moreover, the difference in explained variance between the two analyses is only 5% (52% explained variance in the 4- factor analysis). Participants who significantly attributed to one of the three discourses[5] emerging from three factors can be identified (Table 3) along with the weighted average scores for each statement (Table 4). The correlation between two factors can be explained through Z-scores (Table 5).

4.2. From factor analysis to discourses

Three statistical factors were identified using factor analysis in our study (Table 5). Factor analysis enables us to distinguish variability among observed, correlated factors (Reyment and Jvreskog, 1996). Thus, the factors identified in the Q-methodology reflect the core findings of the study. Even though there are possibilities to identify as many factors as possible (with an infinite number of possibilities), a low number of factors are generally preferred based on the researchers' objectives to identify a limited, manageable number of clusters of similar opinions (discourses) among participants. (Sneegas et al., 2021). These discourses are developed for each factor after recognizing the patterns in the factors through factor loadings (Table 4) and factor scores (Table 5) and the qualitative data from post-sorting interviews. Significantly differing Q statements were also taken into consideration while developing the discourses (Arumugam et al., 2021). In our study, three statistical factors were developed into three narrative discourses: community-oriented, government-oriented, and synergy between government and communities for effective mangrove conservation.

4.2.1. Discourse 1: "community oriented mangrove management" – communities as an integral part of mangrove conservation

According to the perspective drawn from factor 1, communities are considered essential for a positive outcome of mangrove conservation projects (S13), especially when women are involved (S14). According to the stakeholders from the Eastern Province "*without coastal communities we cannot conserve mangroves, because they are the stakeholders who are always associated with mangroves*". This perspective strongly states that local communities have interests in protecting mangroves that go beyond the mere use of mangrove goods and services (S12), and, in return, mangrove restoration programmes should contribute to enhancing the livelihood of local populations (S10). "*Our ecosystems will be disturbed when we don't consider the mangrove forests*" one of the stakeholders insisted. Further, restoration programmes should consider

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[5] Discourse: An individual and subjective "way of seeing and talking about something" Discourses delineate how an aspect of interest is viewed (by an individual/ group in a specific circumstance at a specific time) (Barry and Proops, 1999).

Table 4

Factor scores: Rounded scores attributed to each statement (sta_N) for each factor. The values represent "the weighted average scores for each statement" given by the participants that are significantly attributed to each factor (Zabala, 2014).

Q Statement	Statement number	Factor_1	Factor_2	Factor_3
New development plans should consider the potential encroachment and logging impacts on mangrove forests	sta_1	3	3	1
Forest managers and policymakers should use scientific information in mangrove conservation efforts	sta_2	3	3	1
The government must take efforts (to implement or make amendments) to strengthen current policies before establishing new ones	sta_3	1	3	2
The government should restructure property rights regimes to protect mangrove ecosystems and resources	sta_4	0	2	1
Hundred-meter buffer zone establishment (after the tsunami in 2004) has had negative effects on the land ownership of poor people in mangrove areas	sta_5	0	-2	-1
Degraded mangroves should be converted to residential, commercial, industrial, and agricultural real estate by landfilling	sta_6	-3	-3	-3
Degraded mangroves should be restored to their previous state	sta_7	2	3	2
Overlap of responsibilities and legislation in marine protected areas leads to confusion among both resource users and authorities	sta_8	2	2	-1
All mangroves should be owned by the government	sta_9	-3	2	-2
Mangrove restoration programs should help to support the livelihoods of villagers	sta_10	3	0	3
Institutional coordination and policy enforcement for mangrove conservation is at a satisfactory level (*Altered to give the opposite meaning*)	sta_11	-3	-2	-3
Coastal communities only care about the existence of mangroves as long as they get goods and services from mangroves	sta_12	-3	1	0
Mangrove conservation will not work without the active participation of local communities	sta_13	2	1	2
Mangrove replantation projects show progress when women from the local community are involved	sta_14	3	0	0
Media campaigns play an important role in shaping stakeholders' perspectives on mangrove conservation	sta_15	-1	2	-1
Local communities have, by their efforts alone, have little prospect of improving mangrove management	sta_16	0	0	0

Table 4 (*continued*)

Q Statement	Statement number	Factor_1	Factor_2	Factor_3
Local communities will actively destroy the forests when a sudden ban is enforced	sta_17	0	-1	-2
Incorrect choice of mangrove species is the major reason for failure in restoration	sta_18	2	0	-1
Lack of post-care is the major reason for failure in mangrove restoration	sta_19	1	1	0
There is a lack of evidence on the positive and negative aspects of mangrove planting, as currently practiced in Sri Lanka	sta_20	1	0	0
Information about aesthetic values is poorly documented in Sri Lankan mangroves	sta_21	2	-1	-1
Mangrove conservation should be introduced more at primary and secondary school levels	sta_22	0	2	3
Ecotourism should be integrated with mangrove restoration	sta_23	1	1	1
Mangrove restoration projects are abandoned once the grant/loan is over	sta_24	1	0	2
The post-monitoring process is adequately carried out in mangrove restoration projects	sta_25	-2	-3	-2
Ban on mangrove forest access for local communities prevents the passage of traditional knowledge to the next generations.	Sta_26	1	-1	2
Mangrove areas should be protected because of their inherent value (valuable apart from their usefulness)	sta_27	0	0	3
There is no real need for mangrove restoration in most lagoons and estuaries.	Sta_28	-2	-3	-3
The most appropriate and urgent mangrove management interventions are conservation and management, as opposed to planting propagules and seedlings.	Sta_29	-1	1	0
Natural regeneration should be allowed than planting mangroves	sta_30	-1	-2	0
Newly planted mangrove areas are highly regarded by local people as having successfully contributed to increasing their fish catches	sta_31	-1	-1	1
Mangrove planting for livelihoods development results in diminished fish habitats	sta_32	-2	-3	-3
Mangroves should be protected because they provide shelter and feeding grounds for different aquatic entities	sta_33	0	1	3
Sea-level rise increases inland colonization of mangroves	sta_34	-2	-1	-2
Abandoned shrimp farms can regenerate and become natural mangroves	sta_35	-2	-2	-2
The current mangrove area in Sri Lanka is too limited to function as bio shields against tsunamis and storms	sta_36	-1	-1	1

Table 4 (*continued*)

Q Statement	Statement number	Factor_1	Factor_2	Factor_3
Fear of big waves is no reason to plant mangroves	sta_37	-1	-2	-1

Table 5

Factor Z-scores correlation, variance explained (%), number of Q-sorts loading with p < 0.05, and eigenvalues of each factor. Z-scores represent the correlation between two factors, for all possible combination of factors. "*The number of loading Q-sorts and the explained variance … are approximate indicators of the strength of each perspective and of the proportion of the opinions they explain*" (Zabala, 2014). Finally, eigenvalues are reported in factor analysis for helping in the decision of the number of factors included in the analysis (in larger Q datasets these values could be inflated, therefore eigenvalues are not the only determining aspects) (Herrington and Coogan, 2011).

Z scores	Factor 1	Factor 2	Factor 3	Variance Explained	Loading Q sorts	Eigenvalues
Factor 1	1.00	0.53	0.56	18.20%	30	13.10
Factor 2		1.00	0.53	16.55%	23	11.91
Factor 3			1.00	12.09%	16	8.70

the risk of encroachment and follow scientific advice (S1, S2). "*As much as possible… we need to restore the mangroves according to suitable places*" states a stakeholder from the Northern Province (NP_12). Regarding mangrove management, the supporters of discourse 1 state that government should not own all mangrove forests (S9). "*They (the government) cannot afford to conserve all mangroves for sure… with the current economic situation*" a stakeholder stated. Current jurisdiction and responsibilities over mangrove forests and marine protected areas are considered confusing and unsatisfactory (S8, S11) per this perspective. The selection of unsuitable mangrove species is considered the main cause of the failure of mangrove restoration projects (S18), and sea level rise is not considered a driver of inland colonisation of mangroves (S34). "*A lesson is learned after a failed mangrove restoration project. It's a waste of time effort and a lot of money. We need to figure out the correct species before planting*" a frustrated stakeholder emphasized. Finally, the supporters of factor 1 state that there is not enough documentation about the aesthetic values of mangroves (S21). "*We cannot prove to anyone that we enjoyed our lives with mangroves, we love our mangroves, but no one knows*" a community stakeholder from the Eastern province explained.

4.2.2. Discourse 2: "Government Oriented mangrove management" – Government as the primary responsible entity for improving mangrove conservation

According to factor 2's perspective, mangroves should be entirely owned by the government (S9), but the overlapping scope of current policies with respect to marine protected areas and mangrove conservation is considered confusing for authorities and private enterprises (S8, S11). "*There is no proper coordination among the departments, so the open panel discussion is needed among departments*" states a stakeholder from the Eastern Province (EP_2). Indeed, the government should strengthen current policies over mangrove forests (S3) "*it will take time to implement and approve through the government bodies, so it is better to strengthen the current policies*" states a stakeholder from the Western Province, WP_2), and restructure property right regimes for better mangrove conservation (S4). After the Indian Ocean Tsunami in 2004, hundred meters of the coastal belt were declared as buffer zones. These buffer zones are "*no build zones*" where construction is prohibited. But the government has the authority to provide special permissions to certain development activities within the aforementioned buffer zone (Hyndman, 2007). The hundred-meter buffer zone established after the Indian Ocean tsunami in 2004 is not considered harmful to local communities (S5). "*Coastal communities are okay with the buffer zones. They know that these buffer zones can one day protect them from disasters*" a government stakeholder who witnessed the tsunami in 2004 recalls. The importance of considering the risk of encroachment or logging in case of new development plans is emphasised (S1), as well as the importance of seeking scientific advice on mangrove conservation plans (S2).
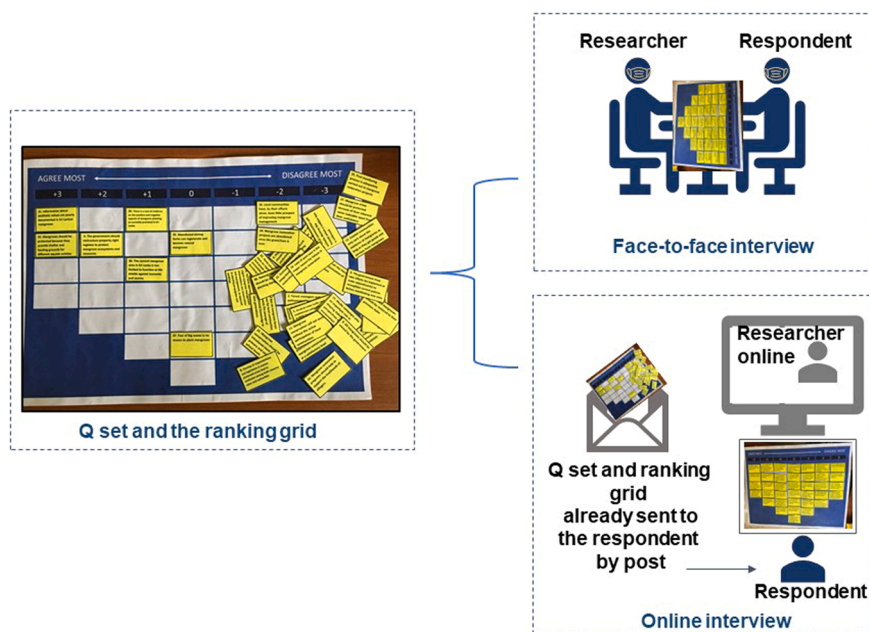
Fig. 3. Q set, and the ranking grid were taken to the respondent in person (face-to-face interview while respecting COVID-19 distancing measures and wearing face masks) or posted (mailed) when there were lockdown situations with travel bans among districts. The respondents notified the researcher after getting their hard copies by post. Following that, an online interview was arranged where the respondent manually arranged the statements in the ranking grid in the online presence of the researcher. As a final method, a Word document containing the grid and Q statements was sent through email and the stakeholders were guided through telephone call instructions on how to fill the ranking grid.

Moreover, mangrove awareness should be introduced starting from primary school (S22). Additionally, media campaigns are considered important drivers for mangrove conservation (S15). A participant from the Eastern Province (EP_1) supports this point stating that *"In Sri Lanka nowadays media especially TV and Radio can change and manipulate many things"*. Regarding mangrove restoration, natural regeneration of mangroves is considered less effective than replanting (S30), which is not believed to impact the marine fauna (S32), and shoreline protection from large waves can be a valid argument for mangrove replanting (S37).

4.2.3. Discourse 3: "synergy between government and communities for effective mangrove conservation"

Factor 3 is associated with arguments directed at the crucial role that mangroves play for the health of the environment and for society, hence at the importance to restore mangroves to their initial state, following scientific advice (S2). According to this perspective, mangroves are at risk of encroachment when new development plans arise (S1). *"Mangroves should be restored rather than prioritizing landfilling and to decrease the shoreline erosion, we have to restore mangroves"* states a respondent from the Eastern Province (EP_4). Mangroves should be protected because of their inherent value (S27), and for the habitat protection that they provide to aquatic fauna (S33). *"Mangroves are there for hundreds of years may be more than that, who are we to destroy them"* a community stakeholder from Eastern Province states. Incorrect mangrove species used in replanting projects are considered one of the main causes of failure (S18), followed by abandonment at the end of a project grant (S24). *"All these so-called mangrove specialists are vanished after some time… when they don't have money. Some restored areas are even worse than before"* an academic stakeholder emphasized. Government and communities (S13) are both considered crucial for successful mangrove conservation and restoration. Therefore, even though governmental ownership of mangrove areas is not considered ideal (S9), the government is considered responsible for strengthening current mangrove-related policies (S3); on the other hand, local communities should be introduced to mangrove awareness early in school (S22), and mangrove restoration programmes should contribute to enhancing the livelihood of the local population (S10). *"When the Government plans restoration programs, then they need to look into improving the economic status of poor people and poor people should also support the government by conserving mangroves"* a stakeholder from the North-western Province emphasized. In the case of bans on mangrove forest access, communities are not considered harmful (S17), although this ban would prevent the passage of traditional knowledge to subsequent generations (S26).

4.2.4. Consensus among discourses

The consensus among factors was reached for a range of different topics. The supporters of the various statements collectively disagree on satisfaction regarding *"co-ordination and policy enforcement for mangrove conservation"* and disagree on turning degraded mangroves areas into commercial or industrial areas and agree that these sites be restored to their initial state with the possibility that abandoned shrimp farms are also converted to mangrove areas. Moreover, the Q-sorts of the different factors reveal a common need for mangrove restoration projects in lagoons and estuaries and show agreement regarding the fact that replanting with the goal of development to support livelihoods is not considered harmful for the aquatic fauna. Finally, an agreement among discourses was also achieved regarding the unsatisfactory post-planting process of restoration projects.

5. Discussion

Our results emphasize that mangrove management in Sri Lanka is viewed from diverse perspectives by stakeholders. Apart from conservation rules by the government, community-based mangrove management with government involvement can be ideal in the Sri Lankan context.

5.1. Improving coastal community stewardship in mangrove management

Coastal communities near mangrove ecosystems do not have any formal rights over mangrove forests in Sri Lanka. Except for the small proportion of private lands with legal agreements, mangrove forests are government property, where land tenure rights cannot be acquired by coastal communities. Communities who depend on mangroves do not see local mangrove forest management by the government as an opportunity for their economic development. Mangrove management stakeholders in our study perceive communities as an essential component of positive outcomes from mangrove management projects, particularly when women are also involved. But in reality, without formal rights, communities involved in mangrove-related trades (e.g., roadside *Sonneratia* spp. juice sellers) and artisanal fishers are unable to connect to the value and supply chains[6] required to improve their economic status. Encroaching mangrove areas is considered a *"punishable offense"* according to the mangrove management jurisdictions of Sri Lanka (Nijamdeen et al., 2022; Wijayadasa and Ailapperuma, 2014). At the same time, field observations in coastal provinces of Sri Lanka show that industrial shrimp farms are extending to mangrove forests, which further restricts adjacent communities from accessing mangroves. However, the expansion of shrimp farms has gradually reduced from 2006 to 2020 and was accompanied by an increase in mangrove cover in North-western Sri Lanka (Ofori et al., 2022). The majority of shrimp farms in the country were established in North-western Sri Lanka in the early 1970 s, which was a threat to the livelihoods of impoverished coastal communities and artisanal fishers (Ofori et al., 2022). Abandoned shrimp farms can potentially be recolonized with mangroves within 5–10 years, provided that sufficient recruitment of mangrove propagules and the hydrological condition of the area is restored (Di Nitto et al., 2013). Shrimp farms in our study areas were usually privately or individually owned (Galappaththi and Berkes, 2014; Dahdouh-Guebas et al., 2002). Coastal communities will not have the possibility to use mangroves from recolonized abandoned shrimp farms, as long as the shrimp farm ownership remains with the original (private or individual) owners or the government. Even though communities consider mangroves as an important part of their overall well-being, there is no sufficient information in Sri Lanka regarding the aesthetic or ethnobiological value of mangroves. There are no legal agreements practiced by Sri Lankan mangrove management to integrate the coastal communities, the communities' values, and well-being (Nijamdeen et al., 2022). However, there are successful community-based mangrove management initiatives in some parts of the country, undertaken with the aid of international non-governmental organizations and government institutes (SLMCP, 2015). A lack of sufficient funding is one of the most common causes to halt mangrove management projects halfway through their completion (Kodikara et al., 2017). Inspirations from successful community-based mangrove management can be adapted to Sri Lankan mangrove management from other countries around the world. For example, *"Custody Agreements in favor of ancestral communities and traditional users"* is practiced by the Ecuadorian government, where the government gives communities living closer to mangroves permission to access mangrove forests and provides these communities financial support and continuous monitoring by the government. These custody agreements are initially activated for 10 years and then updated and renewed upon demonstration of progress. Mangrove areas under these custody agreements (40% of the total mangrove area of Ecuador) have increased threefold for 20 years (1998 −2018) of mangrove forest

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[6] Supply chain: A system and resources needed to move a product or service from supplier to customer. Value chain: Value is added along the supply chain. These values include products services and external and internal stakeholders (McCormick and Schmitz, 2001).

management in Ecuador (Félix and Hurtado, 2019). Such mangrove management agreements with coastal communities could be ideal to incorporate into Sri Lankan mangrove legislation along with continuous monitoring by the government and private stakeholders.

In our study, 85% of the participants from the Western Province significantly load to the first factor or the *"community-oriented"* factor. The governance of the Western Province consists of head offices and ministries of government departments. All district and provincial-level departments are administered by the Western Province. This gives the impression that Western Province stakeholders have a positive impression of community involvement and favor community-oriented mangrove management compared to stakeholders of other provinces. Western Province stakeholders seem to have greater opportunities to translate ideas regarding the inclusion of coastal communities in mangrove management during stakeholder meetings for policy reforms than stakeholders from other provinces. *"They (stakeholders from Western Province) comparatively have higher authority in mangrove management than stakeholders in other provinces, all the head offices, and higher-ranking officers are from Colombo (Western Province)"* a government stakeholder for the Northern Province emphasized. Hence, community-oriented mangrove conservation can be given priority in mangrove project planning initiatives from the Western Province.

5.2. Mangrove management as an integral part of the government's conservation priorities

When mangroves are managed through a top-down approach, management is implemented through higher political authorities via bureaucrats and communicated to the lower levels. This top-down mangrove governance approach is practiced in most countries in the world (Golebie et al., 2021). Even though the liability for top-down mangrove governance is higher, there is still a possibility of poor enforcement of mangrove management regulations (Ahsan et al., 2017; Satyanarayana et al., 2012). Moreover, top-down governance systems are *"highly dependent upon the level of the overall prosperity of the national economy and public wellbeing"* (Barau and Stringer, 2015: 172). With the current economic status in Sri Lanka, it is questionable whether top-down governmental mangrove management can be successful. In line with Jones et al., (2015) mangrove management rules are difficult to enforce without external enforcement capacities (Jones et al., 2015). According to factor 2′s perspectives, mangroves need to be fully owned by the government but with restructured property rights and strengthened conservation laws. In our study, mangrove management is perceived to lead to potential conflict due to overlapping policies. For example, the Forest Department and the Department of Coast Conservation & Coastal Resource Management have overlapping policies over mangroves in coastal zones. In such situations "*no one will take the responsibility of conserving mangroves, assuming that the other departments will do the conservation*" (Government stakeholder). New mangrove management plans and replanting initiatives are welcomed by stakeholders, but only with sufficient emphasis on mitigating encroachment and logging while considering scientific input. Studies show that one of the major reasons for the failure of mangrove restoration projects in Sri Lanka is the lack of scientific input (Kodikara et al., 2017). Out of all provinces, 62% of the stakeholders of the Eastern Province load to the second factor, which is the *"government-oriented"* factor. The Indian Ocean Tsunami in 2004, twenty years of civil war lasting until 2009, and war-related migrations have had considerable changes to MSES in the Eastern Province (Dahdouh-Guebas et al., 2021). Stakeholders in the Eastern Province seem to expect the government to intervene and resolve existing mangrove conservation challenges.

5.3. Setting conservation priorities for mangrove management

Conservation of mangrove ecosystems needs to be prioritized regardless of who owns mangroves. It does not necessarily need to be the government who has legal authority over mangroves for successful conservation. Mangrove management regulations in Sri Lanka need to be flexible enough to integrate the coastal communities in decision-making. The authority over mangroves can be shared with ancestral communities who have lived close to mangroves for generations. These communities living close to mangroves will have an opportunity to improve their well-being while sustainably utilizing resources. When conservation is considered the main focus, then there is a high probability that the relationships between communities will improve leading to a collective responsibility toward nature (Pérez-Orellana et al., 2019). Awareness regarding the importance of mangroves and mangrove forest degradation is lacking in Sri Lanka (Kodikara et al., 2017). Education systems in Sri Lanka can introduce mangrove conservation in primary schools as part of nature conservation education. Moreover, as recommended by Thompson and Rog (2019) charismatic flagship species (i.e., monkeys, turtles, crocodiles etc.,) can be used to generate awareness, secure funding, and utilize existing policies for mangrove conservation. *"No entry"* rules in Sri Lanka prevent the communities from entering mangrove forests (Nijamdeen et al., 2022) thus preventing the passage of traditional knowledge. However, mangrove management stakeholders in our study still emphasise that traditional knowledge necessary for conserving mangroves is often not transferred to younger generations due to changing conservation measures. *"Some of our routes used to collect plant materials to make medicines through mangrove forests are suddenly restricted by the government. We just collect a few leaves…"* a fisherwoman (Community stakeholder) from the Eastern Province recalled. Apart from the goods and services provided by mangroves, these ecosystems need to be protected for their inherent value (Velde et al., 2019). In our study, about 57% of the stakeholders in the Northern Province significantly load to the third factor. Mangroves are one of the major types of forest ecosystems in the Northern Province. After the end of the civil war in 2009, the Northern Province stakeholders have started to give priority to conserving the remaining mangrove forests as part of war recovery (Nijamdeen et al., 2022).

5.4. Policy recommendations and co-management of mangroves with local communities

Mangroves in Sri Lanka are managed by multiple stakeholders and an array of policies that mostly address the definitions of boundaries of mangrove ecosystems and conservation options (Nijamdeen et al., 2022). Mangrove forests were classified as *"marginal lands"* until 1995 and were administered by District and Divisional secretaries (IUCN, 2017). It is still unclear how communities who depend on mangroves might have reacted when the mangrove management shifted from District and Divisional Secretaries to the Ministries and their respective departments after 1995. However, from 2020 onwards, all mangroves in Sri Lanka are given a conservation status regardless of land tenure. Thus, Sri Lanka became the first country in the world to conserve all of its mangroves by jurisdiction (Wickramasinghe et al., 2022). There are several overlapping mangrove conservation policies in Sri Lanka still in practice. Nevertheless, the incorporation of stakeholder perceptions appears to be missing in mangrove management policy reforms. Through our study, three discourses were delineated. Discourses simply show *"the way a particular individual, in particular circumstances and at a particular time, relates to, and forms conceptions of, certain aspects of the world"* (Barry and Proops, 1999, P. 338). Perceptions of mangrove management expert stakeholders in all five coastal provinces give us the overall view that mangroves need to be co-managed by both the government and community, all while prioritizing conservation. We recommend that suitable incentive frameworks need to be included in mangrove management policies to benefit those coastal communities involved in mangrove replantation or conservation. Stakeholders of our study do not consider *"conserving all mangroves under the jurisdiction"* (Wickramasinghe et al., 2022) by the government as a comprehensive policy. Consequently, prime questions surrounding mangrove

conservation remain ambiguous: How will mangroves be conserved? Who will undertake the conservation and funding? How can mangroves be co-managed with communities? Moreover, mangroves support impoverished coastal communities that live under the poverty line in Sri Lanka. Therefore, mangrove ecosystems can also be a means of poverty alleviation when coupled with food security programs.

Successful mangrove conservation, in protected areas and restoration sites, needs constant monitoring and care. Poor governance of mangrove-protected areas (Nijamdeen et al., 2022) and unsatisfactory post-restoration monitoring (Kodikara et al., 2017) are major drawbacks to mangrove management in Sri Lanka. These limitations, as a direct result of the traditional top-down approach can be overcome through co-management between governmental agencies, non-governmental organizations, and local communities. Co-management involves integrated governance and decision-making implemented collectively by state authorities and local stakeholders (Berkes, 2010). Even though the MSES of Sri Lanka comprises diverse stakeholders (Dahdouh-Guebas et al., 2021), the management of mangroves is highly centralized within the Governmental sector (Nijamdeen et al., 2022). Such top-down governance in mangrove management leads to decision-making at the expense of local communities'livelihoods (Aziz et al., 2016). For instance, limited subsistence for mangrove users due to blanket bans (Glaser et al., 2003) and displacement of the local community for restoring mangroves (Cormier-Salem et al., 2016). "Discourse 3″ from our study emphasize the importance of finding a middle ground between government ownership of mangroves and community stewardship. This offers an opportunity to explore the potential for co-management of mangroves in both protected areas and restoration sites in Sri Lanka. Co-management with the localized stakeholders could minimize the burden off the current economically challenged Government in Sri Lanka. Involving local governance could lead to localized decisions such as local mangrove resource management rules and restriction of resource access for outsiders (Akamani and Hall, 2019). This would enable constant monitoring of mangrove forests. Furthermore, establishing a legitimized co-management framework will enable active community participation allowing effective management and in turn sustained access to mangroves (Daw et al., 2011). However, co-management risks favoring dominant local actors resulting in a shift in inequalities rather than their reduction (Ward et al., 2018).

Hence co-management should be carefully incorporated and sensitively managed at different scales. Finally, even though co-management offers an integrated governance system, it may not be appealing to the local community especially if they lack trust in the governance (Golebie et al., 2021). This could be a possibility in Sri Lanka in light of the current political instability and people's dissent over the Government. Therefore, opportunities for co-management could be considered at the provincial or district level based on the local stakeholders' interests.

6. Reflections and future directions

Mangrove management in Sri Lanka has always been challenging due to numerous natural (e.g., the 2004 tsunami), anthropogenic (coastal pollution), and socio-economic situations. A Top-down approach to mangrove management has been followed until the present, where communities or expert stakeholders have little to no avenue to share their perceptions regarding mangrove management in Sri Lanka. Through our study, we understand that the perceptions of expert stakeholders vary regarding mangrove management while there is an urgent need to incorporate diverse stakeholder views. It is important to build flexibility into the mangrove management policies in Sri Lanka from the outset, where the communities and stakeholders can share their ideas and involve in the co-management of mangroves. Future mangrove management projects should aim to build knowledge and experience of expert stakeholders and communities and should promote collaboration between practitioners and scientists. Such mangrove

conservation efforts would be sustainable in the long run in Sri Lanka and beyond.

The co-management approach represents a shift from the traditional custodial system to a more inclusive and participatory management framework (Berkes, 2009). Friess et al. (2016) emphasize the existence of community and government co-management in Southeast Asian mangrove management regimes, yet achieving effective co-management remains in its early stages, requiring the reconciliation of diverse stakeholders and the resolution of conflicting policy objectives. Another critical facet of mangrove co-management in Southeast Asia involves the potential for private-sector initiatives to play a protective role in mangrove conservation, employing both established and innovative approaches to address degradation and potential threats (Friess et al., 2016). Additionally, the concept of payments for ecosystem services gains prominence in the context of mangrove conservation, especially with the growing attention toward blue carbon (Ren et al., 2023). It is important to note that funding agencies often possess economic, political, and strategic interests in the countries they support, offering the developing world valuable opportunities for ecosystem-based funding (Rahman et al., 2021), which can be obtained for the blue carbon trade by developing countries. Numerous studies conducted worldwide, with notable examples from countries closer to Sri Lanka such as Bangladesh (Begum et al., 2021; Khan et al., 2020; Mollick et al., 2022; Rahman, 2022), India (DasGupta and Shaw, 2014), Pakistan (Beresnev et al., 2016), and the Maldives (Macintosh et al., 2011), highlight the significance of strengthening co-management frameworks within the existing mangrove management systems and policies of their respective countries

Mangrove management is inherently intricate, given the valuable goods and services these ecosystems provide and their global conservation significance. Embracing a diverse conservation ethic, which acknowledges both intrinsic and instrumental values of nature, promotes the inclusion of underrepresented perspectives, and emphasizes rigorous, evidence-based assessments of conservation endeavors (Tallis and Lubchenco, 2014), is essential. Mangrove management faces varying social, political, and economic dynamics worldwide. Sustainable management in one country can be enabled by local sociopolitical conditions or stakeholder perceptions, whereas similar situations with contrasting economic contexts in other countries may lead to mangrove destruction. The outcomes of identical mangrove management strategies can yield divergent results. Therefore, an initial step in crafting sustainable mangrove plans is comprehending the legitimacy, customary rules, and the needs of communities and stakeholders. Furthermore, understanding the discourse among diverse stakeholders lays the foundation for the development of more actionable policies for effective mangrove management.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

Data will be made available on request.

Appendix 1. Jurisdictions related to mangrove management in Sri Lanka.

Mangrove management jurisdiction in Sri Lanka

DEPARTMENT	JURISDICTION FOR MANGROVE CONSERVATION
Forest Department (DF)	Forest (Amendment) Act, No. 65 of 2009
Department of Coast Conservation and Coastal Resource Management (CC)	Coast Conservation Act, No. 57 of 1981
Department of Wildlife Conservation (DW)	Fauna and Flora Protection Ordinance (FFPO) (Amendment) Act, No. 22 of 2009
The Department of Fisheries and Aquatic Resources (FA)	Fisheries and Aquatic Resources Act of 1996
Marine Environment Protection Authority (MP)	The Marine Pollution Prevention Act, No. 35 of 2008
Central Environmental Authority (CE)	National Environmental Act of 1980 (No. 47 of 1980) Part II 10b

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