



Rapid ecosystem services assessment to support integrated coastal zone management mangroves management plan in Solomon Islands

Hyun-Ah Choi^{1,2}, Cholho Song², Chul-Hee Lim³, Sangin Kang⁴, Mary Tahu Paia^{5*} and Donguk Han^{6*}

¹Hanns Seidel Foundation Korea, Seoul 04419, Republic of Korea

²Ojeong Eco-Resilience Institute, Korea University, Seoul 02841, Republic of Korea

³Department of Forestry, Environment and Systems, Kookmin University, Seoul 02707, Republic of Korea

⁴Korea Environment Institute, Sejong 30147, Republic of Korea

⁵Faculty of Agriculture, Fisheries and Forestry, Solomon Islands National University, R113, Honiara R113, Solomon Islands

⁶PGA Eco and Bio Diversity Institute, ECO Korea, Goyang 10449, Republic of Korea

ARTICLE INFO

Received August 5, 2024

Revised December 18, 2024

Accepted February 24, 2025

Published on March 18, 2025

*Corresponding authors

Mary Tahu Paia

E-mail marytahu paia@gmail.com

Donguk Han

E-mail ecoguideuk@gmail.com

Background: This study focused on assessing ecosystem services in the Solomon Islands, highlighting their significance and challenges. We evaluated the importance of mangrove management using the Rapid Assessment Wetland Ecosystem Services method and the need for integrated conservation efforts to sustain these valuable ecosystems.

Results: This study assessed the first qualitative ecosystem services in the Solomon Islands with multi-stakeholders. The assessment revealed significant benefits from ecosystem services in the Solomon Islands, particularly in provisioning fresh water, food, and cultural services. However, challenges such as illegal logging and degradation threaten these benefits, reducing the effectiveness of ecosystem services. We also identified the importance of mangrove management and the need for integrated conservation efforts to sustain these valuable ecosystems.

Conclusions: We identified the significance of ecosystem services in the Solomon Islands. This study can help decision-makers in the Solomon Islands determine and ensure the sustainable management of mangrove areas and broader ecosystems.

Keywords: ecosystem services, mangroves management, multi-stakeholders, Rapid Assessment of Wetland Ecosystem Services, Solomon Islands

Introduction

Mangroves in the Solomon Islands are primarily utilized by their respective landowners, who hold customary rights over the land according to the local tenure system. Over 85% of land in the Solomon Islands operates under customary tenure (McDonald 2006), granting local tribes authority over activities within their territories, including mangrove management. Livelihoods in these communities heavily rely on the resources from tribal lands, where all members of customary landholding groups have rights to access these resources for subsistence and income generation (Wairiu 2006). However, managing these resources remains complex due to the customary tenure system, which challenges capacity building, such as acquiring the necessary tools and developing inclusive, effective management frameworks. The overarching issue in the Solomon Islands

is exacerbated by the systematic deforestation and degradation of mangrove habitats due to forestry practices, illegal logging that jeopardizes forest and vegetative health, soil contamination resulting from mining activities, and the intricate management of human capital, infrastructure, and water resources (Bennett 2000; Katovai et al. 2015). Illegal logging poses a particularly severe threat, reducing mangrove coverage and undermining their vital ecosystem services (ES), such as coastal protection, biodiversity support, and water regulation. Complicating enforcement, the customary land tenure system grants landowners significant control over land-use decisions, making regulation difficult. The impacts are especially evident in areas like Malaita, where unregulated deforestation has led to notable mangrove loss (Bennett 2000; Katovai et al. 2015). Mangrove ecosystems also face increasing long-term threats from global climate change and rising sea levels. On low-

© 2025 The Author(s) **Open Access**



This article is licensed under a Creative Commons Attribution (CC BY) 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this license, visit <http://creativecommons.org/licenses/by/4.0/>. The publisher of this article is The Ecological Society of Korea in collaboration with The Korean Society of Limnology.

lying Pacific islands like Tuvalu, minimal land elevation means sea-level rise has a critical impact on mangroves (Bhattarai and Giri 2011). Additional pressures, including changes in air and sea temperatures, storm stresses, variable precipitation, and human disturbances, are expected to worsen over the coming decades (Bhattarai and Giri 2011). Moreover, the Pacific region, prone to seismic activity, exposes mangrove forests to threats from tsunamis and seasonal hurricanes (Bhattarai and Giri 2011). Despite these challenges, Solomon Islands currently lack registered protected areas for mangroves (Albert and Schwarz 2013). Local communities have voiced concerns about overharvesting of mangroves for firewood, building materials, and land clearance for village expansion (Veitayaki et al. 2017; Warren-Rhodes et al. 2011).

The Solomon Islands Community Based Coastal and Marine Resource Management Strategy (Solomon Islands Government 2021), which spans 2021 to 2025, aims to bolster the health of marine and coastal resources crucial for socio-economic well-being and food security. The strategy targets a 25% enhancement in community-based resource management across coastal areas by 2025, emphasizing the scaling up of community-based resource management through robust awareness campaigns, training initiatives, and active community participation (Solomon Islands Government 2021). It integrates sustainable livelihoods, climate change adaptation strategies, and comprehensive monitoring systems to ensure effective coastal management. In this context, ES, which are direct and indirect benefits that ecosystems provide humans, are assessed imperatively to support Integrated Coastal Zone Management (ICZM), a planning and coordinating process that deals with coastal resources and mangrove management in the Solomon Islands. This assessment evaluates the various benefits that mangroves and other coastal ecosystems provide, such as

shoreline protection, fisheries support, carbon sequestration, and cultural significance. By quantifying these ES, decision-makers can prioritize conservation efforts, enhance resilience to climate change impacts, and sustainably utilize resources. For instance, the Coastal Environment Impact Assessment for Honiara emphasizes the importance of systematic monitoring and advanced tools like GIS and remote sensing for informed management and long-term sustainability (Pollard et al. 2021). By recognizing the inherent value of ES, stakeholders can foster resilient coastal communities and preserve the natural heritage that underpins their socioeconomic prosperity, which is fundamental for environmental decision-making and management (Pearson et al. 2019). ES are benefits in the form of goods and services accrued by the human community. Assessing ES is crucial for sustaining mangrove areas in the Solomon Islands. This study employs the Rapid Assessment of Wetland Ecosystem Services (RAWES), a practical tool endorsed by RRC-EA (2020), to evaluate the comprehensive ES provided by mangroves across various spatial scales (Cianchi et al. 2024). This study's key focus is to assess available ES with multi-stakeholder support management decisions and protect mangrove areas as wetland conservation areas in the Solomon Islands.

Materials and Methods

Study site description

Mangroves in the Solomon Islands occur in sheltered coastal bays and along river mouths and lagoons (Bhattarai and Giri 2011; FAO 2006). Solomon Islands mangroves cover a total area of 47,100 hectares, almost 2% of the total land area (Bhattarai and Giri 2011; Fig. 1, Table 1). According to Pillai and Sirikolo (2001), the term “Mangrove” is

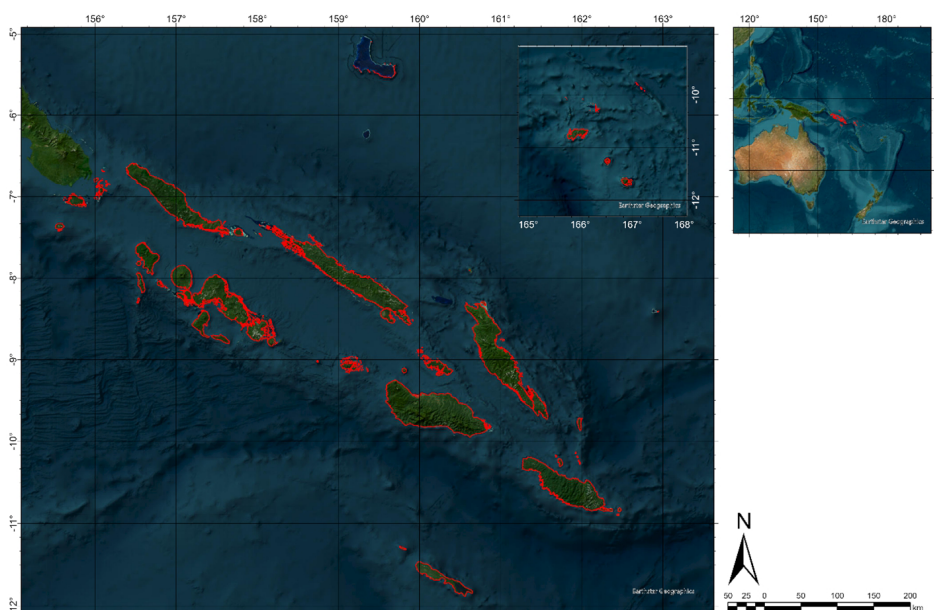


Fig. 1 Study area. Source: Authors' compilation.

now applied to trees that are restricted to the intertidal zone. These plants are strictly littoral, occurring on protected and sheltered shores where environmental conditions are conducive to their growth. The term “mangal” is employed to denote the community. The most luxuriant mangrove flora in the Solomon Islands is associated with estuaries on sheltered shores of the larger islands. Mangroves stand also flourish along riverbanks where salt water penetrates. Mangals may completely fringe some of the smaller sheltered islands or they may extend discontinuously along the coastline. Mangroves colonising less favorable habitats are characterized by a lack of species diversity and stunted plant growth. Malaita seems to have rich mangrove coverage – significant stands area at Lau Lagoon (North Malaita), LangaLanga Lagoon (West Malaita), Are Are Lagoon (Southwest Malaita), Northern Maramasike Passage (between small Malaita and Malaita), which contain the largest contiguous area of Mangroves. Pallai and Sirikolo (2001) surveyed 6 sites the LangaLanga Lagoon; the south of Auki, viz Raulu Creek (mainland), the Kwaro Islands, Surabuta (mainland), Tabuilo Island, Loa Creek (mainland), and the Rade River (mainland). Mangroves of the lagoon area are being felled by nearby villagers for traditional use and by commercial suppliers of firewood in Auki; mangroves are being logged in the area. *Bruguiera gymnorhiza* and *Rhizophora apiculata* are the dominant spe-

cies in Malaita (Pillai and Sirikolo 2001).

Rapid assessment of ES

We applied RAWES for assessing ES in Solomon Islands. Each ES is assessed using a relative scale, very positive benefit (++), positive benefit (+), moderate (0), disbenefit (-), and significant disbenefit (--) from Department for Environment, Food & Rural Affairs (2007), RRC-EA (2020). 33 items were evaluated: 9 provisioning services, 13 regulating services, 6 cultural services, and 5 support services. The indicators for assessment per service were chosen by 27 multi-stakeholders from the Solomon Islands during the workshop on preparation for the ICZM Mangrove Plan from 27 February to 2 March 2024. Participants included representatives from Malaita, Western, Isabel, Temotu, and Guadalcanal regions, as well as individuals from academia, policy-making bodies including government officials, and non-governmental organizations (NGOs) supported by the Climate Technology Centre and Network for preparing ICZM policies and mangrove protection in Solomon Islands. The participants reviewed the assessment results based on experience and perceptions of ES in the Solomon Islands (Fig. 2). Based on the results of RAWES, we also applied the ES Index to quantify and analyze ES in Solomon Islands, as shown in the following formula (RRC-EA 2020).

$$ESI = \frac{\sum(n_{+1.0} + n_{+0.5}) + \sum(n_{-1.0} + n_{-0.5})}{\sum n_{Total}}$$

Table 1 Mangrove area status in Solomon Islands

Total land area	27,556 km ²
Population	+700,000 people
Mangrove area	50,000 ha
Total mangroves plant species	40 species

Source: Personal communication with Mr. Myknee Sirikolo, National Herbarium under the Ministry of Forestry and Research, 27 February 2024.

where, ESI is the ecosystem services index used to all positive scores (+1.0 and +0.5) and all negative scores (-1.0 and -0.5). However, while simple and practical, the relative scale used to assess ES may oversimplify complex ecological dynamics, limiting its ability to capture nuanced variations in service provision.

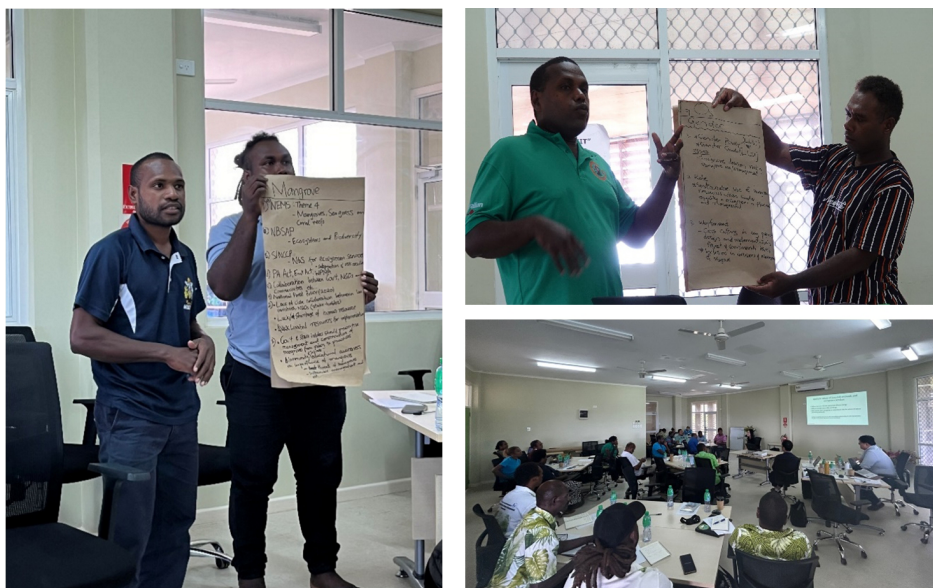


Fig. 2 Rapid Wetland Ecosystem Services Assessment and review of results with stakeholders in the Solomon Islands.

Results

ES assessment

We identified ES's value, which primarily benefits the Solomon Islands. Table 2 showed the qualitative results of ES value with function in the Solomon Islands. As a result of the evaluation of provisioning services, fresh water, food, fuel, fibre, natural medicines, clay, mineral, and aggregate harvesting provide a particularly significant benefit. Significant benefits of the regulating services are air quality regulation, local climate regulation, global climate regulation, water regulation, water purification, and pollination. Most of the cultural and supporting services were evaluated as having significant contributions (++) compared to those making a negative contribution. Soil forma-

tion is crucial for maintaining healthy ecosystems in the Solomon Islands, as it regulates the production of soil and mud essential for nutrient cycling. Within this framework, mangroves play a pivotal role in primary production by harboring vital nutrients that sustain the local food chain and enhance nutrient cycling to benefit marine organisms and communities. Moreover, mangroves significantly contribute to water recycling, thereby improving the availability of clean water. These ecosystems also serve as critical habitats, supporting a diverse range of marine biodiversity, including over 40 species of mangroves in the Solomon Islands. This biodiversity not only enriches local ecosystems but also enhances their resilience in the face of environmental challenges.

The assessment results demonstrated by the cultural and

Table 2 The results of the Solomon Islands ecosystem services assessment

Ecosystem services		Rank	Main benefit
Provisioning	Fresh water	++	It provides domestic drinking supply, sanitation, hygiene, and export potential for drinking.
	Food	++	Food supplies for local, export regionally, and internationally bring revenue.
	Fuel	++	Firewood from mangroves is common in coastal communities.
	Fiber	++	It provides building materials and export revenue.
	Genetic resources	+	40 species of mangroves; support other species, such as birds and mammals.
	Natural medicines	++	Natural benefit to local health: Communities depend on some mangrove plants for cultural remedies, e.g., for the common cold and curing wounds.
	Ornamental resources	+	It is revenue for locals, tourism, cultural significance, and display.
	Clay, mineral, aggregate harvesting	++	Extractor for buildings also damages natural landscapes.
	Waste disposal	0	Proper waste disposal is required in the Solomon Islands.
	Regulating	Air quality regulation	++
Local climate regulation		++	Mangrove forests regulate local climate.
Global climate regulation		++	Supported by ensure mangrove conservatory.
Water regulation		++	Regulated surface water recharges groundwater.
Flood hazard regulation		0	Due to logging and degradation, there is less benefit; Mangroves reduce coastal flooding, and windbreaker protection for villages.
Pest regulation		0	Introduces species of flora or fauna that become invasive over native species.
Disease regulation - human		0	Natural trust air and aquatic life provide fresh air, water, and trees provide healthy, nutritious diets.
Erosion regulation		+	Natural systems ensure less erosion.
Water purification		++	Filter and provide clean water.
Pollination		++	It has flowering plants and orchids for pollination.
Salinity regulation		+	Mangroves protect inland saltwater intrusion.
Fire regulation		0	Fire control barriers.
Noise/visual buffering		+	The mangrove forest ecosystem reduces the noise as a buffer.
Cultural	Cultural heritage	++	It has connectivity between mangroves and people and other regions/people.
	Aesthetic value	++	It is attracting tourism and homestay.
	Social relations	++	The community works together via conversation, which binds tribal groups together; livelihoods for communities and villages.
	Educational and research	++	Environment for a research opportunity.
Supporting	Recreation and tourism	++	It brings revenue to the country and promotes ecotourism.
	Spiritual and religious value	++	It has significant spiritual and religious value for the people.
	Soil formation	++	Regulate produce soil/mud; healthy ecosystem maintains soil aggregation.
	Primary production	++	Houses nutrient supply for the food chain.
	Nutrient cycling	++	Mangroves increase nutrient supply for marine organisms and humans as well.
	Water recycling	++	They are providing an increased clean water supply.
	Provision of habitat	++	Provision of habitat for the majority of marine biodiversity; conditions and stains of Habitat are maintaining 40 species of mangrove.

++: significant positive contribution; +: positive contribution; 0: negligible contribution; -: negative contribution; --: significant negative contribution.

supporting services showed substantial benefits and the need of management planning. For example, the mangroves support natural benefits for the local health in the communities. Some mangrove plants provide cultural remedies and reduce coastal flooding and windbreaker protection for coastal villages. However, due to illegal logging and degradation of mangroves, the benefits derived are diminishing. Effective mangrove management integrating income generation and conservation activities must be implemented. It is crucial to establish alternative livelihoods for communities to incentivize mangrove forest conservation. Therefore, a clear policy involving the government, Solomon Islands communities, academic institutions, NGOs and community based organizations (CBOs) is essential. At the same time, in the Solomon Islands, proper waste disposal is crucial to mitigate environmental impacts, while effective flood hazard regulation is increasingly vital amidst logging and coastal degradation. Mangroves play a pivotal role by reducing coastal flooding and providing windbreaker protection for villages. Challenges arise with pest regulation, as introduced species threaten native flora and fauna. Maintaining natural ecosystems is also essential for disease regulation, ensuring fresh air, clean water, and nutritious diets from healthy trees and aquatic life. Fire control barriers further enhance these efforts to safeguard the islands' biodiversity and community well-being.

However, the destruction of mangroves in the Solomon Islands is driven by several factors. Firstly, deforestation for building materials and development projects, including expanding villages and creating log ponds (storage areas where logs harvested are accumulated), has significantly reduced mangrove areas. Rising sea levels, cyclones, and

storm surges have also exacerbated this loss. The destruction of mangroves due to increasing population pressures, such as harvesting and collecting of species in mangroves for food, waste disposal and use of firewood, further contributes to their decline. Moreover, aquaculture farming practices often involve clearing mangrove forests to establish ponds, which pose a significant threat. Another critical issue is the inadequate understanding of mangroves' importance and the consequences of overharvesting species found in them. This lack of awareness is compounded by the absence of comprehensive mangrove policies and management strategies in the Solomon Islands, leaving these vital ecosystems vulnerable to ongoing degradation and loss. Addressing these challenges requires urgent action to implement effective policies and sustainable management practices to protect and restore mangrove ecosystems.

ESI

The mean of ESI resulted in the supporting services being higher than other services. The provisioning services were 0.55, the regulating services were 0.59, the cultural services were 0.65, and the supporting services were 0.79. We also examined the means of standard errors of the scores estimated from each service, as presented in Figure 3. The standard errors of provisioning and regulating services index was relatively higher than other services in the percentage of the services produced out of the total; provisioning services at 29.64%, regulating services at 37.61%, cultural services at 15.76% and supporting services at 16.99%.

Table 3 showed results for five key regions within the Solomon Islands: Malaita, Western, Guadalcanal, Temotu, and Isabel. Each subfigure provided a breakdown of the ESI scores across provisioning, regulating, cultural, and supporting services specific to each region. The differences across these regions reflected each area's unique ecological and socio-economic dynamics, influencing the prioritisation of ES. For instance, regions with higher dependence on coastal resources, such as Western, were higher in provisioning services, while areas with greater focus on conservation needs, like Malaita and Isabel, emphasised supporting services. This regional variation highlighted the need for a tailored ICZM plan considering localized ecosystem service dependencies and conservation needs.

In addition, the ESI results were segmented by stakeholder groups, specifically academia, NGOs, and policy-making

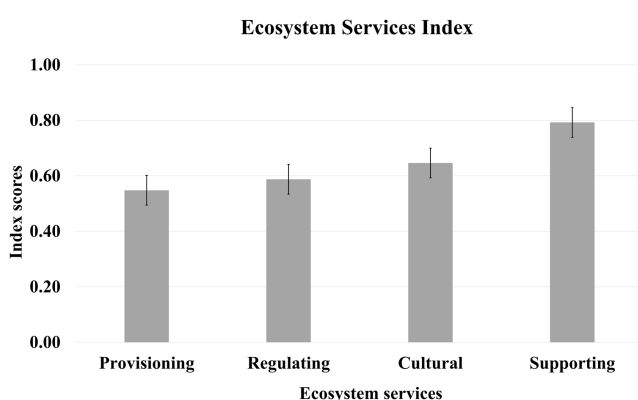


Fig. 3 The results of the Solomon Islands ecosystem services index.

Table 3 The mean of ecosystem services index by regions in the Solomon Islands

Ecosystem services	Regions				
	Malaita	Western	Isabel	Guadalcanal	Temotu
Provisioning	0.12	0.12	0.16	0.06	0.10
Regulating	0.16	0.08	0.11	0.14	0.10
Cultural	0.12	0.08	0.18	0.13	0.14
Supporting	0.21	0.11	0.23	0.12	0.12

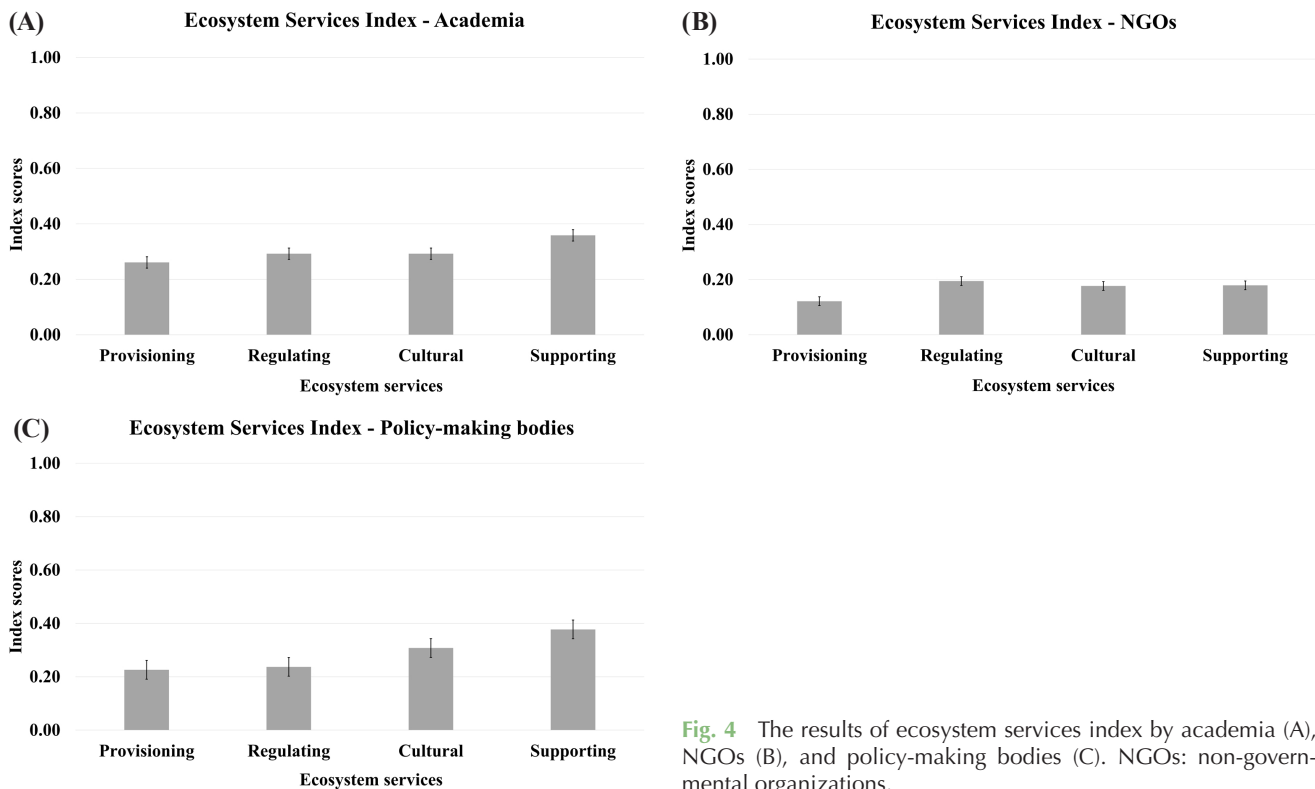


Fig. 4 The results of ecosystem services index by academia (A), NGOs (B), and policy-making bodies (C). NGOs: non-governmental organizations.

bodies in Figure 4. Each subfigure captures how different stakeholder groups assessed the value of ES. Academic institutions tended to score supporting services higher, reflecting their emphasis on ecological sustainability and biodiversity conservation. NGOs, prioritising community welfare and conservation, rated cultural and regulating services highly, underscoring the critical role these services play in sustaining local livelihoods and preserving cultural heritage. Policy-making bodies, focusing on the interconnection between human well-being and ecosystem health, emphasized supporting services, acknowledging their foundational role in maintaining ecosystem resilience. These differences underscored the value of multi-stakeholder involvement in developing balanced ICZM policies that address diverse priorities across ecological, social, and regulatory domains.

Discussion

Advancing place-based ecosystem service assessments

Place-based participatory ecosystem service assessment is gaining significance as a method for identifying and understanding the ES provided by natural environments. This approach allows multi-stakeholders, including local communities, to actively participate in assessing how ecosystems contribute to human well-being and sustainability goals as well as make informed decisions. By engaging those who directly interact with these ecosystems, such as-

assessments can effectively highlight diverse benefits, such as water purification, climate regulation, and cultural enrichment, that natural areas provide. We utilized the place-based rapid assessment approach developed by RRC-EA (2020), which evaluated intricate ecological conditions using a defined set of observable field indicators (Fennessy et al. 2007; Stein et al. 2009). This assessment enabled us to assess ecosystems' positive and negative contributions. Additionally, it provided a comprehensive evaluation of diverse benefits offered, as discussed in studies by Gopal (2015), McInnes and Everard (2017), Aung et al. (2021), Saluja et al. (2023), Choi et al. (2023), which employed similar research methodologies.

Sustainable management for mangrove ecosystems

Mangroves are crucial in connecting terrestrial and marine ecosystems, offering a diverse range of ecosystem functions and socio-economic services that benefit human communities. In the Solomon Islands, however, mangrove forests are facing significant decline, sparking urgent discussions on deforestation and ecosystem degradation. Implementing Other Effective Area-Based Conservation Measures (OECMs), which is achieving the long-term and effective in-situ conservation of biodiversity in collaboration with local communities, is crucial for sustainable use (Cook 2024; Jonas and Sandwith 2019). This involves developing sustainable management plans that monitor small-scale logging, non-timber forest product harvesting, and fisheries management. Emphasis should be placed on

monitoring supporting services like soil nutrient cycling and biodiversity conservation. Integrating aquaculture, fisheries, and beekeeping activities is recommended to promote sustainable economic development linked to ICZM in the Solomon Islands. Mangrove-friendly aquaculture practices can cultivate species like mud crabs (*Scylla* spp.), milkfish (*Chanos chanos*), and mangrove red snapper (*Lutjanus argentimaculatus*) without harming the ecosystem, supported by community education on resource management (Almoguera et al. 2024; Tadokoro et al. 2000). Community-Based Fisheries Management can engage local knowledge in sustainable fisheries practices while enforcing regulations to prevent overexploitation in protected areas. Additionally, exploring opportunities for mangrove beekeeping, particularly with stingless bees (*Trigona* spp.) adapted to mangrove environments, could provide a sustainable livelihood option. This initiative could be bolstered by training and capacity-building efforts aimed at local communities. The continuing education of multi-stakeholders, including the community level in the Solomon Islands, will be fundamental to the sustained implementation of the ICZM Mangrove Plan.

Building capacity for mangrove conservation

Fundamental to the sustained generation of ICZM Mangrove Plan knowledge is the continuing education of multi-stakeholders, including community level in the Solomon Islands. The government is vital in building capacity in various sectors through its ministries. The Ministry of Environment, Climate Change, Disaster Management and Meteorology (MECDM) and the Ministry of Fisheries and Marine Resources (MFMR) are the key ministries having cross-cutting work with mangroves. Apart from the government, many NGOs are implementing projects across the Solomon Islands. It is a cross-cutting process between several ministries, and coordination is a critical issue between these ministries. The opportunity to focus on mangrove-specialized training also needs to be given. Government ministries, community sector, academics, NGOs, and CBOs should collaborate to strengthen relationships and enhance communication through targeted capacity-building initiatives in the Solomon Islands. These efforts can address illegal logging in mangrove zones and promote clear, practical guidelines for sustainable resource use.

Integrating data, policy, and community action

By partnering with NGOs and CBOs, the government can update regulations to reflect local conditions and community practices, ensuring that conservation policies are effective and culturally relevant. In addition, effective ICZM for mangroves in the Solomon Islands necessitates strategic categorization into conservation, restoration, and sustainable use, guided by comprehensive spatiotemporal data. However, discrepancies exist in reported mangrove

areas due to varied statistical approaches and estimation methods. Integrating internationally recognized satellite-derived land cover data with locally sourced information on mangrove distribution is essential to address this. This collaborative effort involving key stakeholders such as the MECDM, MFMR, and Ministry of Agriculture and Livestock need to facilitate improved governance and informed decision-making. Accurate assessment using remote sensing and field research can identify areas of high mangrove density suitable for conservation designation. Protection efforts must include support for local communities and NGOs, particularly in establishing strict conservation zones around vulnerable areas like mining and logging sites. Restoration initiatives should prioritize regions historically occupied by mangroves but now degraded due to coastal development particularly mangrove replanting in logged over areas but taking into consideration specific budget allocation for mangrove conservation and sustainable management. Critical to the delivery of ICZM, the National Environmental Management Strategy guides the integration of environmental considerations into national and local planning processes. It supports mangrove conservation as a natural defence and buffer against climate change impacts such as the sea-level rise and storm surges. Positioning mangrove conservation within the broader climate adaptation framework is essential, as mangroves naturally buffer against climate change impacts such as sea-level rise and storm surges, aligning with national resilience goals. By promoting mangrove conservation projects in national climate action plans, the Solomon Islands can attract funding from international donors focused on climate resilience. Additionally, integrating mangrove conservation into local development plans will protect against coastal erosion and extreme weather events. Additionally, the National Biodiversity Strategy and Action Plan emphasizes the conservation of biodiversity, including mangrove ecosystems, through sustainable management practices. The Forestry Resources and Timber Utilization Act plays a pivotal role in regulating logging activities and promoting sustainable forestry practices within mangrove areas through Community-Based Resource Management. This approach fosters community engagement in mangrove management and aligns with traditional knowledge and practices. By leveraging these policies, institutional arrangements, and legal frameworks, the Solomon Islands can effectively implement an ICZM Mangrove Plan that ensures the sustainable management and conservation of mangrove ecosystems.

Conclusions

The assessment of ES in the Solomon Islands revealed critical findings that underscore the profound benefits of

natural ecosystems, particularly mangroves, to local communities and biodiversity. The RAWES results highlight significant contributions across provisioning, regulating, cultural, and supporting services, each playing a pivotal role in sustaining ecological health and human well-being. Provisioning services such as fresh water, food, and natural medicines are essential to local livelihoods, providing tangible benefits that support daily life and economic activities. Regulating services, including air and water quality regulation, are crucial for maintaining environmental balance and resilience against climate impacts, emphasizing their intrinsic value in ecosystem health. Cultural services are also prominent, reflecting their vital role in traditional practices, community identity, and overall well-being. Supporting services, particularly soil formation and nutrient cycling facilitated by mangroves, are foundational to the sustainability of other ecosystem functions, bolstering resilience and adaptation capacities in the face of environmental stressors.

However, challenges such as illegal logging and mangrove degradation threaten these benefits, necessitating urgent management interventions. Effective conservation strategies that integrate community participation, sustainable practices, and robust policy frameworks are imperative to safeguarding these invaluable ES. In addition, strategic categorization of mangroves into conservation, restoration, and sustainable use categories, guided by comprehensive spatiotemporal data, is crucial for effective ICZM in the Solomon Islands. Challenges include discrepancies in reported mangrove areas due to varied statistical approaches and estimation methods, highlighting the need for integrating satellite-derived and local data. Collaboration among key stakeholders such as government ministries including MECDM, MFMR, NGOs, CBOs, and the private sector is vital for improved governance and decision-making. Conservation efforts must include establishing strict conservation zones and supporting restoration initiatives in degraded areas. Leveraging national policies and legal frameworks, including the National Environmental Management Strategy and the Forestry Resources and Timber Utilization Act, can facilitate community engagement and sustainable management practices crucial for mangrove conservation amidst climate change impacts. Collaborative efforts among government agencies, local communities, academic institutions, NGOs, and CBOs are essential to ensuring the long-term viability of ecosystems and the well-being of Solomon Islands' inhabitants. We also identified the significance of ES in the Solomon Islands. This study emphasized the critical need for proactive management and conservation measures, such as ICZM, to preserve these natural resources. It can help decision-makers in the Solomon Islands determine and ensure the sustainable management of mangrove areas and broader ecosystems.

There were a few limitations in this study's implementation of the RAWES. We engaged 27 participants, including diverse stakeholders knowledgeable about the Solomon Islands' ecosystems and assets, to ensure that assessment results could inform environmental decision-making in the study area. However, we did not incorporate interviews or a local participatory process, limiting insight into the local scale of ecosystem service benefits. In addition, local participation processes with spatial zoning of mangrove areas affecting policymaking in the Solomon Islands can provide directions for the environmental management of ecosystem assets, which different governance levels can manage. Thus, RAWES should be improved to reflect local perceptions of the scales of ES provided by ecosystem assets.

Abbreviations

ICZM:	Integrated Coastal Zone Management
MECDM:	Ministry of Environment, Climate Change, Disaster Management and Meteorology
MFMR:	Ministry of Fisheries and Marine Resources
NGOs:	Non-governmental organizations
OECDMs:	Other Effective Area-Based Conservation Measures
RAWES:	Rapid Assessment Wetland Ecosystem Services
RRC-EA:	Ramsar Regional Center - East Asia
++:	Significant positive contribution
+:	Positive contribution
0:	Negligible contribution
-:	Negative contribution
--:	Significant negative contribution

Acknowledgements

We are grateful to the Ministry of Environment, Climate Change, Disaster Management, and Meteorology in the Solomon Islands, as well as to Hyeseon Do, MPhil in Conservation Leadership, Department of Geography, University of Cambridge, and the comments of anonymous reviewers.

Authors' contributions

HC and CS did conceptualization, data curation, formal analysis, original draft preparation, and wrote the paper. CL did conceptualization, investigation and wrote the paper. SK, MP, and DH did conceptualisations and gave overall comments. HC and DH did a funding acquisition.

Funding

This study was supported by Basic Science Research Program through the National Research Foundation of Korea funded by the Ministry of Education (NRF-2021R1A6A1A10045235) and UN Climate Technology Centre and Network.

Availability of data and materials

Not applicable.

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

References

- Albert JA, Schwarz AJ. Mangrove management in Solomon Islands: case studies from Malaita Province. CGIAR Research Program on Aquatic Agricultural Systems. Policy Brief: AAS-2013-14. 2013.
- Almoguera L, Malamug V, Espino A Jr, Cinense M. Modified mangrove pens for polyculture system in mud crab (*Scylla serrata*) and milkfish (*Chanos chanos*) production. *Diversitas J*. 2024;9(1):146-57. <https://doi.org/10.48017/dj.v9i1.2560>.
- Aung TDW, Kyi SW, Suzue K, Theint SM, Tsujita K, Yu TT, et al. Rapid ecosystem service assessment of a protected wetland in Myanmar, and implications for policy development and management. *Ecosyst Serv*. 2021;50:101336. <https://doi.org/10.1016/j.ecoser.2021.101336>.
- Bennett JA. Pacific forest: a history of resource control and contest in the Solomon Islands. c.1800–1997. Cambridgeshire: White Horse Press; 2000.
- Bhattarai B, Giri CP. Assessment of mangrove forests in the Pacific region using Landsat imagery. *J Appl Remote Sens*. 2011;5(1):053509. <https://doi.org/10.1117/1.3563584>.
- Choi HA, Seliger B, Han D. Rapid ecosystem services assessment of Mundok Ramsar wetland in Democratic People's Republic of Korea and opportunities to improve well-being. *J Ecol Environ*. 2023;47:03. <https://doi.org/10.5141/jee.23.010>.
- Cianchi B, Everard M, McInnes R, Cooke R. Methodological innovations within the RAWES framework for use in development scenarios. *Integr Environ Assess Manag*. 2024;20(1):189-200. <https://doi.org/10.1002/ieam.4799>.
- Cook CN. Progress developing the concept of other effective area-based conservation measures. *Conserv Biol*. 2024;38(1):e14106. <https://doi.org/10.1111/cobi.14106>.
- Department for Environment, Food & Rural Affairs, UK. An introductory guide to valuing ecosystem services. London: Department for Environment, Food and Rural Affairs; 2007.
- FAO. Global forest resources assessment 2005. Rome: FAO; 2006.
- Fennessy MS, Jacobs AD, Kentula ME. An evaluation of rapid methods for assessing the ecological condition of wetlands. *Wetlands*. 2007; 27(3):543-560. [https://doi.org/10.1672/0277-5212\(2007\)27\[543:AEORMF\]2.0.CO;2](https://doi.org/10.1672/0277-5212(2007)27[543:AEORMF]2.0.CO;2).
- Gopal B. Guidelines for rapid assessment of biodiversity and ecosystem services of wetlands. Version 1.0. Asia-Pacific Network for Global Change Research (APN-GCR), Kobe, Japan, and National Institute of Ecology, New Delhi. 2015. p. 134.
- Jonas H, Sandwith T. Towards recognising, reporting and supporting OECMs: report of the fourth expert meeting of the IUCN-WCPA task force on other effective area-based conservation measures. Gland, Switzerland: IUCN; 2019.
- Katovai E, Edwards W, Laurance WF. Dynamics of logging in Solomon Islands: the need for restoration and conservation alternatives. *Trop Conserv Sci*. 2015;8(3):718-31. <https://doi.org/10.1177/1940082915008003>.
- McDonald J. Marine resource management & conservation in Solomon Islands: roles, responsibilities & opportunities. Secretariat of the Pacific Regional Environment Programme. Honiara, Solomon Islands. 2006.
- McInnes RJ, Everard M. Rapid assessment of wetland ecosystem services (RAWES): an example from Colombo, Sri Lanka. *Ecosyst Serv*. 2017;25:89-105. <https://doi.org/10.1016/j.ecoser.2017.03.024>.
- Pearson CJ, Geden M, Mayhorn CB. Who's the real expert here? Pedigree's unique bias on trust between human and automated advisers. *Appl Ergon*. 2019;81:102907. <https://doi.org/10.1016/j.apergo.2019.102907>.
- Pillai G, Sirikolo MQ. Mangroves of the Solomon Islands. USP Marine Studies Technical Report. Marine Studies Programme, The University of the South Pacific. 2001.
- Pollard E, Taraha A, Airahui J. Honiara coastal environmental impact assessment, Solomon Islands. Suva, Fiji: Pacific Community; 2021. p. 36.
- RRC-EA. Rapid assessment of wetland ecosystem services: a practitioner's guide. Suncheon: Ramsar Regional Center - East Asia; 2020.
- Saluja R, Prasad S, Lwin TH, Soe HH, Pottinger-Glass C, Piman T. Assessment of community dependence and perceptions of wetlands in the Upper Chindwin Basin, Myanmar. *Resources*. 2023;12(10):112. <https://doi.org/10.3390/resources12100112>.
- Solomon Islands Government. Solomon Islands community based coastal and marine resource management strategy 2021 - 2025. Solomon Islands Government; 2021.
- Stein ED, Brinson M, Rains MC, Kleindl W, Hauer FR. Wetland assessment debate. *Wetland Science and Practice*. 2009;26(4):20-4. <https://doi.org/10.1672/055.026.0405>.
- Tadokoro Y, Sulit VT, Abastillas RB. Technologies in mangrove-friendly aquaculture. Final Report of and papers presented to the on-site training on mangrove-friendly aquaculture Hai Phong City, Socialist Republic of Vietnam. SEAFDEC; 2000.
- Veitayaki J, Waqalevu V, Varea R, Rollings N. Mangroves in small island development states in the Pacific: an overview of a highly important and seriously threatened resource. In: DasGupta R, Shaw R, editors. Participatory Mangrove management in a changing climate. Perspectives from the Asia-Pacific. Tokyo: Springer; 2017. p. 303-27.
- Wairiu M. Governance and livelihood realities in Solomon Islands. In: Firth S, editor. Globalisation and governance in the Pacific Islands. State, society and governance in Melanesia. Canberra: ANU Press; 2006. p. 409-16.
- Warren-Rhodes K, Schwarz AM, Boyle LN, Albert J, Agalo SS, Warren R, et al. Mangrove ecosystem services and the potential for carbon revenue programmes in Solomon Islands. *Environ Conserv*. 2011; 38(4):485-96.