Disclosure of mangrove conservation policies in SEA: Bibliometric content perspectives

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Abstract

As a result of damage since the 2010s, mangrove forests require conservation efforts, such as reforestation, business permits in coastal areas, rearrangement of coastal spatial planning, and law enforcement regulated by the government in environmental policies. This study aims to assess the evolution and identify knowledge related to mangrove conservation policies in Southeast Asian (SEA) countries using in-depth bibliometric and content analysis. This paper describes mangrove restoration and conservation policies in SEA countries . The results of the study show that as many as 220 articles about mangroves in SEA have been published, this shows that there is an increasing interest in disclosing mangrove restoration policies, included in SEA countries. Globally, there are similarities in regulations between countries: the difference lies in the application of the rules. Changes in land use are one of the drivers of mangrove damage in SEA countries . However, only a few researchers have discussed institutional arrangements and coastal development policies. Mangroves in Indonesia are protected by 22 laws and regulated by at least 18 institutions. Their administration in Thailand is governed by at least 20 laws and overseen by 7 ministries and departments. In the Philippines, 28 laws relate to the conservation of mangroves for cultivation. Additionally, we discuss the main findings, deficiencies, and directions for future research.

Keywords

mangrove, bibliometric analysis, environmental policy, environmental regulation, reforestation, content analysis

Introduction

Mangrove forests are located on waterfronts and are affected by tides; therefore, the forest floor is constantly inundated with water (Alongi, 2018). Mangrove forests are generally described as a tropical coastal community dominated by several species of distinctive trees or shrubs that can grow in salty waters (Ibrahim et al., 2015). The physical functions of the mangrove ecosystem include keeping the coastline stable, protecting the coast from abrasion, accelerating land expansion, and processing waste materials (Turisno et al., 2021). They biologically function as hatcheries for fish and shrimp, spawning grounds for several aquatic species, nesting sites for birds, and natural habitats for various types of biota (Kiruba-Sankar et al., 2018). Furthermore, mangrove forests economically function as a source of fuel, aquaculture, salt production, building materials, food, medicine, acetic acid, fisheries, agriculture, animal feed, fertilizer, and paper production (De Corato et al., 2018). Each country has different conservation policies and practices to preserve the mangrove forest. This study discusses the disclosure of mangrove conservation policies in SEA countries. The have different mangrove conservation policies and practices. It is important to conduct a study on the disclosure and comparison of mangrove conservation policies between them to compare the differences in mangrove conservation policies throughout the SEA region, thus helping to understand the best practices applied in this region. In addition, each country in SEA faces different challenges and problems in carrying out mangrove conservation efforts. Studying policies and practices in other countries can help identify similar challenges and problems in Indonesia and enable the development of better solutions.

SEA hosts 30.9% (47,000 km^2) of the mangrove forests of the world, which have the highest biodiversity in the world (Food & Nations, 2007). However, these mangrove forests are rapidly disappearing due to aquaculture, rice production, and oil palm expansion, which hugely impact biodiversity. As many as 16% of the species in mangrove forests were predicted to be threatened by extinction by 2020. The main cause of mangrove forests damage is uncontrolled use due to the high dependence of people who occupy coastal areas on these forests (Bhomia et al., 2016). Furthermore, mangroves have been converted for various uses such as plantations, ponds, settlements, industrial land, and tourism, without regard to the sustainability and functionality of the surrounding environment (Huxham et al., 2015; Turisno et al., 2021). As a result, seawater intrusion occurs, during which seawater enters the mainland, causing the quality of fresh water from wells or rivers to decrease, even becoming brackish or salty (Purnama and Marfai, 2012). The impact of seawater intrusion is serious because fresh water contaminated with seawater intrusion will cause poisoning if consumed and can damage plant roots (Koet al., 2021). Other consequences of the destruction of mangrove forests include decreased biodiversity in coastal areas, increased beach abrasion, and reduced food sources and spawning grounds for marine species, which result in reduced fish catch production, among many others.

Given these problems, mangrove forest conservation efforts, such as reforestation, business permits in coastal areas, rearrangement of coastal area spatial planning, and law enforcement regulated in environmental policies by the government, are required. Many comprehensive studies have been conducted on the disclosure of environmental sustainability, particularly regarding environmental conservation and related policies. These studies include the disclosure of environmental sustainability in mangrove conservation related to strategies and solutions for preserving mangrove forests in several countries (Islam and Bhuiyan, 2018; Romañach et al., 2018; Sidik et al., 2018). However, it could not find a bibliometric analysis has on policy disclosure regarding mangrove conservation, especially in SEA countries. However, in the context of mangrove conservation in SEA, bibliometric analysis can be used to uncover policies and developments related to the topic through scientific publications published in various journals, conferences,

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and other scientific literature sources. Compared to other approaches such as interviews, surveys, or case studies, bibliometric analysis has advantages in uncovering mangrove conservation policies in SEA because this method is more efficient, more systematic, and can produce complete and quantitatively measurable results data. This allows bibliometric analysis to be used as a reliable method for understanding policies and developments related to mangrove conservation in SEA and helping decision-making in mangrove conservation efforts in the region.

As such, this study aims to use bibliometric and in-depth content analysis to assess the evolution and identify knowledge about mangrove conservation policies in SEA countries in efforts to achieve effective mangrove conservation. This research improves the understanding of mangrove conservation policies in Asian countries and assists in developing more effective policies to protect and sustain the mangrove ecosystem. As it is known, SEA countries have the largest mangrove forest in the world and play a significant role in global mangrove conservation efforts. Therefore, understanding mangrove conservation policies in SEA countries is crucial in addressing global mangrove conservation challenges and opportunities. Additionally, mangroves are important coastal ecosystems that provide numerous ecological, economic, and social benefits to the surrounding communities and environment. However, mangroves are also vulnerable to climate change, habitat destruction, and pollution. Hence, effective mangrove conservation policies protect and sustain this ecosystem. Bibliometric analysis is a statistical and quantitative technique used to analyze many scientific studies focusing on metrics, including trends and citations (Garousi and Mäntylä, 2016; Hou et al., 2015), including in studies of mangrove conservation policies in SEA countries. However, differences in mangrove conservation policies among these countries may not be fully revealed using only bibliometric analysis. By using in-depth content analysis, this research can help understand the differences in mangrove conservation policies in SEA in more detail, such as differences in policy approaches, barriers faced, and factors influencing policy implementation. In the context of mangrove conservation policy, few studies have combined bibliometric analysis and in-depth content analysis. Therefore, this research is much needed to enrich our understanding of mangrove conservation policies in SEA and to generate more effective recommendations for improving mangrove conservation in the region.

The main contributions of this study are the description of publication trends and finding popular keywords in the last ten years; the identification of journals focused on mangrove conservation, the most prolific authors, the participation by institutions and countries, and research trends on mangrove conservation policies; and in-depth content analysis of the ten most influential studies. This study can serve as a guideline for exploring and developing mangrove restoration policies between SEA countries and Indonesia.

The remainder of this paper is organized as follows: Section 2 presents the methodology used in this study, including data collection, processing, and cleaning, and data analysis (bibliometric and content analysis). Section 3 describes the results and discussion of concepts of public policy and environmental law, bibliometric mapping of extant studies, in-depth content analysis of the top 10 most influential studies, and a comparison of mangrove restoration policies in Asia and Indonesia. Section 4 concludes the paper with our main conclusions, a description of the study limitations, and indications of the scope for future research.

Concepts of public policy and environmental law

According to Lasswell (2017), public policy is the projection of goals, values, and practices. Easton (2017) defined public policy as the allocation of values by force (legitimate) to all members of society. According to Roziqin (2018), public policy is one of the efforts made by institutions or organizations, in this case, the sovereign government, to solve

problems to be able to realize human welfare. Policy studies cannot stand alone because they must accommodate other sciences, including environmental policies.

The National Environmental Policy Act (NEPA) represents the first formal incorporation of the impact assessment process in the form of a legislature that establishes environmental policies to guide the activities of federal agencies whose actions have the power to substantially affect people, communities, or the natural environment (Garner and O'Riordan, 1982; O'Riordan and Sewell, 1981). Several countries have incorporated impact assessment processes into their formal procedures or laws related to environmental decision making (O'Riordan and Sewell, 1981; Chris Wood, 2014). The environmental policies that consider impacts have gained momentum from the increasing political recognition of problems related to climate change, loss of biodiversity, threats to freshwater resources and water quality, and damage to the oceans (Morgan, 2012).

In general, policies and legislation on natural resources have been more effectively implemented in developed countries (Kolhoff, 2008). Developing countries have adopted legislation and policy making for natural resource management for more than 30 years (Wood, 2003), but mangrove forest laws and policy guidelines have only been developed in a few developing countries. Legislation and policy are critical to natural resource management (FAO, 2010), and the continued global degradation and thinning of mangroves is a result of high-level policy hesitancy and failure to enforce protective measures (Van Lavieren et al., 2012). Current laws and policies in which mangroves are managed de facto do not effectively contribute to mangrove sustainability because of the many institutions with roles and responsibilities assigned to managing mangroves (Feka, 2015). Coupled with inappropriate laws and policies and a lack of data on the economic value of mangroves in several countries, this has encouraged unsustainable mangrove forest management (Feka, 2015).

Methodology

Using Scopus data, this study combined quantitative and qualitative analytical methods to examine the literature on the disclosure of mangrove conservation policies in SEA countries. The quantitative method applied in this research is bibliometric analysis, a technique used to measure and analyze literature relevant to a particular topic. The bibliometric analysis provides information on the number of publications, author productivity, collaboration networks between authors, institutions, and countries, and research trends related to the chosen topic. On the other hand, a qualitative method can be applied in content analysis, a technique used to analyze the content of documents. This study used content analysis to identify the types of information presented in publications about mangrove conservation policy disclosure in SEA. This can include information about policy objectives, implementation strategies, challenges, and policy impacts. The distribution of mangrove forests in SEA is generally extensive. It covers coastal areas in many countries, including Indonesia, Malaysia, Thailand, The Philippines, Vietnam, and Cambodia, where Indonesia has the largest mangrove forest in the world presented in Figure 1. Using quantitative and qualitative methods in this research can provide a more comprehensive understanding of mangrove conservation policy disclosure in SEA countries (Linnenlueck et al., 2020; Xu et al., 2018). The combination of these two methods demonstrates the evolution of scientific knowledge in a field through quantitative bibliometric tools, and in-depth topic content is determined through systematic qualitative reviews.

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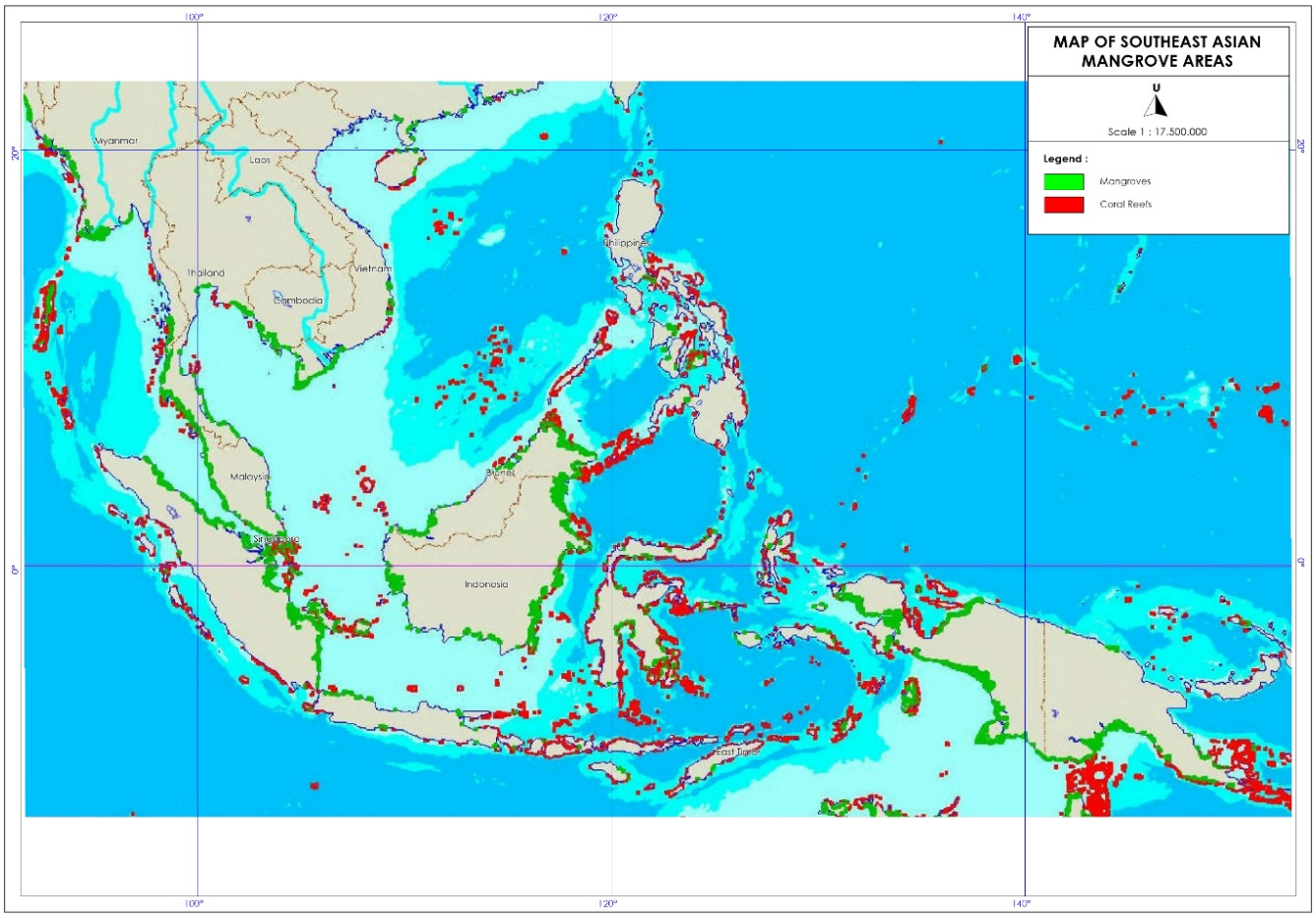

Fig 1. Map of mangrove forest distribution in SEA region. (Source: FAO and Wetlands International)

Article selection: processing and cleaning

This study conducted an online search to collect data articles on the period from 2013 to 2022. Using the updated data article (2013–2022) will be more relevant in the current research context because environmental conservation policies and practices continuously evolve and change over time. Newer information will provide a more accurate picture of current trends and challenges. Using the Scopus database developed by Elsevier. The collected data on November 15, 2022. Scopus is the largest database of the highest quality publications, indexed through rigorous content selection and known to be an excellent resource for bibliometric analysis (Baas et al., 2020). Since 1996, the Scopus citation database has had a broader scope in environmental science, especially for public policy and environmental law topics (Si et al., 2019). This study used the following combinations of search queries to explore the article title, abstract, and keywords in the Scopus database using the operator TITLE-ABS-KEY (mangrove AND conservation). The search results identified 3,441 documents in the preliminary search. Our inclusion criteria were as follows:

1. First, we applied a year filter: we used only documents from 2022 to 2013; as a result, 2,468 documents remained.
2. Second, we applied the document type filter; we used only documents with the “Article”; as a result, 1,860 articles remained.

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3. Third, we applied the publication stage filter; we used only articles in the “Final” stage, so 1,831 articles remained.
4. Fourth, we applied the source-type filter; we selected only articles in the “Journal” type, so a total of 1,827 articles
5. Fifth, we applied the language filter; only the documents written in the “English” language were chosen, so a total of 1,755 articles remained.
6. Sixth, we applied a country filter to SEA countries, and 220 articles remained. The first published article was published in 2009 and the last in 2022. Of the 220 articles, screening was carried out related to abstracts and discussion in accordance with the topics raised. The results of this screening will be used as a source of information related to mangrove regulations.
7. Finally, 143 articles were reviewed by reading the abstracts following the inclusion criteria, which related to this topic were used as the final sample for analysis.

We considered a total of 143 articles in our analysis (abstract, keywords, bibliographic information, citation information, and reference information); we extracted the information in the comma-separated value (CSV) format from the Scopus database. We cleaned the data using Microsoft Excel to remove inconsistencies and blank data, which included, for example, the uniformity of vocabulary from multiple words to single words, deleting double spaces to single spaces, and unifying spelling. According to Briones-Bitar et al. (2020), data cleaning is a fundamental and essential step in bibliometric analysis.

Data analysis

Bibliometric analysis

For the article data from the Scopus database in clean CSV format and bibliometric analysis, we used VOSviewer 1.6.18 to find and visualize scientific maps by interpreting and understanding the network of links between keywords, authors, journals, countries, and institutions. Researchers have widely applied bibliometric analysis to identify critical elements, such as author, affiliation, country, citations, etc., and directions for future research by providing an inclusive visualization of the relationships between essential elements (Deti and Mandasari, 2021; García-Romero and Estrada-Lorenzo, 2014). In this study, the determined the following bibliometric parameters: publication trends in the last ten years, popular keywords, most productive authors, journals that discuss mangrove conservation policies, institutional and state participation, and research trends in mangrove conservation. Content analysis is necessary to identify certain trends and patterns that are not visible through bibliometric analysis, such as specific issues in mangrove conservation that are more important to researchers or stakeholders than the number of publications or prolific authors.

This study also analyzed the content of influential articles to complement the results of bibliometric analysis (Goyal and Kumar, 2021; Mody et al., 2021). Content analysis was used to investigate the dominant logics, approaches, and emphases, identify cognitive schemes and obtained in-depth insights from the literature on mangrove conservation policies. This study conducted an in-depth content analysis of the ten most influential articles.

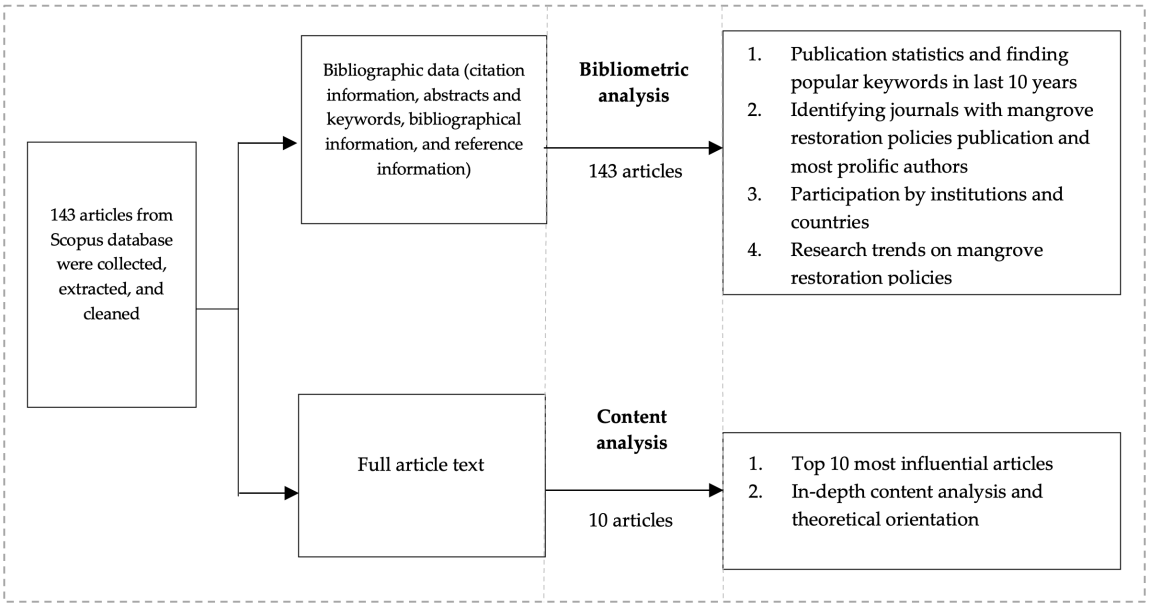

Fig 2. Flow diagram of study design.

Results and Discussion

Bibliometric mapping of extant studies

2013–2022: Publishing Stats and Keyword Trends

The statistical results showed the development of research on mangrove improvement policies. To date all selected papers have discussed mangrove restoration. The development data are shown in Figure 3, which shows the fluctuations in productivity. Thus, we predict a more notable increase in this area of research in the coming years.

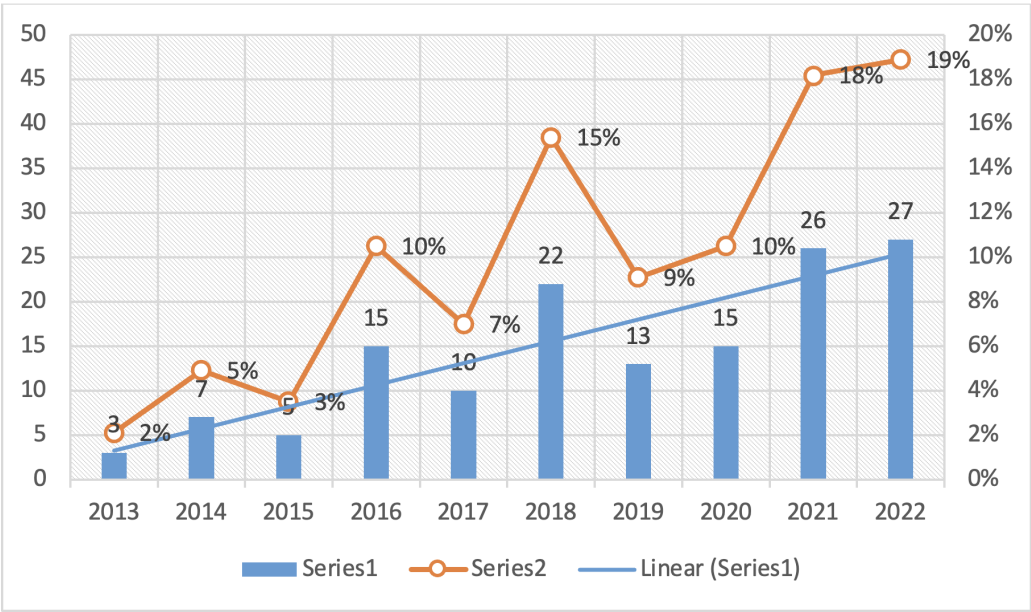

Fig 3. Statistics on publications between 2013 and 2022. (Source: Scopus database)

Figure 4 shows the keywords related to mangroves and the five keywords that appear most often during the 10 year study period in the mangrove restoration policy literature. The keywords that appear most often in this time period are Mangrove, Rhizophoraceae, conservation, environmental protection, biodiversity. The intended keywords are words or phrases listed in the bibliographic database that can be used as search terms to obtain information and represent the contents of related journals.The main keyword in this study is mangrove because the main discussion is related to mangroves and their policies in several SEA countries. Discussions related to mangroves show that there are links with other topics including policy, environment, countries, regulations, people and climate change.Discussion of mangroves with several topics needs a more specific discussion. Notably, the relationship between mangroves and the state is rarely discussed, so it needs to be discussed.

Discussions that involve the country are often related to the topic of mangroves or to topics related to conservation and regulations mangrove. Such studies discuss how a country implements regulations and conservation efforts for mangroves in its territory. On the other hand, studies that do not specifically focus on a country may explore wetlands, the environment, restoration, and climate change without implementing mangrove conservation regulations in a particular country.

Figure 4 also shows that mangroves were the most popular topic from 2013 to 2020. This shows that mangroves have become one of the main focuses in research in recent years, there is preservation of mangrove ecosystems and the development of conservation policies in SEA countries as an effort to protect mangroves.Coastal wetlands are one of the most popular topics related to mangroves because development in coastal areas results in the destruction of mangrove habitat so that related policies are needed. Therefore, in the future, more research on mangrove and habitat restoration policies is expected, which is a topic that has not been widely discussed and will depend on the regional and global situation.

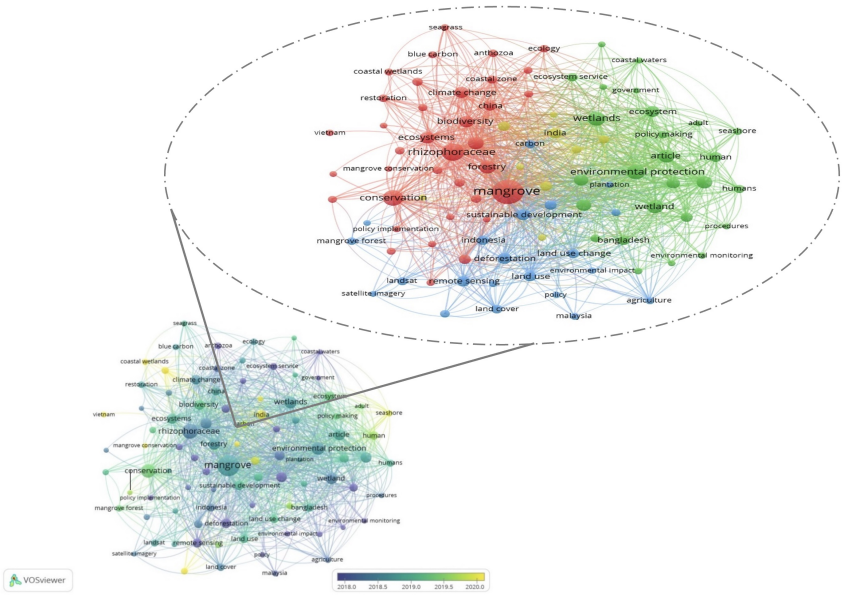

Fig 4. Illustrates a map of the collaboration network of keywords over the years, created using VOSviewer.
(Source: Scopus database, bibliometrically processed by the authors)

Analysis of citations for journals, publishers, and authors.In total, 676 authors contributed to the literature on mangrove restoration policies (Figure 5). Friess, D.A., was the most prolific writer in this field of research. In addition, Friess was the author of the most-cited paper, with 127 citations.

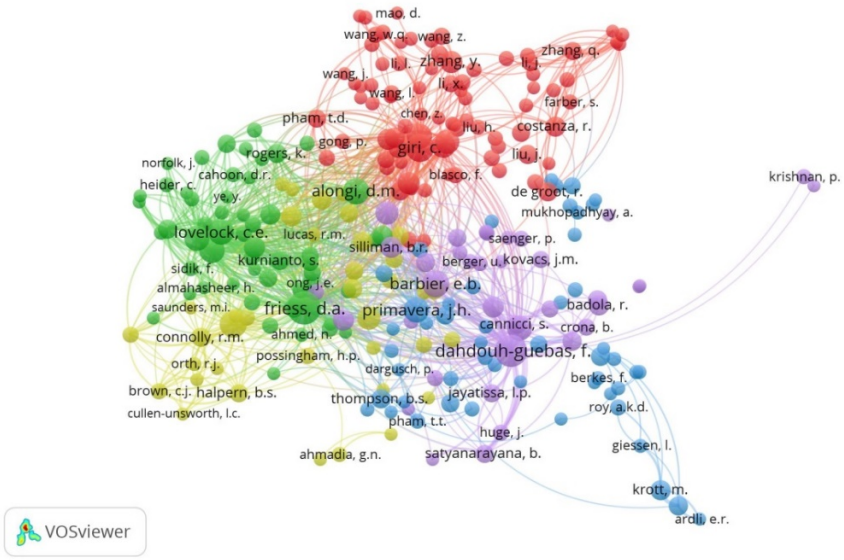

Fig 5. Displays a map of the author collaboration network generated using VOSviewer.
(Source: Scopus database, bibliometrically processed by the authors)

The top 10 most prolific authors with the most cited rates were Friess, D.A.; Dahduoh-Guesbass, F.; Giri, C.; Duarte, C.M.; Barbier, E.B.; Alongi, D.M.; Lovelock, C.E.; Koedam, N.; Primavera, J.H.; and Murdivarso, D. Table 1 shows the number of citations from each of the 10 most popular authors. Table 2 shows that the *Journal of Frontiers in Ecology and the Environment* was the most frequently cited journal as well as the 10 journals that were most often cited in the literature.

Table 1. Most cited and most productive authors of mangrove conservation publications.
(Source: Scopus database, bibliometrically processed by the authors)

Rank	Most Cited and Productive Author	
	Author	Total Cited
1	Friess, D.A.	127
2	Dahduoh-Guebass, F.	122
3	Giri, C.	80
4	Duarte, C.M.	74
5	Barbier, E.B.	73
6	Alongi, D.M.	71
7	Lovelock, C.E.	64
8	Koedam, N.	63
9	Primavera, J.H.	63
10	Murdiyarso, D.	59

Table 2. Most cited journals for mangrove conservation publications.
(Source: Scopus database, bibliometrically processed by the authors)

Rank	Journal Title	Number Cited	Schimago Journal and Country Rank (2022)	Quartile
1	Frontiers in Ecology and the Environment	213	3,19	Q1
2	Global Change Biology	210	3,69	Q1
3	Journal of Environmental Management	140	1,48	Q1
4	Ocean and Coastal Management	125	0,97	Q1
5	Environmental Evidence	121	1,23	Q1
6	Nature Communications	111	4,85	Q1
7	Global Environmental Change	100	3,15	Q1
8	Land Use Policy	90	1,64	Q1
9	Global Ecology and Biogeography	90	2,72	Q1
10	Conservation Biology	80	2,02	Q1

In-depth content analysis of top 10 most influential articles

Articles considered influential are often and most widely cited by other researchers in the same field and contribute to advancing knowledge and understanding of a particular topic. In-depth content analysis of the top 10 most influential articles was conducted by examining in detail the text of each of these articles, examining the arguments, methods, data, findings, and conclusions presented. This help to identify the strengths and weaknesses of each article and also provide a more comprehensive picture of the topics covered. Annex 1 shows the results of content analysis of top most influential articles. Most researchers focused on specific environmental and ecosystem policies regarding marine biodiversity and mangroves. Nguyen (2014) reviewed the state of knowledge on the drivers of coastal mangrove habitat change in SEA, emphasizing the policy drivers of state forest allocation from coastal mangrove change in Kien Giang, Vietnam. The important issues discussed in subsequent studies were directly related to mangrove conservation policies and regulations in Kien Giang, Vietnam. In SEA, the spatial–temporal relationships experiencing changes in mangrove habitat and coastal land use have widely varied from one country to another. Some of the studies indicated human-caused land-use change as one of the main drivers of mangrove destruction in SEA countries. Few researchers have examined the impact of institutional arrangements and policies on coastal development in relation to social issues or other drivers. As a result, the root causes of the loss of mangrove habitat are not fully understood because the reviewed studies showed that the destruction of coastal mangroves is caused by the increased use of coastal land. The study identified the mangrove ecosystem services, namely provision, regulation, and cultural services, and how these services contribute to community welfare. Beresnev, Phung, and Broadhead (2016) stated that the Government of Vietnam is developing a new policy on the management, protection, rehabilitation, and development of coastal forests to respond to climate change with assistance from Vietnam's USAID-funded Forests and Delta program. The policy seeks to strengthen the management and protection of coastal forests by prohibiting the conversion of coastal forests, except for reasons of national interest; move construction and production units that may have negatively impact the coastal forest protection function away from the area planned for critical watershed protection forests; and withdraw coastal forest areas used or converted for wrongful purposes. The draft policy has been endorsed by the MARD and submitted to the Ministry of Justice for approval. Nguyen (2014) suggested that further studies should focus on the trade-offs between ecosystem services and various mangrove stakeholders in the Klang Archipelago, as well as the ecosystem service mechanisms that contribute to community welfare as an effort to empower or enhance the flow of ecosystem service benefits to

society. These studies should explore the different priorities among stakeholders and the different interests of each party.

In a second, Turschwell, Brown, Pearson, and Connolly (2020) identified hotspots with the potential to impact coastal wetlands and coral reefs at the country or marine ecoregion level, as well as marine species that were at risk of impacting the development of the Belt and Road Initiative (BRI) in China. The development of the mBRI has negatively impacted marine habitats, where 410 species were found to be threatened across all major spatial scales. The highest proportion of potentially impacted coastal marine habitats was 27.5%. A comprehensive framework must urgently be implemented in areas most at risk of loss of biodiversity and habitats and in countries that lack the financial support to implement appropriate environmental protection policies. Local or regional EIAs will not be effective without the thorough enforcement of policies that have biodiversity conservation as a core principle. The global integration of conservation actions for the mBRI can ensure the best results for biodiversity conservation. This study differs from that of Nguyen (2014), which only involved policies in one country; Turschwell et al. (2020) considered policies in several countries because the mBRI development process involves several countries.

In three other studies, researchers discussed policies related to mangrove management in several SEA countries. Friess et al. (2016) as the author of Article 4, addressed the loss of mangrove forests and identified conflicting or unclear policies by considering four approaches that can be used in SEA countries. This aim of this comparison of policies in various SEA countries was ensure sustainable livelihood and biodiversity conservation. Complex governance environments can hinder the formation of coherent policies and leave institutions with conflicting mandates. The mangroves in Indonesia are protected by 22 laws and regulated by at least 18 institutions. In Thailand, they are governed by at least 20 laws, which are overseen by 7 ministries and departments. However, mangrove protection in Thailand is hindered by lacks of policy and legislative clarity, human and financial resources, local participation in mangrove management, and information about mangrove area boundaries (Beresnev et al., 2016). In Thailand, mangroves are regulated and managed by various entities located at the interface of marine and terrestrial environments (Beresnev et al., 2016). Historically, policies and regulations run by different entities have conflicted, and national decentralization processes have created disruptions. According to Beresnev et al. (2016), several laws are relevant for mangrove management, including The Promotion of Marine and Coastal Resource Management Act 2015 (hereinafter, MCRM Act); Forest Act 1941 (2484 B.E.); National Park Act 1961 (2504 B.E.), covering national parks and mangroves located inside national parks; National Reserved Forest Act 1964 (2507 B.E.); Wildlife Reservation and Protection Act 1992 (2535 B.E.), covering wildlife sanctuaries and nonhunting areas; Commercial Forest Plantation Act 1992 (2535 B.E.); Decentralization Act 1999 (2542 B.E.); and Land Code 1954 (2497 B.E.).

According to Melana, Melana, and Mapalo (2005), the conversion of mangroves into fishponds has become the main cause of the decline and degradation of Philippine mangroves, accounting for approximately 175,000 ha (35%) of mangrove forest loss. To overcome these negative impacts, the government has vigorously pursued efforts to restore lost resources through mangrove reforestation, the declaration of mangrove forests covering an area of 83,593 ha and mangrove swamp forests as reserve areas, and the launch of community-based programs that focus on coastal environment and coastal resource management. Additionally, regulations governing mangrove conservation are needed. In the Philippines, 28 laws are related to the conservation of mangrove forests in aquaculture. Melana et al. (2000) stated that mangrove use regulations in the Philippines are based on a defined resource use plan or government-determined use plan. According to Edgardo et al. (2022), the empowerment of local communities with their legitimate resource use rights and management responsibilities is a key factor driving the success of mangrove restoration (Edgardo et al.,

2022). The limitations to large-scale mangrove conservation in several SEA countries are due to different policy and governance challenges that must be overcome. The governance of mangroves is complex because of their unique intertidal arrangements, diverse economic and noneconomic uses, and diversity of stakeholders in broad coastal zones. Edgardo et al. (2022) identified several approaches to ensure the sustainability of mangroves and biodiversity conservation in SEA.

Giessen and Sahide (2017) analyzed the content of ASEAN forest and environmental policies and conducted interviews to gain access to some internal documents. ASEAN environmental and forest policies fulfill four functions, whereas policies developed by regional regimes, such as ASEAN, are aligned with the interests of the most powerful member states. Issue-specific actions are based on the interests of the bureaucracy related to the issue, which is tasked with representing certain member countries in the policy areas of certain regimes. DasGupta and Shaw (2013) reviewed contemporary country-specific literature to analyze the main factors delineating them and their potential impacts and to identify challenges to mangrove conservation and restoration initiatives among several developing countries in South and SEA through a comparison of mangrove management frameworks. Specific human activities, namely coastal agriculture and shrimp ponds, were the main factors destroying mangrove forests in SEA. Mangrove forest loss was also caused by the vulnerability of coastal communities to disasters. Therefore, a series of strategies were recommended, which the authors categorized into three parts: restructuring the legislative framework, governance, and the institutional dimensions of mangrove management, including balanced economic development and cross-border cooperation. The three studies covered the same area, SEA countries, and discussed mangrove forest policies.

The other five articles specifically discussed mangrove policies in countries such as Indonesia, Thailand, Malaysia, and Vietnam. Wever, Glaser, Gorris, and Ferrol-Schulte (2012) analyzed participation in the use of local ecosystems affected by the decentralization of coastal management in Indonesia. The authors comparatively analyzed the policy developments in coastal management; reviewed legal documents, policy plans, and secondary literature; summarized achievements in coastal management policy challenges; and reviewed important political developments in Indonesia. The Integrated Coastal and Small Island Management Law in Indonesia considers sustainability, integration, decentralization, accountability, justice, equity, and community participation. For coastal management to be more socially just and environmentally friendly, local communities need to be informed, empowered, and supported so that clear measures for environmental ecosystems can become part of national and international policy agendas. Mursyid et al. (2021) analyzed the existing regulations by analyzing scientific publications, government policies, strategic planning documents, and interviews with stakeholders to contribute to policy development regarding the conservation of mangrove ecosystems to support climate change mitigation actions in Indonesia. In 2021, the institutional arrangement of mangroves became more complex with the formation of the Mangrove Peat Restoration Agency (BRGM), which will rehabilitate mangroves with a target of 600,000 ha. Mangrove resource policies must be directed toward preventing the degradation of intact mangroves and rehabilitating degraded ecosystems. Institutions related to the use, management, and conservation of mangroves must be synchronized with a strong regulatory framework that overcomes sectoral boundaries.

Jusoff (2013) highlighted the urgent need for proper management and conservation to ensure the continued existence of mangrove forests in Malaysia. They conducted a literature review by comparing issues related to mangrove conservation and restoration in Malaysia to those in the rest of the world. National legislation and plans for mangrove management exist in Malaysia, but enforcement and further planning are suboptimal. If protective measures are not enforced, Malaysian mangrove species will be threatened with extinction. In a study of existing policies in Thailand, Thompson

(2018)examined the relationship between actors and institutions that can lead to mangrove rehabilitation and found that corporations that play an important role in financing mangrove rehabilitation have emerged, which has effectively transferred decision-making power from the central government. This created a hybrid, and increasingly neoliberal, network.

Comparison of mangrove conservation policies between South Asia and Indonesia.

In general, Indonesia has adopted many regulations from other SEA countries, so the policy regulations show many similarities. Comparison of mangrove conservation policies between SEA countries was carried out to assess evolution and identify knowledge related to mangrove policies in each SEA country as an effort to find out more effective mangrove conservation so that it can help develop policies to protect and preserve mangrove ecosystems. Wever et al. (2012) analyzed the participation in the use of local ecosystems affected by the decentralization of coastal management in Indonesia; they found stated that the Integrated Coastal and Small Island Management Law in Indonesia considered sustainability, integration, decentralization, accountability, justice, equity, and community participation. Within their jurisdiction, regional and provincial governments are responsible for 1) exploration, exploitation, conservation, and management of coastal resources; 2) administrative matters; 3) zoning and spatial planning matters; 4) enforcement of regulations; 5) participation in security maintenance; and 6) participation in defense sovereignty (Mursyid et al. (2021). Over the past three decades, no synchronous cross-sectoral regulation has occurred, with different bureaucracies pursuing their own goals and policy priorities. In 2020, the President of the Republic of Indonesia canceled Presidential Decree No. 73 of 2012 and replaced it with Presidential Decree No. 108 of 2020. This regulation simplifies the bureaucracy regulating mangrove use. The MoNDP issued Ministerial Decree No. 89 in 2020, which mandates the establishment of a new strategic coordination team for wetland management. This is different from regulations issued by governments in other SEA countries regarding mangrove restoration, which first emphasized management, such as in Malaysia, highlighting the urgent need for proper management and conservation to ensure the continued existence of mangrove forests in Malaysia. Regulations in Thailand place more emphasis on mangrove rehabilitation, resulting in the emergence of corporations that play an important role in financing mangrove rehabilitation. The mangroves in Indonesia are protected by 22 laws and are regulated by at least 18 institutions. The administration in Thailand is governed by at least 20 laws and supervised by 7 ministries and departments. In the Philippines, 28 are laws related to the conservation of mangrove forests for cultivation. The limitations of large-scale mangrove conservation in several SEA countries are caused by different policy and governance challenges that must be overcome.

Conclusions

The interest in disclosing environmental policies and marine ecosystems, especially regarding mangroves, has is evident in the literature, through the many publications related to environmental policies and marine ecosystems, particularly mangroves, totaling 2,468 documents from 2013 to 2022. A total of 220 articles on the disclosure of mangrove policies in Asia were published from 2009 and 2022. Friess and Dahduoh were the most cited authors on the topic of mangrove conservation and its policies, with 127 and 122 citations, respectively. Regarding journals, publishers, and authors, the most widely cited were those in *Frontiers in Ecology and the Environment*, with a total of 213 citations.

Based on the analysis of the results carried out, globally there are similarities in regulations between countries regarding mangrove conservation policies. The difference in mangrove policies lies in the application of the regulations. In Indonesia, regulations regarding mangrove restoration cover 1) exploration, exploitation, conservation and management

of coastal resources; 2) administration affairs; 3) zoning and spatial planning matters; 4) enforcement of regulations; 5) participation in security maintenance; and 6) participation in sovereign defense. Human-induced land-use change is one of the main drivers of mangrove destruction in SEA countries. However, few researchers have examined the impact of institutional arrangements and coastal development policies on social issues or other drivers. As a result, the root causes of loss of mangrove habitat still need to be fully understood. Mangroves in Indonesia are protected by 22 laws and regulated by at least 18 institutions. Their administration in Thailand is governed by at least 20 laws and overseen by 7 ministries and departments. In the Philippines, 28 laws relate to the conservation of mangroves for cultivation. The limitations of large-scale mangrove conservation in several SEA and SEA countries are caused by various policy and governance challenges that must be overcome.

This study has some limitations. First, the combination of search queries in bibliometric analysis may have resulted in limitations due to differences in the sample of bibliometric articles. Second, we considered only the Scopus database. Extracting valuable data from more than one database, such as adding sample articles from WoS, can provide more information for future bibliometric analyses. Finally, we selected our article sample only from articles published in SEA countries and written in English. We recommend further investigation into the global scope of English and non-English articles in this domain to conduct similar studies in the future.

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Annex

Annex 1: Content analysis of top most influential articles

No	Reference/Citation/Journal	Subject	Study Aim	Methods	Data or Result	Conclusion
1	Ruslan et al. (2022)/ 144/*Marine Policy* (Q1)	Mangrove ecosystem services: contribution to well-being of coastal communities in Klang Islands	Exploring relationship between mangrove ecosystem services and human well-being by adapting and modifying three conceptual frameworks.	Semi structured interview with questionnaire containing 11 questions developed to capture various aspects of ecosystem services as well as objective and subjective dimensions of well-being; nonprobability purposive sampling used to identify fisher respondents with assistance of village head and local government officials.	Three categories of ecosystem services (providing, regulating, and supporting) ecosystem services were acknowledged by respondents. Provisioning services received most references (115 comments from 22 respondents), followed by cultural services (53 times by 18 respondents), and regulatory services (43 times by 19 respondents). Mangroves were recognized as providing source of food such as crabs, shrimp, snails, fish, mangrove apples, mangrove flowers, and honey for community. Respondents rated mangroves as environmental space that connects community with nature.	At local level, based on perceptions of people living in Klang archipelago, Malaysia, findings reveals ecosystem services provided by mangroves, regulation, and culture, and how these services contribute to community welfare. Cultural provision and services contribute to basic human and economic needs, and subjective well-being; regulatory services help provide basic human needs, environmental needs and subjective well-being. Intangible cultural ecosystem services must be included in decision-making process.
2	Turschwell et al. (2019)/112/ *Marine Policy* (Q1)	China's Belt and Road Initiative (BRI): conservation opportunities for threatened marine species and habitats	Identifying hotspots with potential impacts on coastal wetlands and coral reefs at country or marine ecoregion level, and identifying threatened marine species most likely to be affected by China's BRI development.	Synoptic assessment of spatial footprint of port development and expansion linked to mBRI for coastal wetlands, coral reefs, and any species threatened from planned development; 61 ports extracted from the location point layer and buffered with a distance of 5 km assuming that port dredging did not exceed 5 km.	mBRI work has negatively impacted marine habitats, with 410 species threatened across all major spatial scales; infrastructure development has potential to affect 55,300 ha of seagrass beds, 8,400 ha of coral, 4,000 ha of mangroves, and 2,100 ha of salt marshes. Highest proportion of coastal marine habitats potentially affected by ports related to mBRI is 27.5%.	mBRI project provides an opportunity to take internationally coordinated approach to ecologically sensitive development. Environmental planning for mBRI can use newly developed environmental governance frameworks or enhance existing frameworks for environmental impact assessments, strategic environmental assessments, and strategic land use planning to minimize risks to port and shipping development and expansion of marine biodiversity.
3	Nguyen et al. (2019)/90/ *Ocean and Coastal Management* (Q1)	Relationship of coastal mangrove changes and adjacent land-use: review in Southeast Asia and Kien Giang, Vietnam	Understanding factors associated with changes in coastal mangroves, every possible causal factor was examined, particularly state forest allocation in Kien Giang, Vietnam.	Reviewed articles and government documents that addressed issues of coastal mangrove ecosystems and vegetation related to land use change. Overview of causes of mangrove habitat loss in Southeast Asia compared with the world context. Investigated influence of past and present state policies on mangrove conservation devolution and local participation.	Southeast Asia has more than 61,000 km^2 of mangroves, accounting for 35% of world's total. However, coastal mangroves in Southeast Asia, as in other continents, are disappearing at alarming rate. Drivers of most notable destruction of mangrove habitat at 50–80% on a regional scale are aquaculture and agricultural expansion. Mangrove habitat is mostly converted to agricultural land in Thailand (50%); 43% in Malaysia, 98% in Myanmar, 63% in Indonesia, and 50% in the Philippines have been converted to pond cultivation.	Findings shed light on causes of mangrove habitat destruction in Southeast Asia. Several studies examined the relationship between spatial and temporal changes in coastal mangroves and land use adjacent to coast related to coastal development policies. This review highlights the need to examine whether the main causes of mangrove damage are due to complex institutional arrangements and weak policies over coastal resources and other socio-economic influences.

No	Reference/Citation/Journal	Subject	Study Aim	Methods	Data or Result	Conclusion
4	Friess et al. (2015)/30/*Conservation Biology* (Q1)	Policy challenges and approaches to conservation of mangrove forests in Southeast Asia	Addressing loss of mangroves and correct conflicting or unclear policies. Considering four approaches that could be used in Southeast Asia to ensure sustainable livelihoods and biodiversity conservation.	-	-	Limitation on cost of maintaining mangroves on a large scale is not due to a lack of biological or ecological knowledge, but rather to the different policy and governance challenges that must be overcome.
5	Giessen et al. (2017)/67/*Land Use Policy* (Q1)	Blocking, attracting, imposing, and aligning: utility of ASEAN forest and environmental regime policies for strong member states	Analyzing usefulness of ASEAN forest and environmental policies for specific member countries and responsible bureaucracies.	Content analysis of key policy documents. Interviews helped gain access to several internal documents, in addition to publicly accessible documents collected from various ASEAN websites.	Indonesia has strict CITES regulations to safeguard protection and business of existing areas, and the ASEAN Center for Biodiversity has been instrumental in blocking ambitious claims to biodiversity from international actors. Malaysia and Singapore have imposed ASEAN forest fire haze pollution agreement on other member countries to protect interests of those directly affected by air quality and traffic. ASEAN is also attracting international environmental funding in areas including climate change, community-based forestry, and sustainable peatland management. Member states under ASEAN are actively aligning their positions in international climate negotiations and global forest discussions to increase their influence.	ASEAN environmental and forest policies fulfill all four functions. Policies developed in regional regimes such as ASEAN are aligned with interests of more powerful member states, and their bureaucracies. Not only potential hegemons, but also second or third powers may have this option. Activities of member states do not appear to be conducted by states as unitary actors; instead, issue-specific actions are based on interests of bureau related to the issue, which is tasked with representing certain member states in policy areas of certain regimes.
6	Wever et al. (2012/66/*Ocean & Coastal Management* (Q1)	Decentralization and participation in integrated coastal management: policy lessons from Brazil and Indonesia	Analyzing participatory use of local ecosystems affected by decentralized coastal management in Indonesia and Brazil.	Comparative analysis of recent policy developments in coastal management, and emerging outcomes and challenges around direct ecosystem user participation in coastal ecosystem management. Reviewing legal documents, policy plans, secondary literature; summarizing achievements and challenges of coastal management policies; and reviewing important political developments in Indonesia and Brazil	In Indonesia, Integrated Coastal and Small Islands Management Law 2007 adopts principles of sustainability, integration, decentralization, accountability, justice, equity, and community participation. Within their jurisdictions, regional and provincial governments are responsible for 1. exploration, exploitation, conservation and management of coastal resources; 2) administrative matters; 3) zoning and spatial planning matters; 4) enforcement of regulations; 5) participation in security maintenance; 6) participation in sovereign defense.	Development in Indonesia in era of major political reforms, with better understanding of perceptions and interests as well as institutional conditions and dynamics that make them incompatible, is needed to improve prospects for democratic decentralization in coastal management. For coastal management to be more socially equitable and environmentally friendly, local communities need to be informed, empowered, and supported so that clear measures for environmental ecosystems can become part of a wider national and international policy agenda.

No	Reference/Citation/Journal	Subject	Study Aim	Methods	Data or Result	Conclusion
7	Jusoff, Kamaruzaman/ 2013/22/*Environment*	Malaysian mangrove forests and their value to coastal marine environment	Highlighting urgent need for proper management and conservation to ensure continued existence of mangrove forests in Malaysia.	Intensive literature review; ecology and ecological management, distribution, and extent of existing mangrove forests in world and Malaysia; issues related to mangrove conservation and restoration.	Eleven international treaties and instruments provide protection, at least on paper, for mangroves in general, some of which have been in effect for more than 50 years. These agreements and instruments include the RAMSAR Convention, Convention on the Prevention of Marine Pollution, CITES, International Tropical Timber Treaty, Convention on the Protection and Development of the Marine Environment in the Greater Caribbean Area, and Convention on Biological Diversity.	National legislation and management plans already exist in Malaysia, but further enforcement and planning are needed to protect individual species that may be uncommon or locally threatened, and to protect entire mangrove area and important ecosystem functions. Malaysia mangrove species are threatened with extinction and may disappear if protective measures are not enforced.
8	DasGupta et al. 2013/*Ecosystems*	Overview of cumulative impacts of human interventions and climate change on mangrove ecosystems of South and Southeast Asia	Reviewing contemporary country-specific literature to analyze key delineation factors and their potential impact. Identifying achievements and challenges of mangrove conservation and restoration initiatives among developing countries in South and Southeast Asia through comparative analysis of mangrove management frameworks.	Comparative analysis of applicable legislation for mangrove management focusing on nine existing frameworks in developing countries in the Southeast Asia region.	On regional scale, development of coastal agricultural land and shrimp ponds were main factors contributing to 90% of reported losses. Across nine countries in a comparative analysis of existing legislative arrangements for mangrove management, weak law enforcement and inappropriate monitoring were key weaknesses in conservation and restoration initiatives.	Two specific human activities were main factors destroying mangrove forests in South and Southeast Asia: coastal agriculture and shrimp ponds. Loss of mangrove forests was closely related to increased vulnerability of coastal communities to disasters. Three strategies were recommended to sustain this valuable ecosystem: restructuring legislative framework, governance, and institutional dimensions of mangrove management. Balanced economic development and cross-border cooperation are required.
9	Mursyid et al/2021/133/ *Forest Policy and Economics* (Q1)	Governance issues related to management and conservation of mangrove ecosystems to support climate change mitigation actions in Indonesia	Contribute to ongoing policy discussions on mangrove ecosystem conservation to support climate change mitigation action in Indonesia.	Analysis of existing regulations supplemented by analysis of scientific publications, gray literature, government policies, and strategic planning documents. Interviews with relevant stakeholders, focus group discussions, and series of executive lectures from top government officials.	In 2021, the institutional arrangement of mangroves became more complex with formation of Mangrove Peat Restoration Agency (BRGM), which is specifically mandated to rehabilitate mangroves with a target of 600,000 ha. Over past three decades, synchronous cross-sectoral regulation has been lacking, with different bureaucracies pursuing their own goals and policy priorities. In 2020, the President of the Republic of Indonesia canceled Presidential Decree No. 73 of 2012 and replaced it with Presidential Decree No. 108 of 2020. This regulation simplifies bureau that regulates use of mangroves. MoNDP has issued Ministerial Decree No.89/2020, which mandates establishment of new strategic coordination team for wetland management.	To support country's climate change mitigation strategy, mangrove resource policies should be directed at preventing degradation of intact mangroves and rehabilitating degraded ecosystems. Institutions related to use, management, and conservation of mangroves must be synchronized with strong regulatory framework that overcomes sectoral boundaries. Sectoral use and management of mangroves can be guided by sustainable landscape approach by prioritizing multi-stakeholder and multi-stakeholder principles, transparency, clarity of rights and responsibilities, and participatory monitoring.

No	Reference/Citation/Journal	Subject	Study Aim	Methods	Data or Result	Conclusion
10	Thompson, B.S./2018/78/*Land Use Policy* (Q1)	Institutional arrangements and power dynamic political ecology of mangrove forest restoration in Thailand	Examining relationship between actors and institutions that lead to mangrove rehabilitation in Thailand with focus on political, financial and sociocultural factors. Investigating how two mangrove rehabilitation projects in Thailand experienced institutional challenges. Recommending improvements for mangrove rehabilitation in context of actors, institutions, and politics.	In-depth interviews were conducted with 44 key informants involved in mangrove rehabilitation at various levels of government, and across public, private and civil sectors. An analysis of the traditional institutional arrangements for mangrove restoration in Thailand is based on data obtained from all respondents, whereas contemporary accounts of the two rehabilitation projects are based on data from key stakeholders involved in these projects, usually at the subnational and local levels.	National mangrove restoration policy and the financial capacity of the government agency tasked with implementing the policy were inconsistent, leading to dependence on private sector funding through corporate social responsibility (CSR), which concentrates decision-making power with companies regarding how, where, and when mangrove rehabilitation occurs. Prevailing institutional arrangements began to evolve through radical formal changes including the Reforestation Act of 1992, which encouraged CSR for forest restoration; establishment of DMCR in 2004, which prevented budget adjustments; and more recently, the forced 'Get Back Forest' policy.	Weak and unequal relationships between actors due to capacity constraints, power asymmetries, and cultural ideologies, create gaps between policy design and policy implementation, resulting in ineffective environmental governance regimes with little institutional learning. Prevailing institutional arrangements began to evolve through radical, formal reforms including the Reforestation Act of 1992, which encouraged CSR for forest restoration; creation of DMCR in 2004 which prevented budget adjustments; and, more recently, the forced 'Get Back Forest' policy.

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