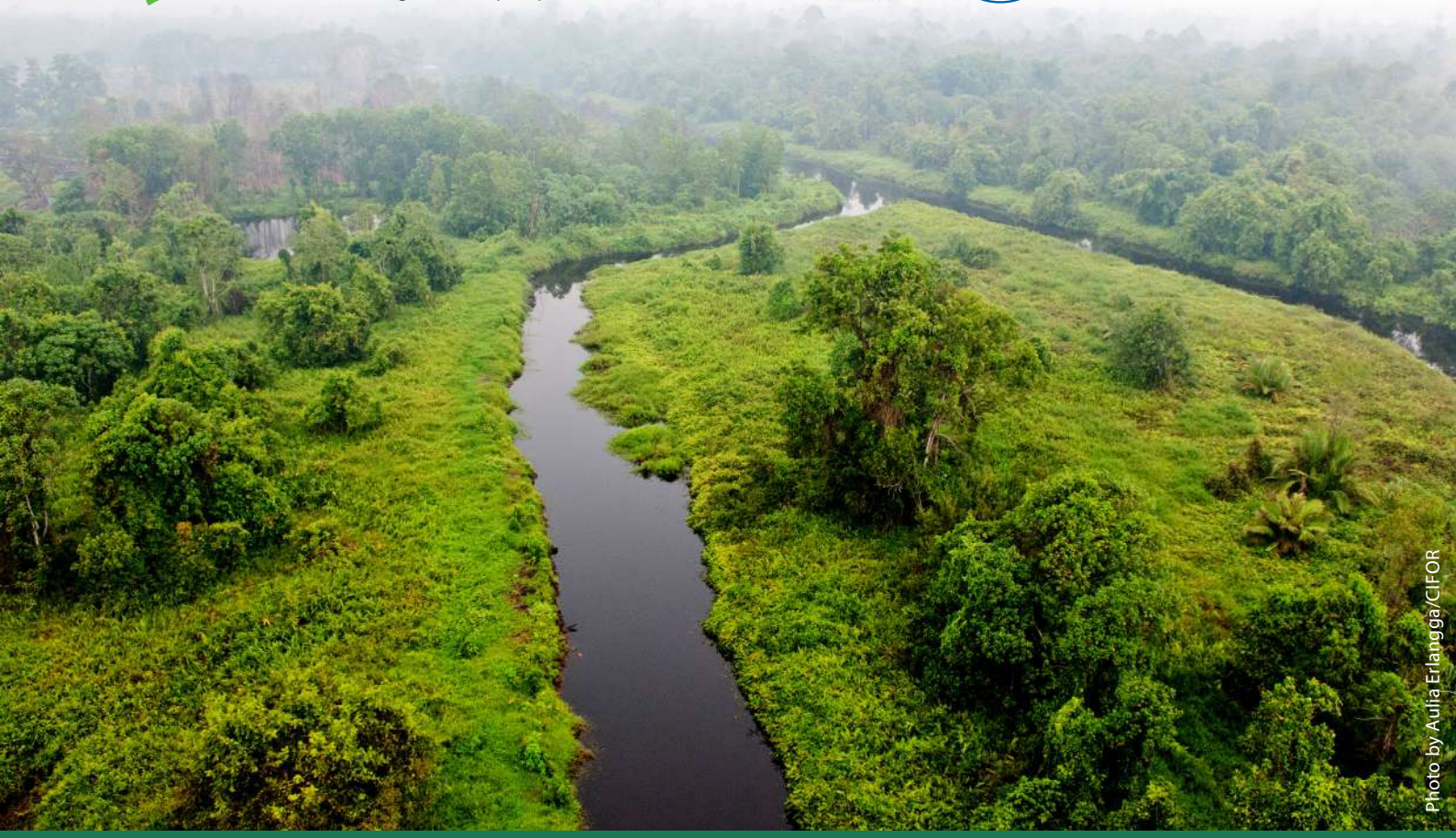

Photo by Aulia Erlangga/CIFOR

A stocktaking of knowledge products on peatlands, fires and haze in Southeast Asia, 1990 to 2020

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List of abbreviations

AMS	ASEAN member states
ASEAN	Association of Southeast Asian Nations
ASEC	ASEAN Secretariat
CAB	Commonwealth Agricultural Bureaux
CIFOR	Center for International Forestry Research
GEC	Global Environment Centre
IFAD	International Fund for Agricultural Development
IFM	Integrated Fire Management
MAHFSA	Measurable Action for Haze-Free Sustainable Land Management in Southeast Asia
RSPO	Roundtable on Sustainable Palm Oil

1 Introduction

1.1 About the MAHFSA programme

The Measurable Action for Haze-Free Sustainable Land Management in Southeast Asia (MAHFSA) programme is a joint initiative between the ASEAN Secretariat (ASEC) and the International Fund for Agricultural Development (IFAD) for supporting efforts to reduce transboundary haze pollution and its impacts in Southeast Asia. The programme's aims include systematizing data and information management; creating a flexible regional coordination platform for engaging all relevant actors; building capacity; harmonizing programmes and projects; and facilitating multiple sources of finance for promoting haze-free farming and sustainable management of peatlands, as well as developing and operationalizing a 10-year investment framework to enable enhanced and coordinated implementation of haze and peatlands projects/programmes towards a haze-free ASEAN region.

One of the programme's objectives is to advance the haze agenda through systematic data collection, management and analysis. Programme partners will assist ASEAN member states (AMS) through the development of knowledge products aimed at guiding decision-making processes at the ASEAN Ministerial Meeting on the Environment and ASEAN Heads of State Summit on issues of land-use policy, regulation, enforcement, incentive frameworks and resource allocation to haze hotspots at local, national and regional levels. Anticipated outcomes are a reduction in forest conversion and land clearance using fire, and the adoption of haze-free farming systems by smallholders and large plantations. MAHFSA programme implementation comprises several activities, from generating knowledge products, developing and implementing communication and engagement strategies, and developing and implementing an investment framework.

MAHFSA is co-developed by a consortium of the ASEC, the Center for International Forestry Research (CIFOR) and the Global Environment Centre (GEC), working with IFAD and in close consultation with ASEAN member states (AMS). As a member of the MAHFSA programme consortium of partners, CIFOR is responsible for implementing Component 2: Data, information and results analysis for strategic knowledge product development. The objective of Component 2 is to enhance the availability and usage of knowledge products on sustainable peatland and haze management. The expected outcome is better availability and utilization of knowledge products on peatland and haze management. Component 2 has one output: the collation and development of new knowledge products for informing different stakeholder groups. There are two major activities: 1) Stocktaking of existing knowledge products; and 2) Development and deployment of a communications strategy and knowledge products.

This report refers to Activity 2.1.1 (Stocktaking/ analysis of existing knowledge products) and aims to document activities carried out in stocktaking and analysing knowledge gaps.

1.2 Peatlands and climate change in Southeast Asia

With their high water-holding capacity, peatlands play an essential role in conservation and climate regulation. Southeast Asia is home to 60% of the world's tropical peatlands; an area of 25 million hectares (ASEAN Environment Division 2016). High rates of deforestation on peatlands have resulted in them losing their key functions in mitigating climate change, particularly capturing and storing carbon. (Muslihat et al. 2009; Murdiyarso et al. 2017). Massive land clearing for plantations and the construction of drainage canals

have resulted in peatlands drying out and becoming highly vulnerable to fire. (Hooijer et al. 2012; Ritzema et al. 2014; Huijnen et al. 2016; Page and Baird 2016). Peatland drainage directly impacts groundwater levels and emissions, and increases subsidence in peat soils. (Wösten and Ritzema 2001; Agus and Subiksa 2008; Hooijer et al. 2012; Hirano et al. 2014). Emissions from converted and drained peatlands (including from peat fires) are significant and unavoidable (Gaveau et al. 2014; Huijnen et al. 2016; Warren et al. 2016; Hergoualc'h et al. 2017; Wijedasa et al. 2017). More than 45% of Southeast Asia's land has been logged or drained, posing a fire vulnerability threat to the region. Peatland fires cause significant losses of carbon reserves, water reserves and biodiversity (Cheyne et al. 2008; Kurnianto et al. 2015; Page and Baird 2016) and have major impacts on community livelihoods. Increases in emissions of greenhouse gases drive global warming (IAARD 2011).

Transboundary haze pollution is one of Southeast Asia's most severe cross-border environmental issues. Indonesia has the most extensive area of tropical peatlands in Southeast Asia, with around 14.9 million hectares spread across the regions of Sumatra, Kalimantan and Papua (Ritung et al. 2012). Peatland fires in Indonesia contribute significantly to transboundary haze pollution across Southeast Asia with winds carrying smog from Indonesia to Singapore, Malaysia, Thailand and other countries. Fires and the resulting transboundary haze have enormous impacts, including economic losses, loss of natural resources, ecosystem degradation, increased greenhouse gas emissions, health problems and social sector losses.

Proper management of peatland ecosystems can help support climate change mitigation actions. Implementing ecosystem-based approaches to climate change mitigation, including conservation, sustainable management and restoration of peat forests, is critical to the sustainable development of peatlands. Assessments of, and improvements to sustainable peatland management practices can help maintain or increase carbon sequestration and other ecological functions and reduce the incidence of fires and recurring haze. Additionally, it is crucial to have post-fire rehabilitation work on peatlands. Hydrological management is critical in determining peatland ecosystems' long-term viability, and is essential for ensuring effective peatland fire prevention (Wösten et al. 2008; Barus and Iman 2009; Page et al. 2011).

2 Methods

2.1 Scope of knowledge products

An essential feature in this stocktaking exercise is the notion of "knowledge products". In this paper, we follow ADB (2012), which characterizes knowledge products as "… tangible outputs (products) … of development, sharing, or application of information and knowledge contents… those where the analytical value addition is significant, increasing the understanding of relations and causality between elements in a body of evidence."

The types of knowledge products included in the paper are as follows: 1) journal articles; 2) books; 3) information briefs; and 4) strategies and plans. We have not included regulation and data. Regulation is not included because it is not always an outcome of the knowledge generation process. However, we have included analyses of policies. Meanwhile, we classify data as information requiring some analytical method to become a knowledge product.

2.2 Data sources

Our stocktaking of knowledge products focused on two groups of data sources. The first group consisted of scientific databases, where knowledge products were primarily journal articles. We searched for knowledge products in four major international scientific databases: 1) Web of Science; 2) Scopus; 3) CAB Abstracts; and 4) Proquest, assigning a timeframe from 1990 to January 2020. Initially, we created separate files using EndNote (a reference management software package) for the search results from each scientific database to understand the distribution of each database's search results on the topics of interest (see Section 2.3). We then merged the papers from the four scientific databases into one EndNote file, removing any duplicate entries. This procedure resulted in the collection of 1,431 entries from these scientific databases. A complete list of these entries is provided in Annex 1.

The second knowledge product data source was a list of publications of MAHFSA consortium members (CIFOR, GEC and ASEC). MAHFSA partners have published various products, including journal articles, books, information briefs, posters, etc. We collected publications from the websites of the ASEAN Secretariat and its associated projects, as well as those of GEC and CIFOR. We downloaded papers from two ASEAN websites: 1) Haze Action Online (haze.asean.org); and 2) Sustainable Management of Peatland Resources in Southeast Asia (aseanpeat.net). We also downloaded publications from the Global Environment Centre's website (www.gec.org.my). In addition, numerous CIFOR articles on peatlands are accessible through its website (https://www.cifor.org/library/). In total, we collected 253 publications. A complete list of hyperlinks to all MAHFSA consortium members' knowledge products is provided in Annex 2.

Given that several CIFOR publications are journal articles, it is conceivable that overlaps may exist between the first and second data sources. The resulting list of publications is not exhaustive since documents in hard copy might not form part of the database. Figure 1 below presents trends in numbers of publications over time by year of publication.

The third data source group was organizations in ASEAN member states. A list of these AMS organizations, which include government institutions and organizations and universities, is provided in Annex 3. This list should not be considered exhaustive, given the number of national organization publications on peatlands, haze, and fires are conceivably far higher than those provided in Annex 3. We searched for documents using the keywords:

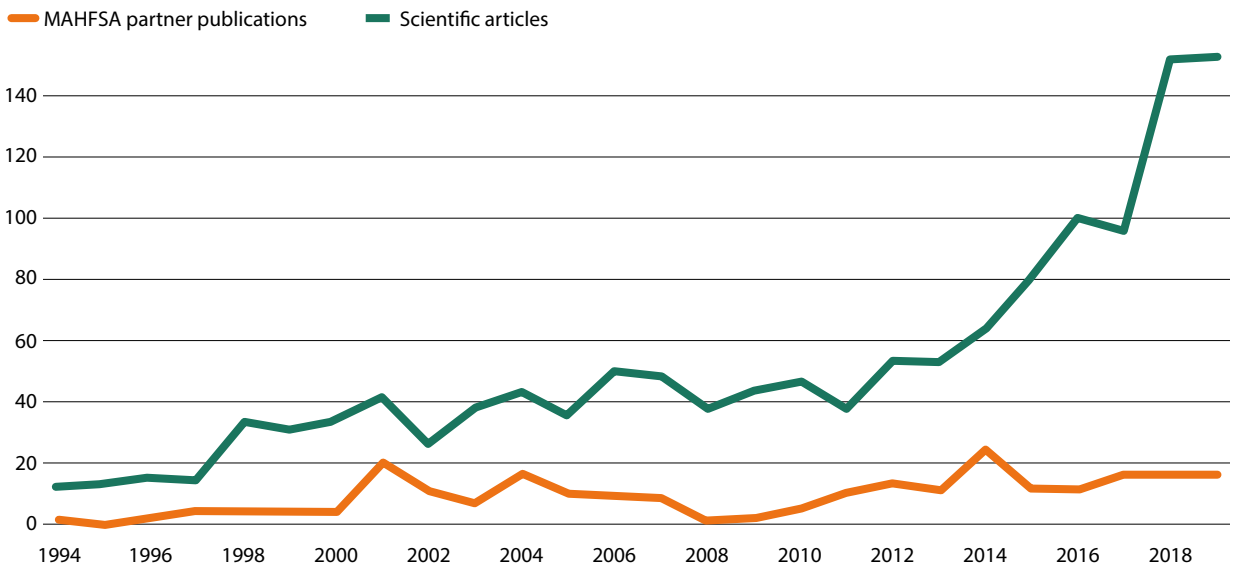

Figure 1. Trends in numbers of publications, 1990–2019

"peat", "peatland", "haze", and "fire(s)", as well as Google translations of equivalents in AMS national languages, such as Burmese, Indonesian, Khmer, Laotian, Malaysian, Thai and Vietnamese. We also collected additional information through observations during events (webinars, workshops, etc.) about peatland management and forest fires in Southeast Asia.

2.3 Formulation of search keywords

Following the MAHFSA Programme Implementation Manual, stocktaking and gap analyses of existing knowledge products in the ASEAN region applied the following topics or thematic keywords:

- Policies on peatland management, fire and haze pollution (summarized as "policies")
- Land tenure, land use and land-use changes in peatland ecosystems ("tenure")
- Communities, economics and livelihoods in peatlands ecosystems ("economics")
- Best practices of sustainable peatland ecosystem management ("best practices")
- Knowledge products related to monitoring, such as changes in peatland condition, the extent of peatlands affected by fire, or the technologies used for monitoring fires ("monitoring")

We developed a list of search keywords to capture the five thematic areas above. The basic structure of search keywords is presented in Annex 3. In addition, we adjusted searches to the format of the search form provided in each scientific database.

To complement these keywords, we created another search group consisting of keywords relating to Integrated Fire Management (IFM), an internationally recognized approach that includes the keywords "prevention", "preparedness", "suppression" and "recovery" (Heikkila et al. 2007). In addition, we applied wildcards (e.g., prepare*, prevent*, etc.) to capture variations on each of the words relating to IFM.

We also created a search group by country and region. In this group, we searched for text containing the keywords "ASEAN" and "Southeast Asia" and each ASEAN member country: Brunei Darussalam, Cambodia,

Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam. This stocktaking analysis covered the period from 1990 to 2020.

2.4 Data analysis

Most of the papers in the scientific databases are journal articles and conference proceedings. In addition, each MAHFSA consortium member has different comparative advantages in terms of types of knowledge products. Therefore, we separated the search results between scientific databases and MAHFSA consortium members' publications.

We conducted a bibliographic analysis of the documents to gather information on their thematic and geographical scopes. We developed a simple system for classifying documents by type (article, book, chapter, brief, etc.) and content (analysis, information, guidelines, strategy, legislation). We analysed texts using the search codes listed in Annex 4, in addition to the IFM and country codes. Using Atlas.ti (a qualitative analysis software package) (Atlas.ti 2017), we created three projects: scientific databases, MAHFSA partner publications, and ASEAN member state government organizations relevant to peatlands. We applied the same analysis procedures to each of the sources.

For each one, we identified the results for individual search groups (thematic and IFM keywords). We then cross-referenced these groups, i.e., between the country, thematic and IFM keywords. This cross-referencing identified where keywords co-occurred within the same sentence, with the unit of analysis set at the sentence level (Bullinaria and Levy 2012; Atlas.ti 2017).

2.5 Gathering feedback

We presented the study's initial results in a regional workshop held on 16 March 2021. We also presented the proposed modifications to the existing knowledge products and the generation of new knowledge products. The workshop aimed to gather feedback on the findings and proposed knowledge product generation and modifications, and to develop a list of knowledge products to be prepared during the programme. We also received feedback through other mechanisms, such as the programme steering committee meeting.

3 Results

3.1 Peatlands and climate change

Publications found in the scientific databases as well as those of MAHFSA partners generally indicate strong links between peatlands, fires and climate change. In terms of processes, for example, these studies can be divided into drivers or causes of peatland fires (Evard et al. 2019; Edwards et al. 2020); fires and associated outcomes, e.g., extent of burned areas (Miettinen et al. 2016, 2017; Li et al. 2018); consequences (Kim et al. 2017; Saputra 2019); and responses to peatland fires (Jefferson et al. 2020; Trouve et al. 2020). These studies show climate change as a cross-cutting issue linking peatlands and fires, as well as their drivers and consequences.

3.2 Scientific databases

Figure 2 presents the numbers of publications resulting from the initial searches on the topics highlighted in Section 2.2. These searches focused on bibliographic information, i.e., title, abstract and keywords. Of the four scientific databases, Web of Science and Scopus returned higher numbers of papers than CAB Abstracts and Proquest. The total number of records presented in each scientific database indicates overlaps between search results across themes 1–5. Figure 2 shows an approximation of the distribution of topics recorded in the scientific databases by thematic keyword appearing in the title or abstract. Results indicate the thematic keywords occurring most frequently in the scientific databases to be "economics" and "best practices", with "monitoring" occurring least frequently.

We classified scientific article titles or abstracts by country. Figure 3 shows Indonesia, Malaysia and Thailand are the ASEAN states occurring most frequently in scientific article titles or abstracts. We also

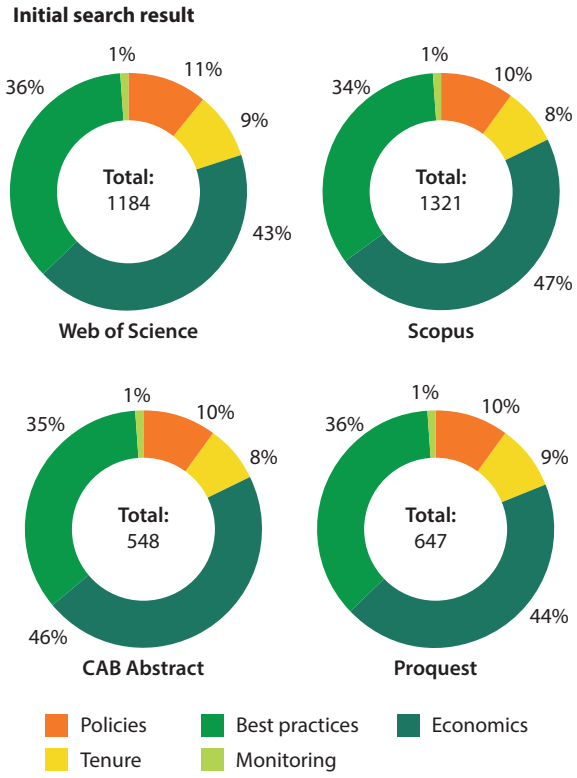

Figure 2. Results of the initial search of scientific databases

found many papers mentioning ASEAN or Southeast Asia, indicating the prominence of regional-level analyses.

After combining records of the four scientific databases into an EndNote file, we repeated the search protocol and removed any duplicate records. We continued by applying country keyword searches to bibliographic information and full texts. Figure 4 presents the results, in which as with Figure 3, Indonesia appeared most frequently, followed by Malaysia and Thailand. Combined results for ASEAN and Southeast Asia were slightly higher than for Malaysia, again indicating the prominence of regional-level analyses.

We extended the scope of the search of bibliographic records to full papers. We

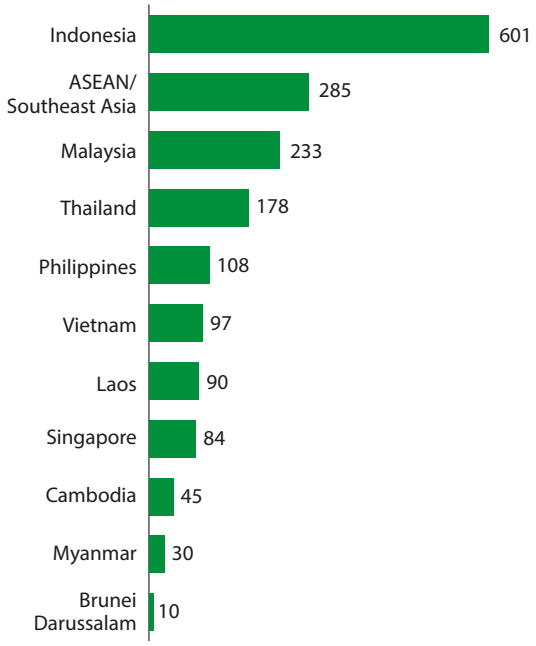

Figure 3. Numbers of articles where countries or the region appear in the title or abstract

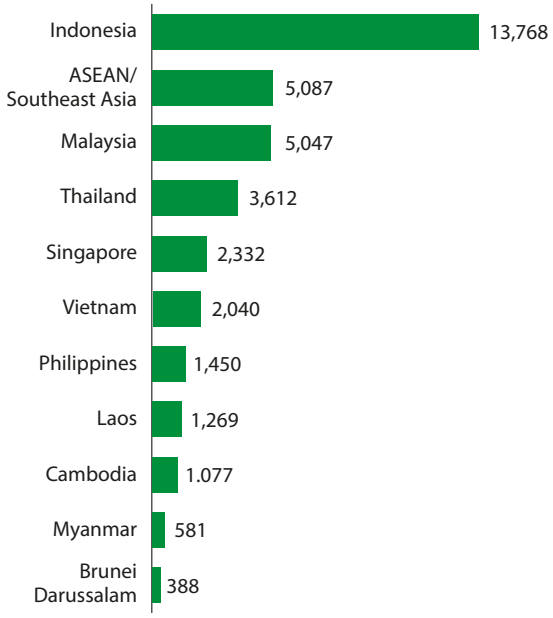

Figure 4. Numbers of articles where countries and the region appear in full texts

searched for sentences containing thematic keywords and recorded the numbers of those that did. Figure 5 shows the results of this extended search. The thematic keywords "monitoring" and "tenure" appeared most frequently in the scientific databases.

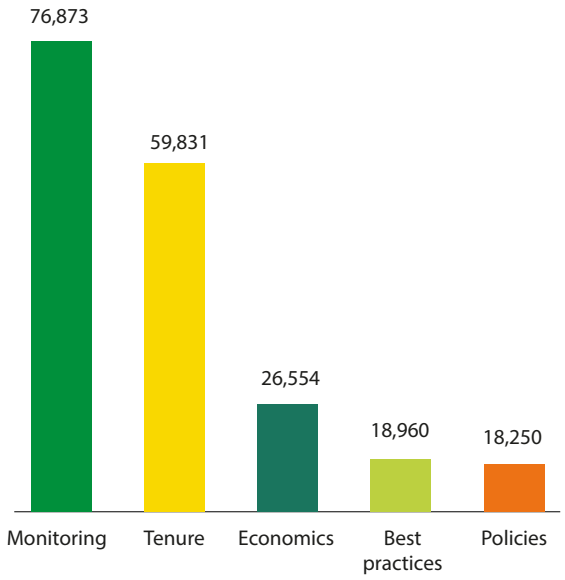

Figure 5. Search results by theme

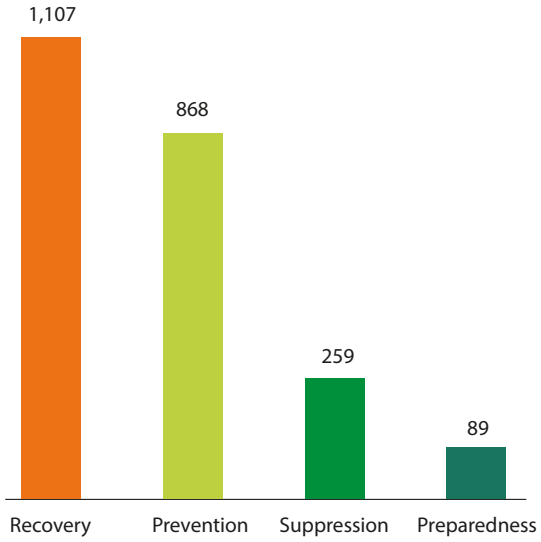

Figure 6. Search results by IFM keyword

We then applied another search to papers from the scientific databases using the keywords relating to Integrated Fire Management: "prevention", "preparedness", "suppression" and "recovery". Figure 6 shows the results of this search, where the keywords "recovery" and "prevention" appeared more frequently than "suppression" and "preparedness".

The following exercise was to identify instances where thematic keywords co-occurred with IFM keywords in the same sentence. Figure 7 shows the keywords

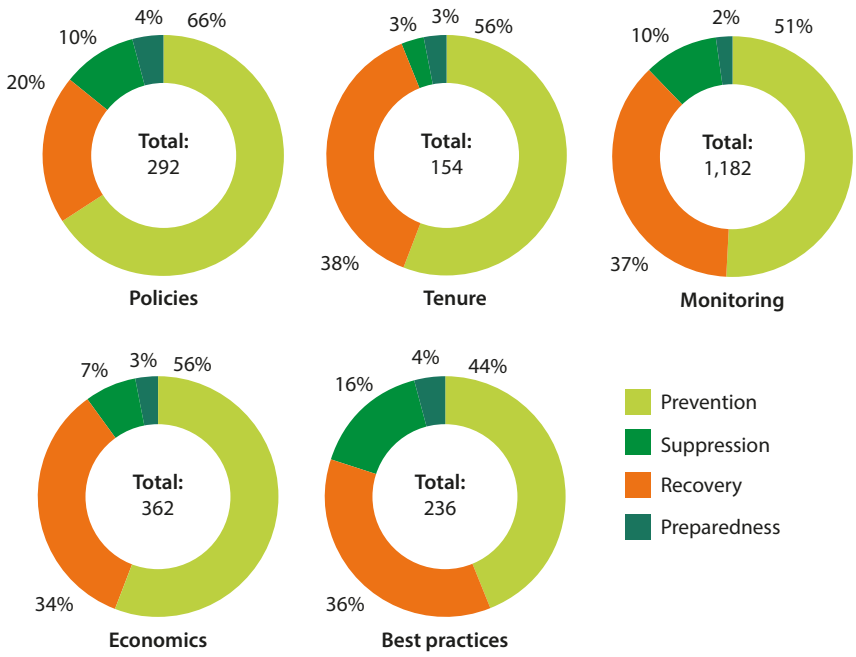

Figure 7. Search results showing co-occurrence of thematic and IFM keywords

Figure 8. Search results showing co-occurrence of country and thematic keywords

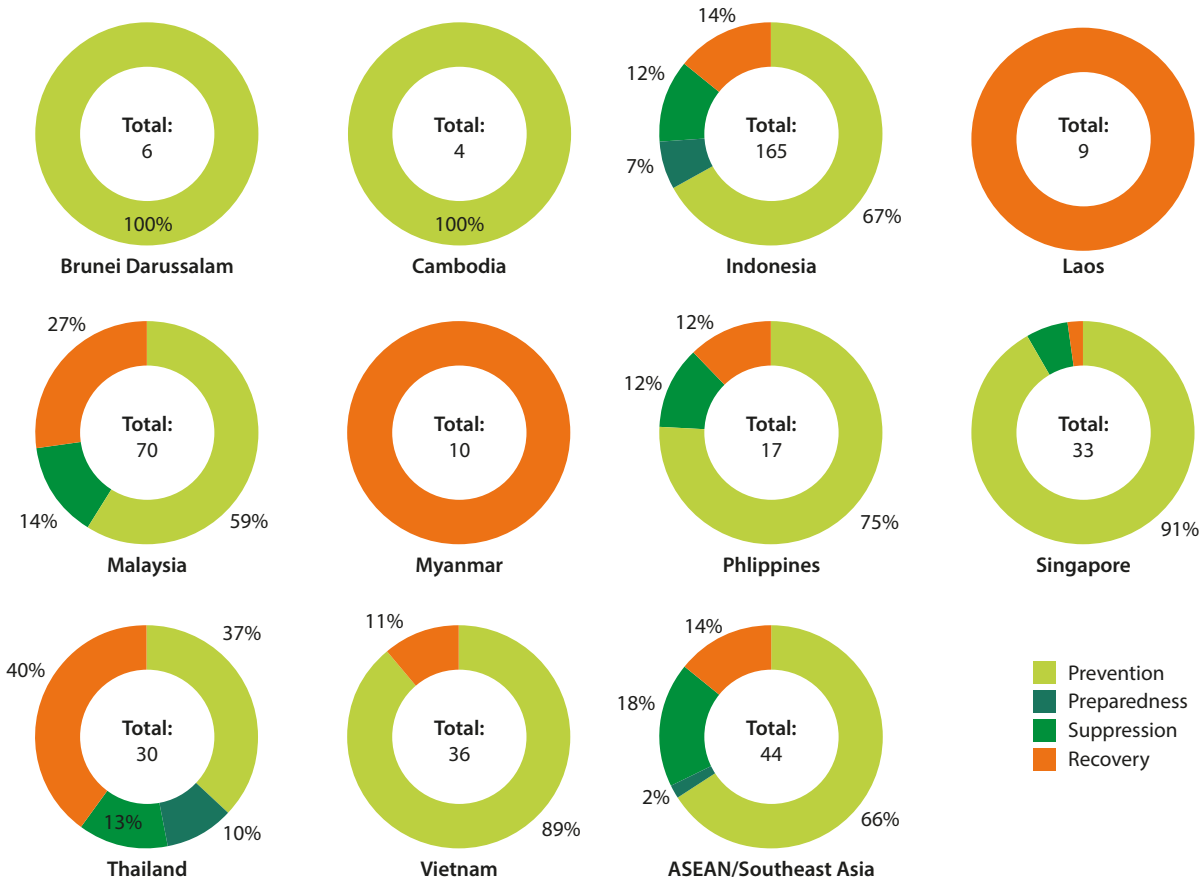

Figure 9. Search results showing co-occurrence of country and IFM keywords

"monitoring", "economics" and "policies" co-occurred more frequently than others in the same sentence as IFM keywords. The IFM keyword "prevention" had the highest level of co-occurrence with all thematic keywords, while "preparedness" had the lowest.

We then identified instances of co-occurrence between thematic keywords and country or region keywords. Figure 8 presents the results, showing the thematic keyword "monitoring" co-occurring most frequently with each of the countries and with ASEAN or Southeast Asia, while "best practices" co-occurred least frequently. The occurrence of other thematic keywords varied across countries. This figure reflects the need to analyse topics relating to best practices in managing peatlands and dealing with forest and land fires.

Finally, we cross-referenced the country and IFM keywords. Figure 9 presents the results, showing country keywords frequently co-occurring with prevention. By combining these results with insight from Figure 8, this finding might suggest that monitoring is an essential instrument for prevention.

3.3 MAHFSA partner publications

We applied a similar exercise to MAHFSA partner publications by determining publication type and content. Figure 10 shows the distribution of MAHFSA partner publications by type. Books, journal articles and info or policy briefs constituted over 70 percent of all publications. Figure 11 shows that similar percentages of publications reviewed in this study provide information and analysis, with the lowest percentage of publications focusing on strategy. It is important to distinguish between information

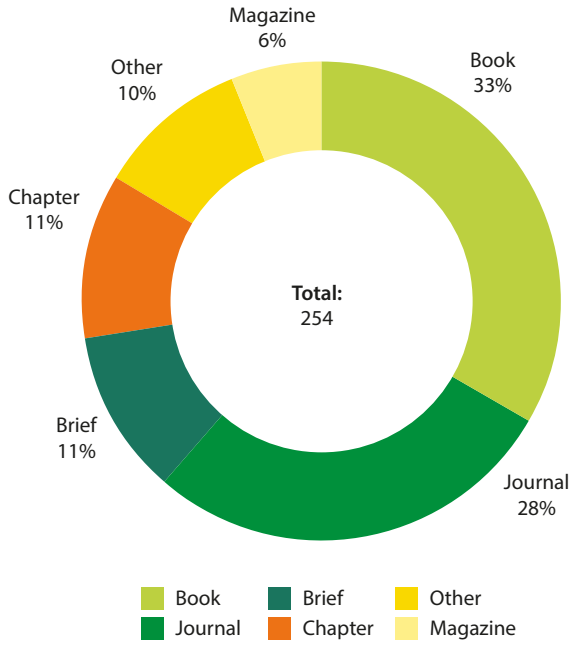

Figure 10. MAHFSA partner publications by type

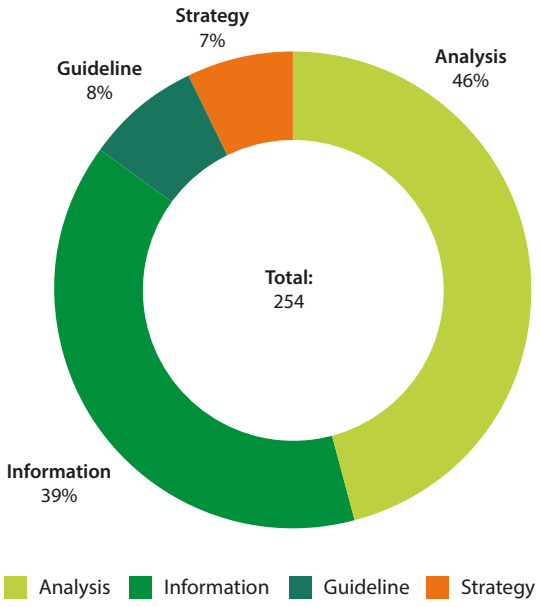

Figure 11. MAHFSA partner publications by content type

as a content type presented in Section 2.1 and in this section. Information in Section 2.1 still requires processing to generate knowledge (for example, statistical data), and was therefore classified as a knowledge product (ADB 2012). In this section, information means a knowledge product having the general purpose to inform.

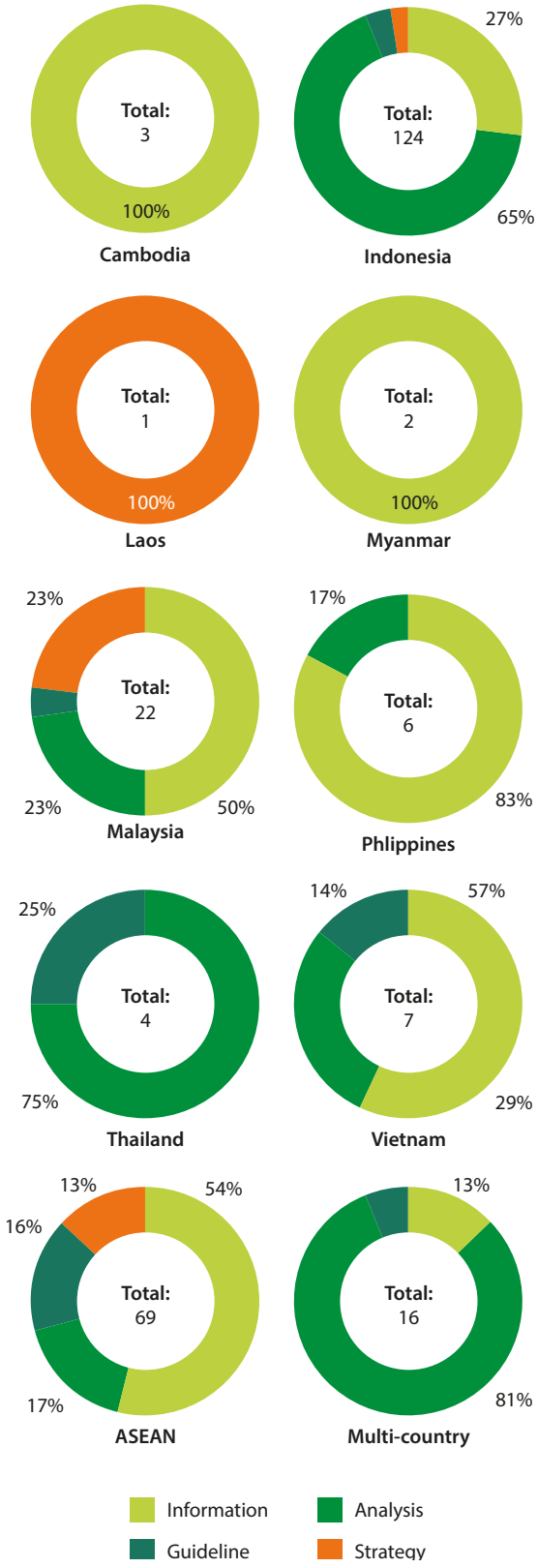

Figure 12. MAHFSA partner publications by knowledge product type

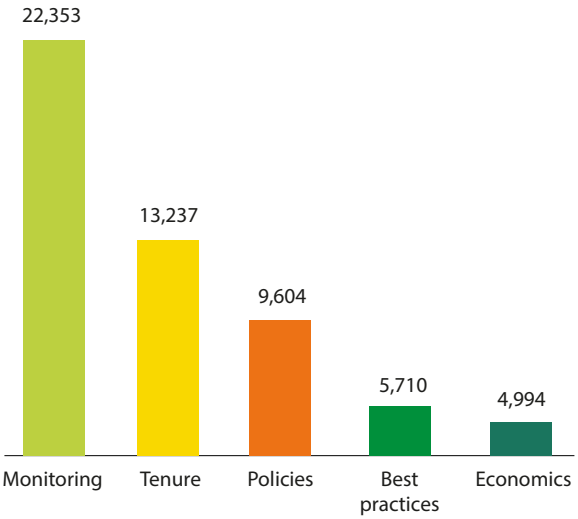

Figure 13. Search results by thematic keyword

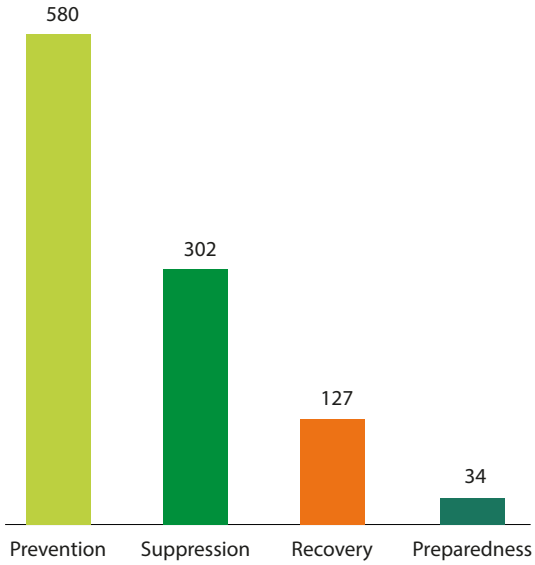

Figure 14. Search results by IFM keyword

Figure 12 provides a breakdown of publications by country, showing that for Indonesia, Thailand and Laos, most MAHFSA partner publications focus on analysis. Thailand and Laos are different because the numbers of publications are not significant. Higher percentages of documents focusing on information are published in Malaysia, the Philippines, Vietnam, Cambodia and Myanmar. The small number of publications focusing on strategy is understandable given the ASEAN Secretariat is probably the only MAHFSA partner producing such documents, and produces more publications on strategy than on other the other three content types.

Figure 13 presents results of searches of MAHFSA partner publications for the five thematic keywords outlined in Section 2.3. We found sentences containing the keywords "tenure" and "monitoring" appeared most frequently across publications, while "economics" and "best practices" occurred least frequently.

Figure 14 presents the results of searches for IFM keywords, where fire "prevention" and "suppression" occurred in sentences most frequently, and "preparedness" least frequently.

Figure 15 presents the results of searches using the country and region keywords. Unsurprisingly, Indonesia, Malaysia, and

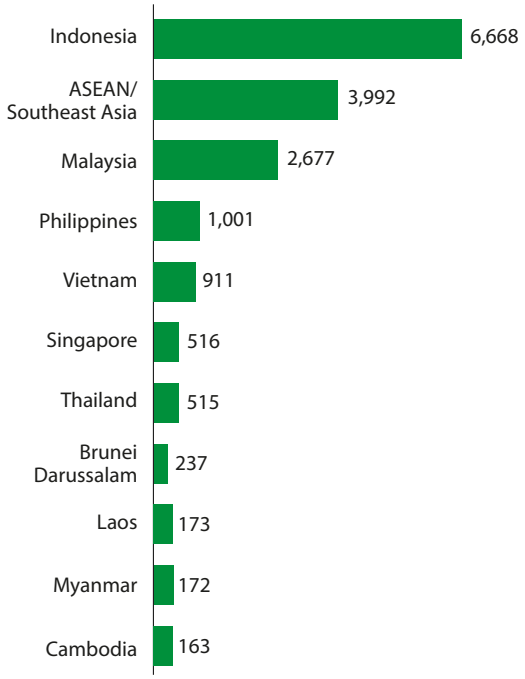

Figure 15. Search results by country/region keyword

ASEAN/Southeast Asia recorded the highest numbers of hits. CIFOR's numerous studies on peatlands in Indonesia and the ASEAN Secretariat and GEC's wealth of material on ASEAN and Southeast Asia were key factors contributing to these results. Figure 15 also shows the relatively low prevalence of studies or reports by MAHFSA partners on ASEAN countries other than Indonesia and Malaysia.

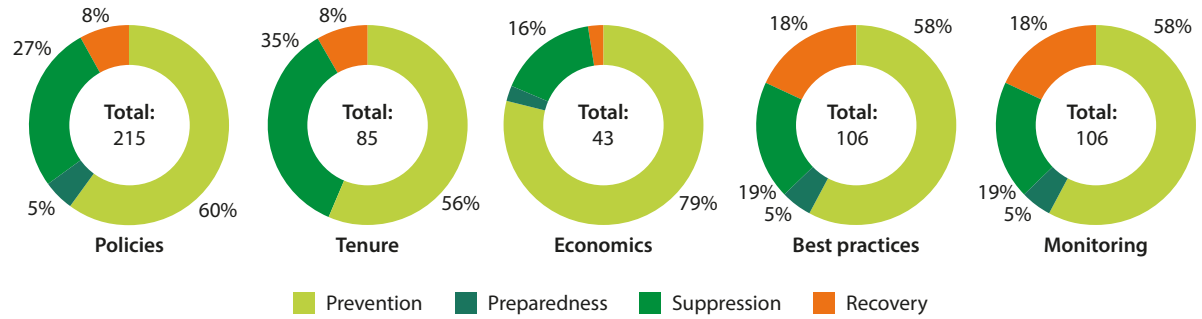

Figure 16. Search results showing co-occurrence of thematic and IFM keywords in MAHFSA partner publications

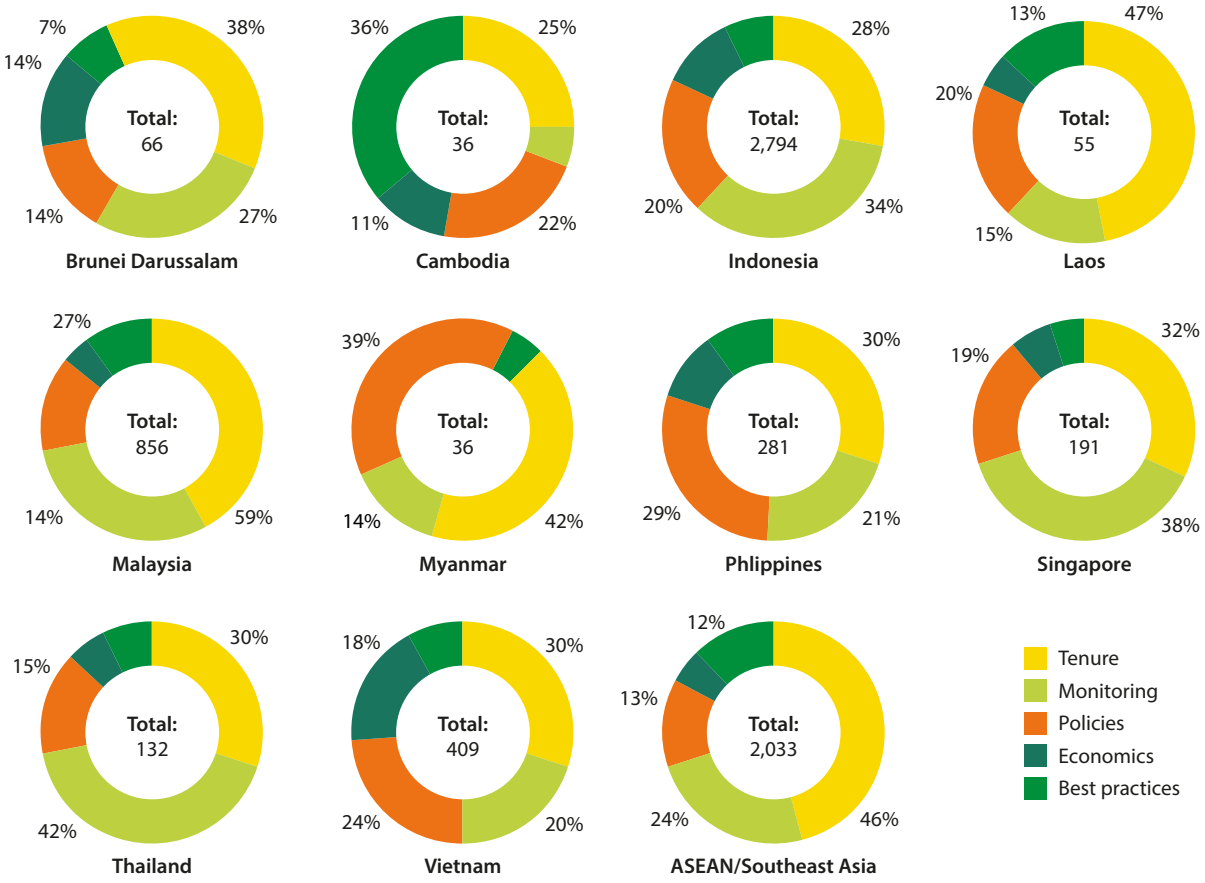

Figure 17. Search results showing co-occurrence of country and thematic keywords

Figure 16 presents instances of co-occurrence between thematic and IFM keywords, showing "prevention" to be the IFM keyword with the highest levels of co-occurrence with all themes, and "preparedness" with the lowest. Indeed, several MAHFSA partner publications emphasize the importance of prevention in the context of Integrated Fire Management (see Figure 14).

Finally, Figure 17 presents instances of co-occurrence between the country and thematic keywords, showing higher levels of co-occurrence for the thematic keywords "tenure", "monitoring" and "policies".

3.4 Documents from national organizations in ASEAN member states

We classified documents collected from organizations in ASEAN member states by content type. Figure 18 shows that documents from organizations in Indonesia, the Philippines and Myanmar focus more on analysis than on other content types. In other countries, larger proportions of documents focus on providing information. In Indonesia, one reason for this was that papers collected included those from the Ministry of Environment and Forestry's Research and Development Agency, which has published numerous documents on peatlands, and forest and land fires. Government agencies generally produce documentation focusing on information, strategies, guidelines and legislation.

Figure 19 presents the distribution of thematic areas for publications from national organizations in five ASEAN member states. For example, it shows "economics" to be the most prominent keyword for Brunei Darussalam, "tenure" for Indonesia, "monitoring" for Malaysia, "best practices" for the Philippines, and "tenure" and "monitoring" for Singapore.

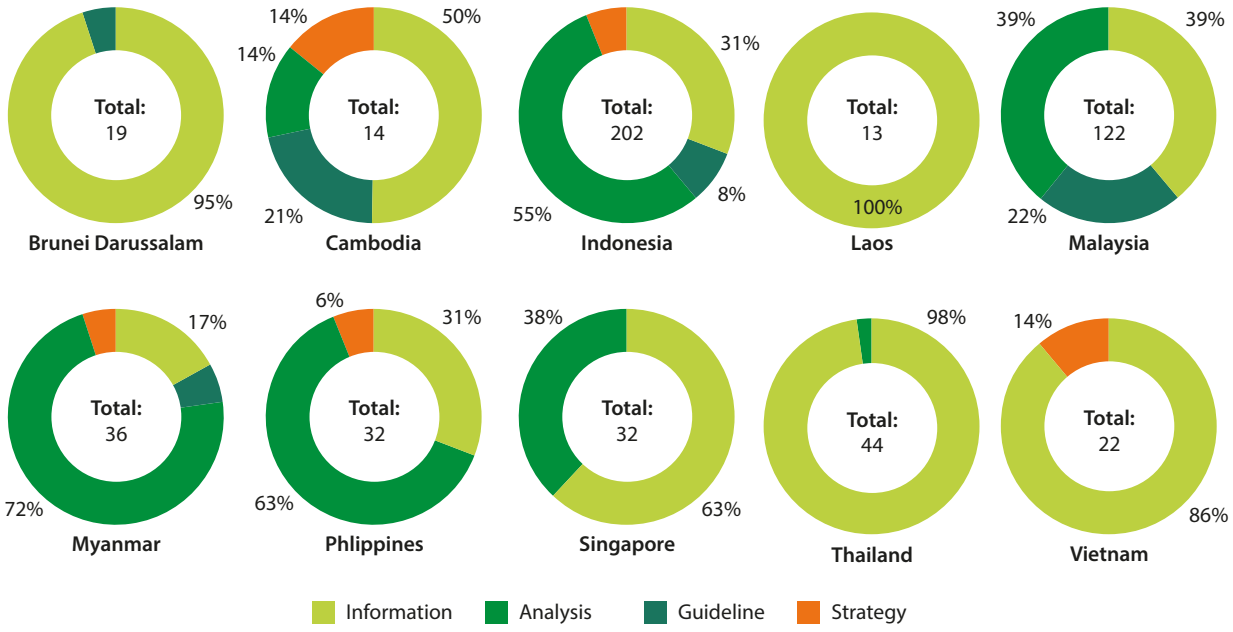

Figure 18. Documents from organizations in ASEAN member states by country and content type

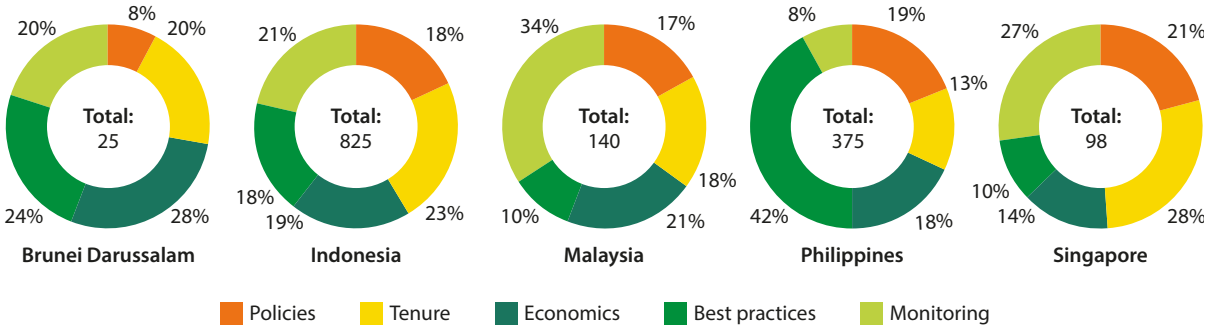

Figure 19. Search results showing co-occurrence of country and thematic keywords

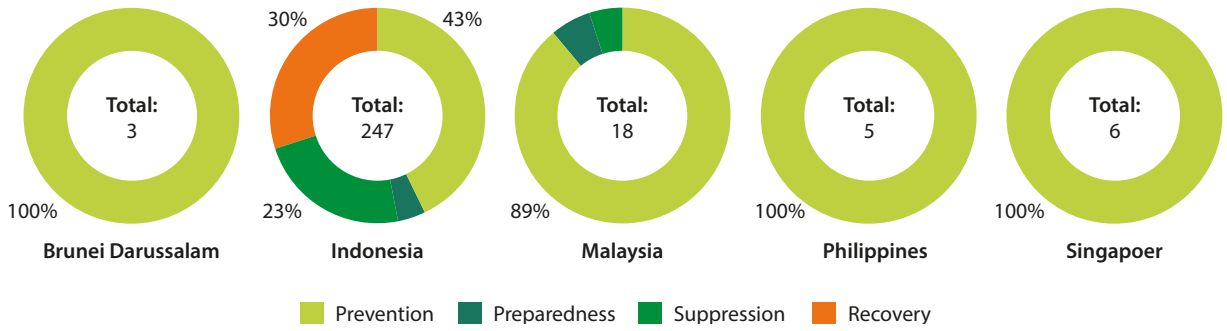

Figure 20. Search results showing co-occurrence of country and IFM keywords

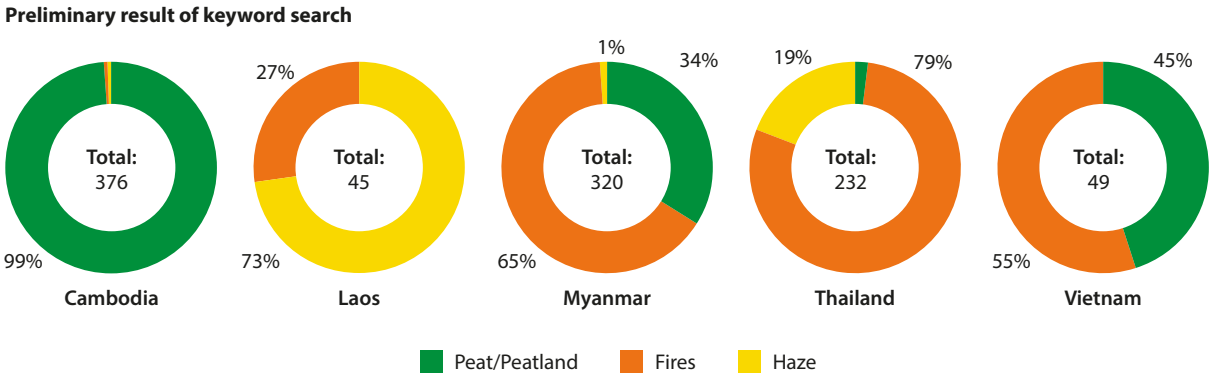

Figure 21. Search results for primary keywords in some ASEAN member states

Figure 20 shows the frequency of IFM keywords appearing in documents published in ASEAN member states. In the five selected states, the keyword "prevention" was most prominent. For example, though both Indonesia and Malaysia have publications covering several IFM keywords (prevention, preparedness, suppression and recovery), the other three countries focused only on the prevention aspect of IFM.

We encountered several challenges translating national languages for Cambodia, Laos, Myanmar, Thailand and Vietnam, with relatively low returns from searches of documents on government websites using Google Translate. Consequently, we did not follow the procedures applied to other countries. Instead, Figure 20 presents the results of searches for the keywords "peat", "peatland", "fires" and "haze". We do not show instances of co-occurrence between these keywords since they were low to non-existent.

4 Discussion

4.1 Summary of findings

In-depth examinations of full texts from the scientific databases indicate the keywords "monitoring" and "tenure" appear most frequently. This finding suggests that most papers mention the importance of aspects relating to monitoring and tenure, even documents not primarily about the policies and economics of peatlands, fires and haze. The prominence of the keywords "monitoring" and "tenure" is relevant considering the most relevant sentences relate to *recovery* and *prevention*. While papers frequently mention thematic areas and Integrated Fire Management separately, co-occurrence between thematic and IFM keywords only arises in a few instances. The co-occurrence analysis shows "prevention" to be the most frequent co-occurring thematic keyword.

Several MAHFSA partner publications are books and journal articles, focusing primarily on *analysis* and *information*. Some exceptions include the ASEAN guidelines on peatland fire management (ASEAN 2015); RSPO manuals for existing oil palm plantations (Parish et al. 2019a, 2019b); and a manual on the management and rehabilitation of natural vegetation associated with oil palm cultivation on peat (Parish et al. 2019b). In addition, some available guidelines or manuals are presented in briefs, though these tend to focus on localized sites.

Similar to scientific articles, MAHFSA partner publications also show the thematic keywords "tenure" and "monitoring" to be most prevalent. In addition, the IFM keywords feature prominently, with the notable exception being a lack of instances of the keyword "preparedness".

National government documentation consists of regulations, government documents, statistics, research papers, and press or media releases. While sentences cover various thematic areas, the most frequently occurring keyword is "prevention".

The two most prevalent thematic keywords across all three document sources are "monitoring" and "tenure", while the most frequently occurring IFM keyword is "prevention".

4.2 Gaps – data sources

The study shows far higher numbers of documents from the scientific databases and MAHFSA partners than from ASEAN member state national governments, except those of Indonesia and Malaysia. Government agencies in Indonesia and Malaysia provide various information relating to peatlands, fires and haze. Indonesia has at least three national agencies involved with peatland issues: the Ministry of Environment and Forestry, the Ministry of Agriculture and the Peatland Restoration Agency. In addition, both aforementioned ministries have their research and development agencies. We managed to collect more than 200 publications of different types covering various topics and content types.

Meanwhile, additional effort is necessary to obtain relevant documents from the national governments of Cambodia, Laos, Myanmar, Thailand and Vietnam, or information about such documents. The lack of available records may be due to the relatively small extent of peatlands in these countries. Another possible cause could be limitations resulting from the use of Google Translate in searches of several documents. This difficulty constitutes a significant challenge to understanding the extent of government policies, plans, studies, or information in several ASEAN member states, particularly those in the northern part of the region.

Another issue was the study not attempting to assess the quality of each of the publications. The initial search of the scientific databases was the first filter for documents and publications on peatland fires and haze and associated thematic areas (policies, tenure, economics, best practices and monitoring). We did not apply any additional filtering for documents beyond removing duplicates. Instead, we tried to resolve this issue by implementing sentence-level co-occurrence analyses of the documents' bibliographic information as well as their full texts.

4.3 Gaps – thematic areas for consideration

Co-occurrence analyses between country and thematic keywords, and between country and IFM keywords indicate the different emphases of thematic and IFM areas. For example, Figure 8 suggests that the most frequently occurring keyword in the scientific databases for each ASEAN member state is "monitoring". Meanwhile, Figure 9 indicates the most frequently occurring IFM keyword is "prevention". A similar pattern is apparent in analyses of MAHFSA partners' publications. These findings suggest the possibility of a link between monitoring and prevention. Another interpretation might be that monitoring has become an increasingly prevalent topic with the advancement of remote sensing technologies and agencies that monitor fires and haze at both national and regional levels.

We combined data from Figures 8 and 17 to develop a simple ranking system for thematic areas. The topic with the highest number of co-occurrences was assigned a rank of 5, while the lowest number was ranked 1. Table 1 highlights areas that might be considered for each country. It shows that partners could pay attention to developing knowledge products on topics relating to best practices in developing future knowledge products. For Cambodia, the development of knowledge products on policies and tenure seems to be of higher importance. For Myanmar and Laos, in addition to best practices, knowledge products could also be explored in the topic of economics.

The findings are generally consistent with those that came from our participation in meetings or events. At the national level, knowledge products on tenure, economics and best practices are lacking. In the thematic area of tenure, there have been few knowledge products on the tenure situation and dynamics in peatland areas, changes in the tenure system and their implications on the communities, and collaboration and conflicts among tenure holders. The financial or economic analysis of income-generating peatland activities and their consequences on peatland conditions are gaps in the

Table 1. Thematic areas for preliminary consideration by country

Country	Policies	Tenure	Economics	Best practices	Monitoring
Brunei Darussalam	**	*	**	***	*
Cambodia	***	***	*	*	*
Indonesia	*	*	*	***	*
Laos	*	*	***	***	*
Malaysia	*	*	*	***	*
Myanmar	**	*	***	***	*
Philippines	*	*	**	***	*
Singapore	*	*	**	***	*
Thailand	*	*	**	***	*
Vietnam	*	*	**	***	*

Source: Authors

Note: *** high priority, ** medium priority, * low priority

Table 2. Preliminary idea for prioritization of knowledge products by country

	Analysis	Guidelines	Information	Strategy
Cambodia	***	***	*	**
Indonesia	**	***	**	*
Laos	*	***	***	***
Malaysia	**	***	*	**
Myanmar	***	***	*	**
Philippines	**	***	*	***
Thailand	*	**	***	***
Vietnam	**	**	*	***

Source: Authors

Note: *** high priority, ** medium priority, * low priority

economics theme. A comparative study on different best peatland management practices across ASEAN member states is also lacking. There are two thematic areas where future knowledge production could be considered at the regional level. First, there is a lack of products and standards on burned area identification and mapping in fire monitoring and mapping. Second, studies focus on lowland peat, which raises the need to fill in the gap in methods for and mapping of upland peat in ASEAN countries.

We applied the same process to data on knowledge product type by assigning a simple ranking system. From the data presented in Figure 12, we developed a table showing knowledge product content that might be considered for each country. Table 2 shows that guidelines and strategies are a higher priority for most countries, while analysis is lower. Guidelines could be developed at a more localized level for Indonesia and Malaysia, as both countries have already developed national- and subnational-level guidelines. It is important to consult with key stakeholders in each country on the results of this prioritization exercise.

While the findings provide some indications from thematic and IFM keywords for each ASEAN member state, soliciting feedback from focal points in those states could provide a better understanding of the knowledge product needs of each one. Consultations with ASEAN member state focal points may help identify the extent to which existing knowledge products are available to meet stakeholder demands. New tailored knowledge products could be developed. For example, new analyses on the implications of major events (such as COVID-19) on fires and haze in ASEAN member states. Moreover, creating a series of guidelines in the form of briefs in ASEAN member states' relevant local languages would help farmers better understand messages on peat, fires and haze. Additionally, more rigorous systematic reviews could be conducted on specific topics.

The study shows that thematic areas and knowledge product types vary between ASEAN member states. In general, knowledge products that provide *analyses* of various issues pertinent to peatlands outnumber knowledge products that *translate* studies to *inform* programme beneficiaries. In addition, this study indicates some areas that have been covered less frequently in previous studies. These areas relate to the economic aspects of and best management practices for peatlands. These are relevant, particularly in light of efforts being made to prevent fires and haze and strengthen various stakeholders' fire preparedness capacity. Since needs may vary between ASEAN member states, during the course of the programme, it will be necessary to gather feedback from ASEAN member states on issues of relevance.

4.4 Feedback from the workshop

The workshop aimed to present and verify the findings and recommendations with relevant stakeholders on the stocktake analysis of existing knowledge products. In terms of knowledge product types, translating analytical products into information and necessary guidelines by key stakeholders will become a key area for consideration. Furthermore, as the MAHFSA programme envisages developing or enhancing a total of 20 knowledge products, consultation with ASEAN peatland and haze stakeholders is an important means for gathering feedback.

4.4.1 Verification and feedback on priorities for updating and reissuing existing knowledge products

Before the workshop, we selected 15 existing knowledge products developed by MAHFSA partners. We applied a scoring method using 23 criteria (Annex 11). We applied a score of 0–3 to all the existing knowledge products, where 0 represented no relevance, 1 – low relevance, 2 – medium relevance, and 3 – high relevance, to identify a list of 15 top-ranked documents (Annex 12). We then verified the list with workshop participants.

During the workshop, participants classified the 15 knowledge products by mapping each of them into four quadrants: a) high urgency-high needs or "do it now"; b) high urgency-low needs or "do it next"; c) low urgency-high needs or "do it when there is time"; and d) low urgency-low needs or "low priority" (Figure 22).

		Needs	
		High	**Low**
Urgency	High	"Do it now"	"Do it next"
	Low	"Do it when there is time"	"Low priority"

Figure 22. Classification method for the knowledge products

Using an electronic Miro board, the exercise showed that 14 of the 15 publications fall under the "do it now" quadrant (Figure 23). Numbers of votes shown in the figure provide an insight into priorities for modifying existing products during the MAHFSA programme. MAHFSA might consider starting with the top five choices in 2021, the following five in 2022, and the remainder in 2023.

4.4.2 Feedback on priorities for new knowledge products

The stocktake analysis identified gaps in existing knowledge and also the need for new knowledge products on the following topics:

- A guideline on burned area identification and mapping
- Development of a methodology and mapping of upland peat in the ASEAN region
- A review of best practices on sustainable peatland management in AMS
- A review of tenure systems on peatlands across AMS
- A review of essential livelihood sources derived from peatlands in AMS

Similar to the previous exercise, using Miro, the participants prioritized the proposed new knowledge products by mapping each of them into the four urgency-needs quadrants: "do it now"; "do it next"; "do it when there is time"; and "low priority".

The exercise showed all five proposed new knowledge products falling under the "do it now" quadrant. Numbers of votes shown in Figure 24 provide an insight into priorities for new knowledge products during the MAHFSA programme. MAHFSA might consider starting with two new knowledge products in 2021, two in 2022, and one in 2023.

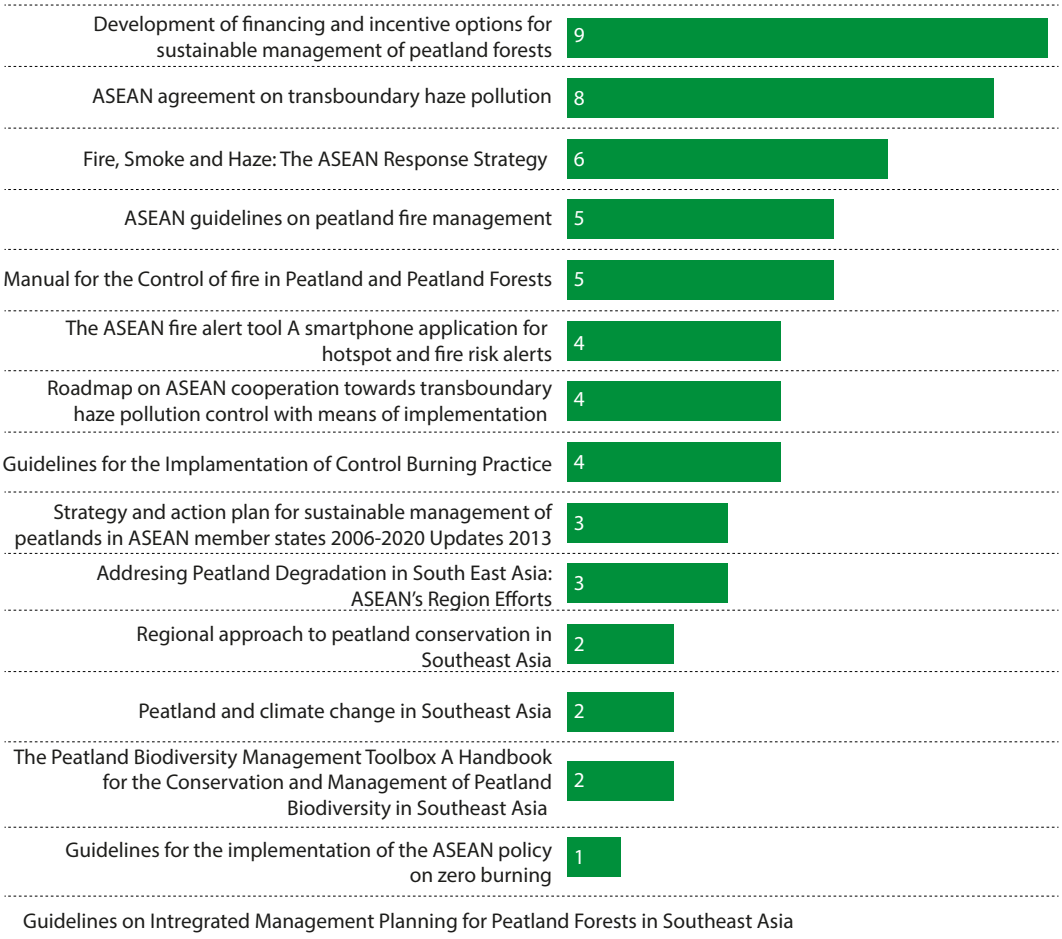

Figure 23. Results of "do it now" quadrant voting on existing knowledge products

Note: Voting results for other quadrants are available in Annex 13

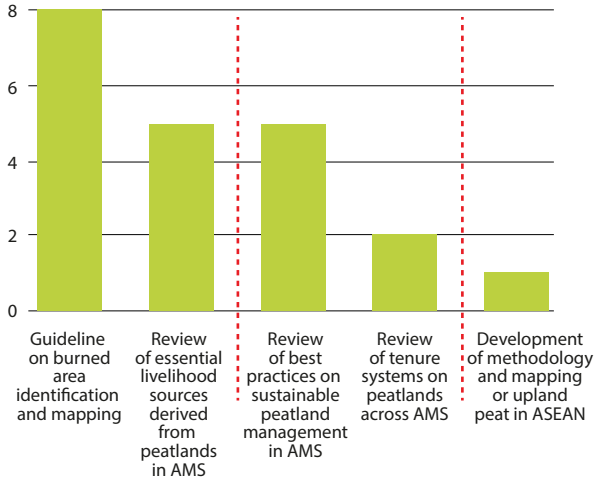

Figure 24. Result of "do it now" quadrant voting on proposed new knowledge products

Note: Voting results for other quadrants are available in Annex 14

4.4.3 Other feedback on knowledge products

Using Miro, we asked the participants to suggest additional knowledge needs. We classified the input received into the following seven categories:

- Paludiculture: A paludiculture study and manual; alternatives to slash and burn; and an overview of traditional controlled burning practices for shifting cultivation in hilly regions for haze pollution prevention
- Hydrology: Hydrology management; technical guidelines on canal blocking and rewetting; a handbook for integrated hydrological management of peatlands; and quantification of stormwater absorption capacity of peatlands

- Peatlands and climate change: ASEAN peatland contributions to climate change issues; a manual for carbon stock assessments on peatlands; evaluations of GHG fluxes and emissions; valuation of peatlands; and climate change adaptation for peatlands
- Monitoring systems: An integrated peatland monitoring system for the national to village levels; and a real-time fire occurrence warning system using citizens' contributions (e.g., a smartphone app available for free)
- Sustainable peatland management: Sustainable peatland management by large-scale corporations; and public-private business models for sustainable peatland management
- Technologies: Determining peat depth using ground-penetrating radar; and vegetation mapping and landcover classification for peatlands using UAVs with RGB and NIR sensors
- Knowledge portal: as a service for accessing knowledge products

5 Conclusions

This study provides an overview of knowledge products on various thematic areas relating to peatlands and fires in Southeast Asia published over the last 30 years. Analyses of scientific databases show that, to different degrees, existing journal articles cover the five thematic areas of interest: policies, tenure, economics and livelihoods, best practices, and monitoring. Analyses of the economic and livelihood implications of policies, tenure systems, and monitoring methods and technologies are relevant in guiding best practices. In terms of fire management, most products specifically discuss fire prevention as a critical area under an integrated fire management system.

Meanwhile, analyses of MAHFSA partner publications (ASEAN Secretariat, CIFOR and GEC) and other organizations suggest that most constitute studies in the form of journal articles and reports. To enable knowledge products to reach a wider audience, one consideration might be to update or synthesize them by adding the latest knowledge from the scientific databases. An additional option might be to develop complementary products derived from these publications on the thematic areas discussed above using the latest data analyses and insights. Another key area for consideration should be to strive to translate analytical products into the information and guidelines deemed necessary by key stakeholders.

Concerning findings at the AMS level, the study suggests major thematic areas for modifying existing knowledge products or generating new products to be best practices, economics and tenure. Relatively few knowledge products have been published on peatlands and fires in AMS other than Indonesia and Malaysia. The lack of knowledge products specific to peatlands might suggest peatland management issues lie in broader development contexts. These findings are also corroborated by the results of the ASEAN Peatland Management Strategy review, where countries in the Mekong region consider peatlands to be an integral part of broader development contexts such as wetland management and agricultural development. For that reason, MAHFSA might consider generating knowledge products in different thematic areas as well. In this regard, developing knowledge products on a broader range of thematic areas is particularly important under the context of the ASEAN Peatland Management Strategy review.

Consultations with ASEAN member state focal points and other relevant partners were essential for gathering feedback. Their feedback generally corroborated findings, where additional feedback concerned modifying existing products or proposing new knowledge products.

6 Recommendations

MAHFSA could pay more attention to developing a knowledge base relating to all thematic areas associated with peatland management. It is important to note that while the initial number of knowledge products collected is large, knowledge generation in this area has become more frequent over time, as indicated in Figure 1. This means the preparation of knowledge products should consider available information and any new information yet to be included in this stocktaking. When such documents or tools are already available, the MAHFSA programme might consider developing a variety of knowledge products that better serve the programme's beneficiaries. Understanding the types of knowledge products could help provide a better understanding of the demands of stakeholders in Southeast Asia and beneficiaries of the MAHFSA programme.

As the next step, we recommend conducting systematic reviews of existing documents for thematic areas deemed important by the programme's key stakeholders, including MAHFSA partners, to better understand the complexity of issues within a given thematic area or the interactions between different thematic areas. Conducting such systematic reviews would facilitate knowledge generation by synthesizing existing knowledge in a rigorous and systematic way. Knowledge products that are more accessible to the key target groups indicated in Table 1 and Table 2 could either be developed simultaneously, or derived from the results of the systematic reviews.

Table 3 shows the list of existing knowledge products for 2021 and their proposed modifications. We note that several of these products do not need to go through updating processes, particularly as this will be time consuming and require AMS re-approvals. We will consider translating the current knowledge products into AMS national languages or preparing other formats representing the original products, such as the development of info briefs or infographics, with updated information.

We propose developing two new knowledge products in 2021. The first is a guideline on burned area identification and mapping. Building on the policies and practices underway in Indonesia, this new knowledge product will explain methodologies for identifying and mapping burned areas, which could be applied in other AMS.

The second knowledge product is a review of essential livelihood sources derived from peatlands in AMS. A framework for livelihood analysis will be developed, and case studies

Table 3. Proposed re-issuance of existing products in 2021

Title	Proposed modifications		
	Update	Translate (AMS)	Reformat
Fire, Smoke and Haze: The ASEAN Response Strategy	N	Y	Y
ASEAN guidelines on peatland fire management	Y	Y	N
Manual for the Control of Fire in Peatlands and Peatland Forest	N	Y	N
Development of financing and incentive options for sustainable management of peatland forests	N	Y	Y
ASEAN Agreement on Transboundary Haze Pollution	N	N	Y

on the ways communities derive livelihoods from peatlands and their implications on peatland conditions will be reviewed and analysed.

Finally, in addition to transforming existing knowledge products and generating new ones, MAHFSA could consider supporting converting and sharing specific knowledge products that are not addressed in the stocktake analysis. One major area of concern is to emphasize the importance of peatlands for climate change mitigation, and elaborating on the opportunities and challenges therein.

Another major area is to facilitate knowledge sharing between relevant agencies in AMS. For example, at the request of other ASEAN member states, MAHFSA could help translate some of the best management practices developed in Indonesia. MAHFSA could also build synergies with other ASEAN peatland programmes on developing knowledge products on topics that are deemed relevant. In this case, MAHFSA would facilitate knowledge exchange on various issues related to peatlands and haze between AMS and between ASEAN peatland programmes.

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Annexes

- Annex 1 - List of scientific articles
- Annex 2 - MAHFSA partners' publications
- Annex 3 - Agencies in AMS and their publications
- Annex 4 - Initial search codes
- Annex 5 - List of codes
- Annex 6 - Summary of policy issues
- Annex 7 - Summary of tenure issues
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- Annex 9 - Summary of management issues
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- Annex 13 - Votes for the existing knowledge products in other quadrants
- Annex 14 - Votes for the proposed new knowledge products in other quadrants

Being a host of 60% of global tropical peatlands, studies on Southeast Asian peatlands are enormous. This paper attempts to summarize the knowledge products on various issues related to peatland in the region. The report draws from a literature review of scientific databases and the publications of the partners of the Measurable Action for Haze-free Sustainable Land Management in Southeast Asia (MAHFSA) programme. The report aims to highlight how studies on five thematic areas (policies, tenure, economics, best practices, and monitoring) emerge over the last 30 years. This finding suggests that most papers mention the importance of monitoring and tenure and the focus on prevention and recovery. The report also indicates several knowledge gaps. At the regional level, new knowledge products could develop a framework for identifying and mapping burned areas applicable among ASEAN member states. As studies mainly focus on lowland peat, there is a need for knowledge products on the methods and mapping of upland peat in Southeast Asia. Other gaps are related to better understanding the tenure system on peatland and its dynamics, income-generating activities, their impacts on peatlands, and different best peatland management practices.

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