FOREST FIRE
MANAGEMENT
IN THE TROPICS

AFoCO

PREFACE

As reflected in this webinar, fire management has been and remains an active issue of interest and concern for decades. In order to manage knowledge and information gained through AFoCO projects on fire management, as well as for future project development and to share these with relevant stakeholders systematically, the Secretariat organized this webinar on 'Forest Fire Management in the Tropics' on 8-9 December 2021.

The intention was to gather some of the knowledge based on the materials presented and other materials as appropriate on the AFoCO website, provide a consolidated publication summarizing the content and input from the webinar and use this to improve project proposals of forest fire management and/or provide ideas for new program/project by applying the input from the webinar.

This event also provided an opportunity to update on progress in research, projects and activities across the region and globally and provide some inputs to enrich the Fire Management Forum to be held during the World Forestry Congress. Reflecting fire ideas, issues and innovations from the region provides relevant input to the Forum and provides visibility for the region through the efforts of AFoCO, Food and Agriculture Organization of the United Nations (FAO) and their partners.

The AFoCO Secretariat warmly acknowledges and appreciates the dedicated and generous contributions of all authors and editors who have made this publication possible.

Firstly, we would like to express our sincere appreciation to our authors, Peter Moore, Fire Management Specialist, FAO, Dr. Kikang Bae, Program Officer in Cooperation and Project Division, AFoCO, Dr. Jesus San-Miguel-Ayanz, Program Officer, European Commission-Joint Research Centre, Dr. Dimitris Stratoulias, Senior Scientist, Asian Disaster Preparedness Center, Dr. Nion Sirimongkonlertkun, Researcher, Rajamangala University of Technology Lanna, Thailand, Mr. Raphy Favre, Consultant, FAO- Timor-Leste, Dr. Ahmad Ainuddin, Project Manager of Sustainable Management of Peatland Ecosystems in Malaysia, and Dr. Barbara Goncalves, Technical Advisor, Sustainable Use of Peatland and Haze Mitigation in ASEAN for the input that they provided throughout the entire process.

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We would like to extend our gratitude to the AFoCO and all respective organizations involved in this publication.

FOREWORD

Since AFoCO was officially established in 2018, it has grown to 16 member countries and is planning to start our regular webinar as a channel to communicate more with member countries and partners to cope with global issues in forestry.

The increasing incidence, extent and severity of uncontrolled burning globally, together with its many adverse consequences, has brought fire into the international environmental policy arena, with growing calls for international action leading to greater control of burning, especially in tropical countries. Despite this concern, there is a lack of accurate and timely information on the numbers of fires and area burned annually at national, regional and global scales, and on the social, economic and environmental costs.

Given that the fire is also an important natural process in many ecosystems, and that people have traditionally used fire for millennia as a land-management tool, the challenge is to develop informed policy that recognizes both the beneficial and traditional roles of fire, while reducing the incidence and extent of uncontrolled burning and its adverse impacts.

Forest fire management was selected for our first webinar to underscore the need to address the increasing vulnerability of ecosystems and human populations to uncontrolled forest fires in the tropics. I believe this webinar will provide information on the status, regional trends of forest fire management issues in the tropics and also will be a venue to think about future directions in terms of fire management in the region.

Thank you.

April 2022
Ricardo Calderon
Executive Director
Asian Forest Cooperation Organization

KEY MESSAGES

The region has good examples of fire management research, operational procedures, agency capacities and national approaches, that provide a set of ideas and actions that are relevant and replicable.

Indeed, good practices exist and have been developed in the countries of the region, with key examples illustrated during the Asian Forest Cooperation Organization (AFoCO) webinar. It is acknowledged that the solutions identified are not yet widely known or applied and there are further fire management problems that need attention.

Hence, the approach to be taken to close the gaps, by AFoCO and other partners, will need to strengthen cooperation among countries, identify the appropriate levels to address the issues of fire management for example regional, national, sub-national and/or community. Moreover, it would be essential to create synergies among the relevant fire management stakeholders to work collaboratively and exchange data, information, methods, approaches and systems.

The initial steps may include

▹ Continuing to identify, examine and document existing fire management good practices
▹ Enhancing cooperation among countries
▹ Ensuring a collaborative effort among stakeholders for integrating fire issues as part of sustainable development
▹ Enabling and reinforcing an integrated framework approach to fire management
▹ Linking fire management efforts in the region to those elsewhere

This could be achieved through

▹ Enabling collaboration and strengthening existing fire networks
▹ Building the body of knowledge
▹ Supporting regional approaches
▹ Identifying the initial steps as an example during the Fire Management Forum at the World Forestry Congress (WFC) in Seoul, Republic of Korea (2-6 May 2022)

CONTENTS

FOREST FIRE MANAGEMENT IN THE TROPICS
: STATUS, CHALLENGES & OPPORTUNITIES

1. Forest Fire Management in the Tropics:
Status, Challenges & Opportunities

1.1 Trends of Forest Fires

Damaging forest and land fires are symptomatic of an imbalance in natural systems exacerbated by human interventions. An average of 122 million hectares of forests are annually affected by forest fires, pests, diseases, invasive species, drought and adverse weather events. In particular, 76 million hectares are affected by forest fires alone. A mutually reinforcing cycle of climate change and wildfire is emerging. Wildfires increase degradation through their impacts on forest ecosystems, and degradation contributes to wildfires in altered and secondary forests with exposed fuels, invasive species and recurring fires, and associated impacts on forest health. Available data shows a trend of increasing frequency and intensity of uncontrolled fires adversely affecting biodiversity, ecological services, human well-being, livelihoods and national economies.

Extreme wildfires are the result of past and present policy, planning and governance decisions that, coupled with increasingly adverse weather conditions due to climate change, create the conditions for fires to ignite and spread across landscapes beyond societies' capacity to suppress them.

This is also the case in the Asia region and coherent action is required to prevent extreme wildfires where possible and limit the disastrous results of such events. The impacts of extreme wildfires can be significantly reduced with the right approaches such as investments in wildfire prevention and integrated fire management. As demonstrated in this webinar, application of such approaches, tools and technologies are more cost-effective as opposed to fighting larger and fast-spreading wildfires.

1.2 Major Causes of Forest Fire in Asia

Forest fires vary regionally among the countries, and even different temporal and spatial causes can arise within the same country. Among the possible causes, man-made or anthropogenic activities are recorded as the main cause of the forest fires according to the available country reports and interventions by the participating member countries during the training. A summary of the causes of the forest fire in member countries is shown in **Table 1**.

According to **Table 1**, a majority of the participating countries reported that human activities are the main cause of forest fires. The most commonly mentioned anthropogenic causes include land clearing for agriculture, shift cultivation, settlement, concession, harvesting non-timber forest products and hunting.

The Central and North-East Asia countries of Kazakhstan, Kyrgyzstan and Mongolia have reported that the transition of steppe fires is a major cause for the

shift to large-scale forest fires. In particular, lightning-induced fires is one of the natural factors observed in Central Asia Countries such as in Kazakhstan and Kyrgyzstan. The main natural factor includes the lightning discharge, followed by the transition of steppe fires and human-induced causes. Lighting ignition is relatively high, owing to the continental climate and the regular occurrence of thunderstorms during the fire season (April–September) in Kazakhstan. The country report of Kazakhstan reported that about 32.5 percent of the forest fire is caused by lightning. However, in addition to the identified causes, the unknown reasons which account to 48.5 percent and 78.5 percent of the forest fires in Kazakhstan and Krygystan respectively are mentioned in the country reports.

Table 1	Underlying causes of forest fire in Asia													
Activities	BT	BN	KH	ID	KZ	KG	LA	MY	MN	MM	PH	SG	TH	VN
1 Poor agricultural practices (e.g., open burning for land preparation, agricultural debris burning etc.)	N	Y	N	Y	N	N	N	Y	N	Y	N	N	N	Y
2 Human activities for daily livelihood and recreation (e.g., hunting, honey harvesting, resin collection etc.)	Y	N	Y	N	N	N	Y	N	N	Y	N	N	Y	Y
3 Natural Setting and its effect (e.g.,topography, weather, lightning discharges, strong wind, etc)	Y	N	N	N	Y	N	Y	N	Y	N	N	N	N	Y
4 Carelessness	Y	Y	N	N	N	N	Y	N	N	N	N	Y	Y	N
5 Shifting cultivation	N	N	Y	N	N	N	Y	N	N	Y	N	N	N	Y
6 Land conversion for settlement, agriculture, concession, etc.	N	Y	Y	N	N	N	N	N	N	N	N	N	N	N
7 Conflicts (e.g., policy conflict, human-wildlife conflict, etc.)	Y	N	N	N	N	N	N	N	N	N	Y	N	N	N
8 Limited capacity on addressing forest fire problem (e.g., human resource, technology, financial etc.)	N	N	N	Y	N	N	N	N	N	Y	Y	N	N	N
9 Transition of steppe fires	N	N	N	N	Y	Y	N	N	N	N	N	N	N	N

(Source: Country reports from the Member Countries at the AFoCO Short-Term Training Course on Forest Fire Management Information System , 1-5 November 2021) Y= Yes, N= No or N/A | **BT**= Bhutan; **BN**= Brunei Darussalam; **KH**=Cambodia; **ID**=Indonesia; **KZ**= Kazakhstan; **KG**= Kyrgyzstan ; **LA**= Lao PDR; **MY**= Malaysia; **MN**= Mongolia; **MM**= Myanmar; **PH**=Philippines; **SG**= Singapore; **TH**= Thailand; **VN**= Viet Nam.

▶▷ Forest Fire by Agricultural Activities

▶▷ Forest Fire by Waste Burning

1.3 Statistics of Forest Fire

The status of wildfires vary among continents and countries. **Figure 1** shows the average burned area and the average number of fires that occurred across continents from the years 2002–2019. Asia is highlighted as the 4th continent to have the largest burned area and the 3rd highest number of fire occurrences compared to other continents. According to the Global Wildfire Information System (GWIS), an average area of approximately 560,000 hectares was burned by 2,280 forest fires throughout the years of 2002–2019.In the region, most of the fires that occurred in that period took place mostly in the mainland Southeast Asia (Lower Mekong Basin) as shown in **Figure 2**. Kazakhstan had the highest burned area of approximately 8.8 million hectares in the past decade, while the number of fire occurrences is recorded as 7,463, which is relatively low compared to other countries. As seen from **Figure 2**, the burned area ratio being higher than the number of

fires is also similar to Mongolia, whereas in Cambodia, Indonesia, Laos, Myanmar, Philippines, Thailand and Vietnam, the number of fires is higher than the subsequent burned area.

According to the 2002–2019 data obtained from the GWIS, the average ratio between burned area and country size is very high in AFoCO member countries, with a ratio of 2.3. Even though the ratio needs to be validated by comparing field data on the ground, this information is meaningful as an only source of global forest fire information.

Figure 3 shows the total number of fires that occurred in the member countries within the past decade. It can be deduced that there are no significant trends across years. This does not support the general understanding that as climate change creates warmer, drier conditions and increases the occurrence of droughts, fire seasons are becoming more extreme and widespread across

| **Figure 1** | Average burned area and the average number of fires in continents (GWIS, 2002–2019) |
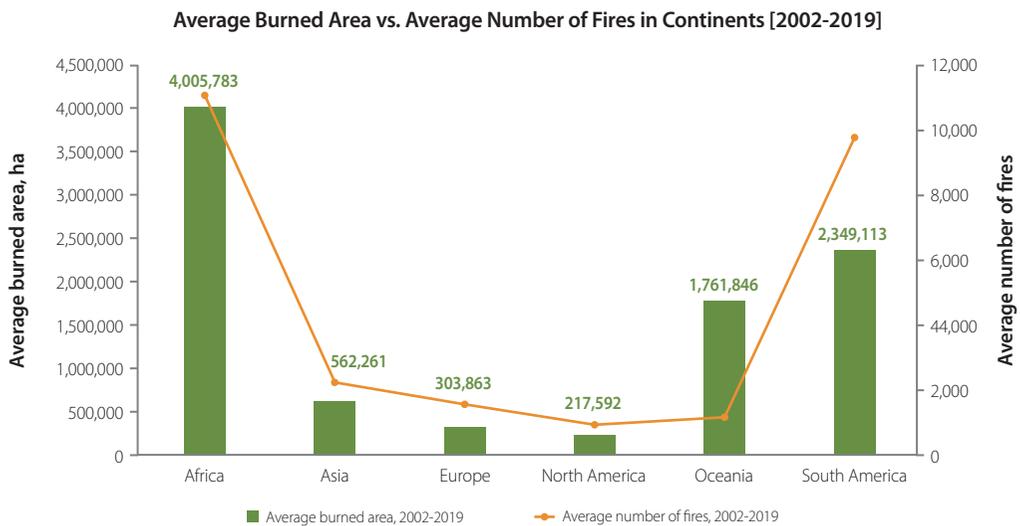
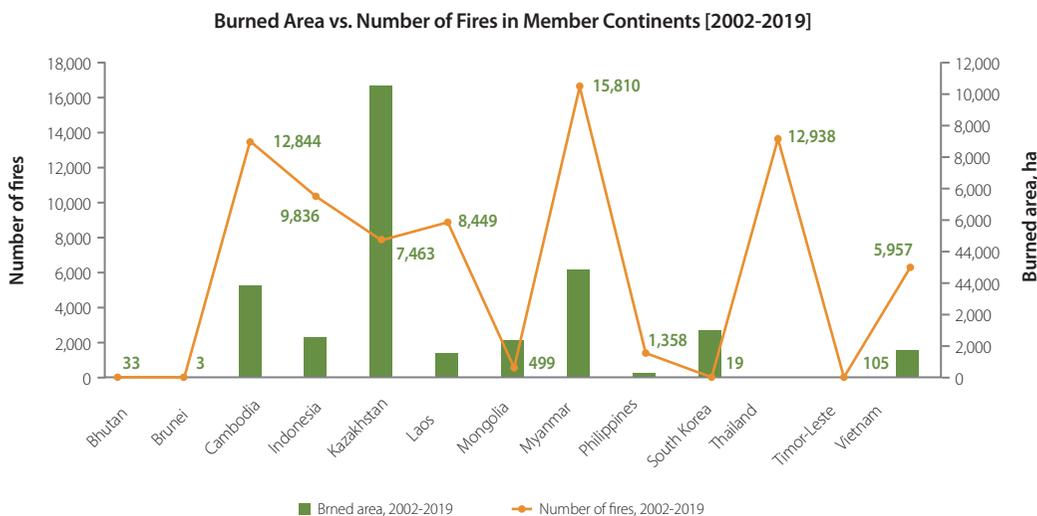Source: Globa Wildfire Information System, 2002-2019

the globe, increasing the impacts of forest fires. In total, 1,355,000 hectares of area was burned from 2002–2019 (this area is similar to the total land area of our member country, Timor-Leste).
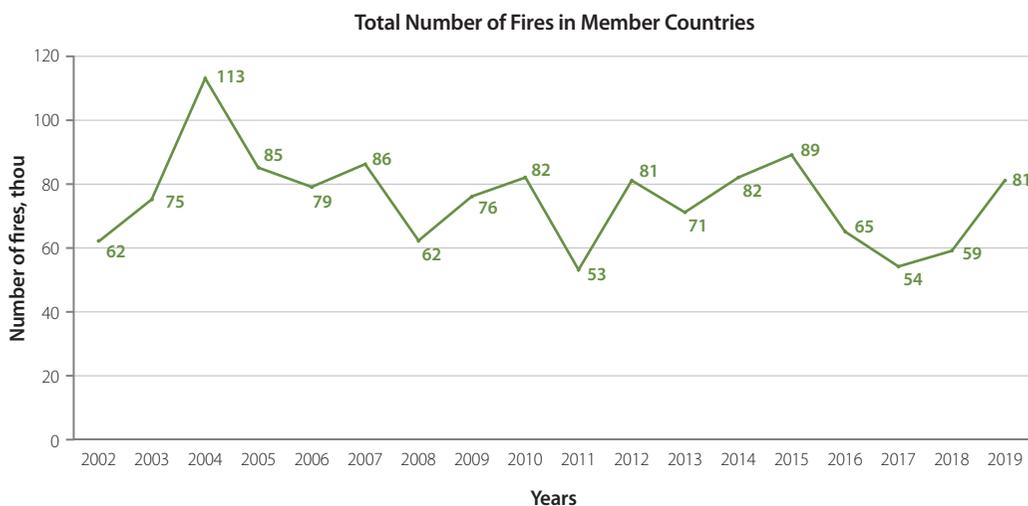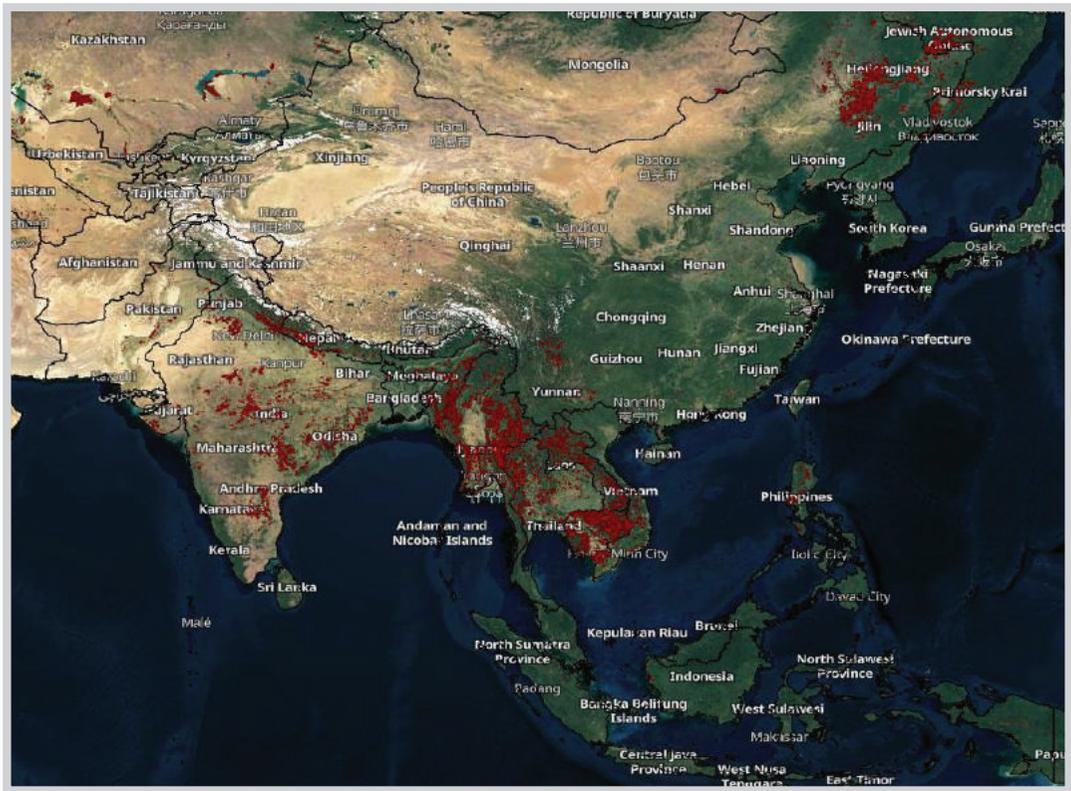
Burned Area vs. Number of Fires in Member Continents [2002-2019]

Source: Globa Wildfire Information System, 2002-2019

Total Number of Fires in Member Countries

▶▷ Fire Burned Areas in 2021, GWIS

1.4 Forest Fire Research Trends in Asia

Forest fire is a complex system with multidimensional factors that influence its growth, propagation, and extinction. Over the years, forest fires have become larger and more frequent causing large-scale destruction and environmental impacts. To manage these forest fires, considerable effort is needed to understand the dynamics and factors that lead to these circumstances and identify potential mitigation actions to reduce the impacts.

It is important for each country to undertake forest fire research to provide insight and potential solutions for the occurrences of forest fires. Asian countries have been embarking on forest fire research activities and this study aims to highlight the research trend that each country has on forest fire research. Ideally, insights obtained from the study will provide an understanding of the direction of each country's research, its strengths and weaknesses, and the research gaps that exist.

This study was conducted using the Scopus© database and a preliminary search using the keywords, 'forest fires', and 'country names' from the year 2016–2020. The database is able to filter keywords found in the title

and abstract of articles, conference proceedings, and books that were available within the stipulated period. The search results were then analyzed for duplications and errors. Notably, the limitation of the database is that only for English-written articles, conference proceedings, and books within the reference years are available.

Indonesia ranked highest with a total number of 395 publications on forest fires for the study period (2016–2020) followed by Malaysia with (66) then the Republic of Korea with (59) (**Figure 4**). Timor-Leste had no publications. Lao PDR had the second-lowest (9) and Bhutan had the third-lowest number of publications (8) during the study period. The database search reveals that Indonesia is way ahead in the publications of forest fires research materials regionally.

Analysis on the types of publications showed that 85 percent of the publications were journal articles, 10 percent were from conference proceedings and 5 percent were from books (**Figure 5**). As the majority of the publications were from journal articles, it shows that academic journals are the preferred medium for

researchers to share their work with colleagues and other researchers.

Research on forest fires often involves various themes (**Figure 6**), showing the diversity and complexity in forest fire research. Our analysis shows that 26 percent of the publications were categorized as Environmental Science followed by Earth and Planetary Sciences (16 percent) and Agricultural and Biological Sciences (13 percent). The fourth highest was from the Social Sciences category making up 8 percent of the total publications.

In summary, articles in the Environmental Science category focus on the impacts of forest fires on the environment especially on the haze and atmospheric pollution. The articles in Earth and Planetary Sciences category deal with the earth's atmospheric processes such as variation in temperatures, occurrence of droughts, and other meteorological factors that influence forest fires. The articles in the Agricultural and Biological Sciences category study the relationship between forest fires, plant species and ecological processes. In the Social Sciences category, a majority

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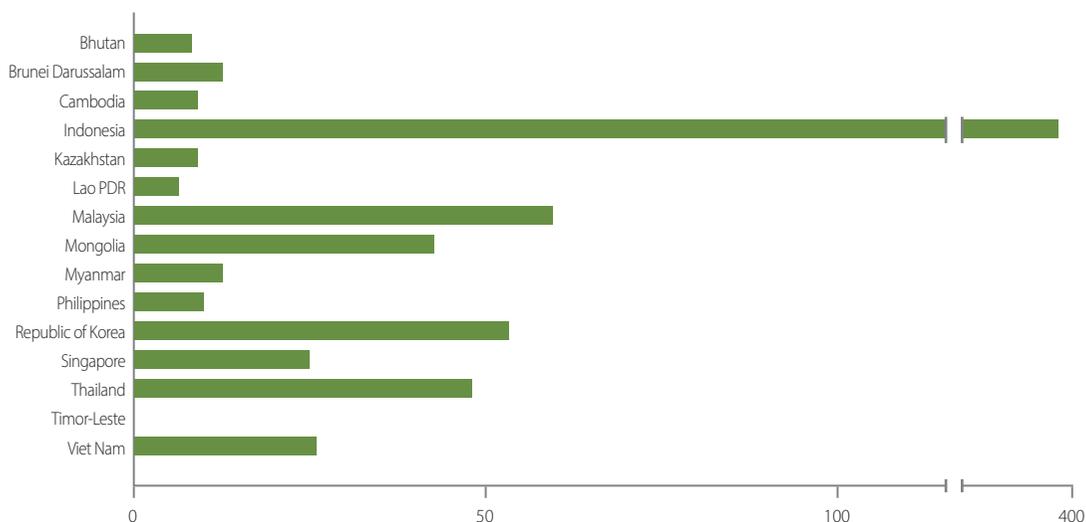**Figure 4**   The total number of publications published in the Scopus Database during the study period (2016–2020)

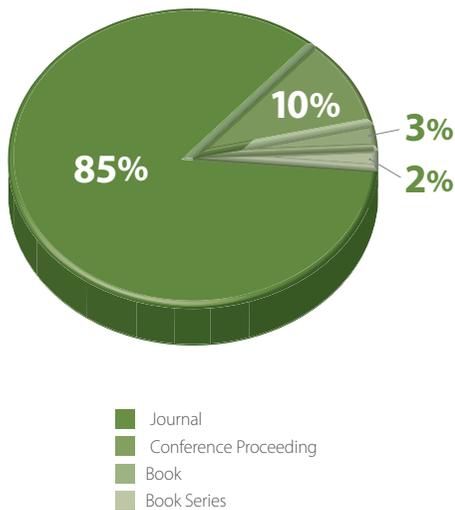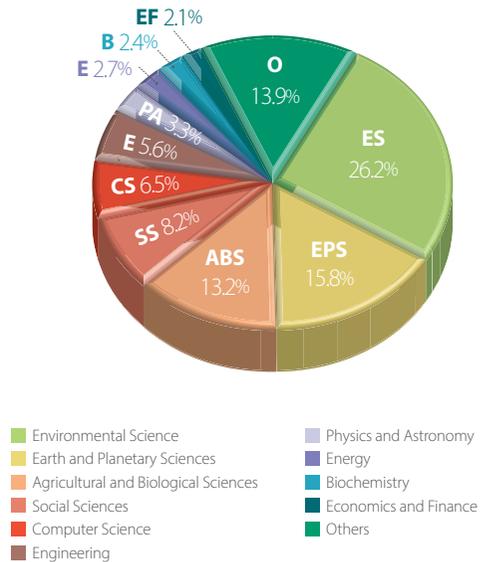**Figure 5** Percentage types of publication published during the study period

85%
10%
3%
2%

- Journal
- Conference Proceeding
- Book
- Book Series

Figure 6 Subject matter category of the published publications

EF 2.1%
B 2.4%
E 2.7%
PA 3.3%
E 5.6%
CS 6.5%
SS 8.2%
ABS 13.2%
EPS 15.8%
ES 26.2%
O 13.9%

- Environmental Science
- Earth and Planetary Sciences
- Agricultural and Biological Sciences
- Social Sciences
- Computer Science
- Engineering
- Physics and Astronomy
- Energy
- Biochemistry
- Economics and Finance
- Others

of the publications analyze forest fires-human interactions. The latter category is especially important in understanding the attitude and perception of the community towards forest fires and insights from the articles can help in designing participatory forest prevention programs.

Observation on the regional forest fire research ecosystem reveals that universities with access to well-trained researchers and adequate laboratory facilities play an instrumental role in impactful research activities. This is where Asian countries that have good research facilities can help other countries in terms of manpower training and access to better laboratory facilities. Indeed, collaborative research among the countries should be encouraged and facilitated.

In particular, research funding plays a crucial role in understanding key themes affecting fire management in forests. Funding for fire research should primarily come from the government and international

donations can be solicited to bridge the funding gap. However, for countries where research funding is limited, opportunities for international funding and other forms of assistance are to be further explored.

FOREST FIRE
MANAGEMENT SYSTEM
AND BEST PRACTICES

2. Forest Fire Management System and Best Practices

2.1 Global Wildfire Information System

The Global Wildfire Information System (GWIS) is a joint initiative of the Group on Earth Observations (GEO) and the EU Copernicus Work Programs. The Global Wildfire Information System (GWIS) aims to bring together existing information sources at regional and national levels. This provides a comprehensive view and evaluation of fire regimes and fire effects at a global level and provides tools to support operational wildfire management from national to global scales.

GWIS builds on the ongoing activities of the European Forest Fire Information System (EFFIS) in the pan-European region, the Global Terrestrial Observing System (GTOS), Global Observation of Forest Cover-Global Observation of Land Dynamics (GOFC-GOLD), Fire Implementation Team (GOFC Fire IT), and the associated Regional Networks, complementing existing activities that are on-going around the world with respect to wildfire information gathering. The development of GWIS is supported by the partner organizations and space agencies. Support to GWIS is provided by NASA through its GEO-GWIS activities in the Research Opportunities in Space and Earth Sciences (ROSES) program.

Currently, the GWIS is made of four applications:

Ⅰ. **The Current Situation Viewer** - This application provides near-real time information on:
- ▹ Fire danger forecast up to 10 days in advance on the bases of the Canadian Fire Weather Index (FWI)
- ▹ Lightning occurrence and active fire detections from the NASA MODIS and VIIRS sensors
- ▹ Near-real time burnt area perimeters derived from MODIS and VIIRS
- ▹ Fire emissions from the Copernicus CAM Service. In addition, access to a static global fuel map is available

Ⅱ. **Country Profiles -** This application provides a historical overview of fire regimes at country and sub-country levels for the period of 2002–2019. It includes maps of yearly and monthly burnt areas, burnt area frequency and burnt area seasonality. Additionally, it provides multi-year and single-year charts of:
- ▹ Number of fires derived from GlobFireBurnt areas derived from MODIS MCD64A1 sensor
- ▹ Fire regimes (seasonality) and monthly fire size distribution per year
- ▹ Landcover damage
- ▹ Yearly and/or monthly wildfire emissions

Ⅲ. **Long-term fire weather forecast -** Monthly and seasonal forecast of temperature and rainfall anomalies that are expected to prevail over the world.

Ⅳ. **Data and Services -** This application provides access to the data used in the GWIS web services. Data from the Current Situation Viewer are provided in the form of Web Map Services (WMS).

**GWIS provides in an effective way support to data access, process and data in support of:**

▷ Nations, institutions and agencies that do not have the physical capacity to access the data – internet access, computing capacity.

▷ Nations, institutions and agencies that do not have the institutional capacity to process and use the data – technical staff to performs data transformation and create products, research capacity to adapt and refine data transformation fit for purpose.

However, there are still requirements for capacity building, collaboration, partnership and peer-to-peer exchange for nations, institutions and agencies that do not have the operational capacity to apply the products in a constructive and useful way to the address the issues, problems and planning needs that those things may support. Institutions and agencies that do not have the in-depth understanding and potential use of satellite data can be supported by remote sensing providers and researchers to formulate their own needs, questions and requirements with sufficient definition and clarity to enable appropriate capacity development.

A new application referred to as Statistics Portal will provide information on the seasonal trends in the form of weekly evolution of number of fires, burnt areas and emissions in near-real time. This will complement the existing historical information that is already present in the "country profile" application, but for the current wildfire season.

| Figure 7 | GWIS concept: follows the EFFIS (European Forest Fire Information System) fire cycle |
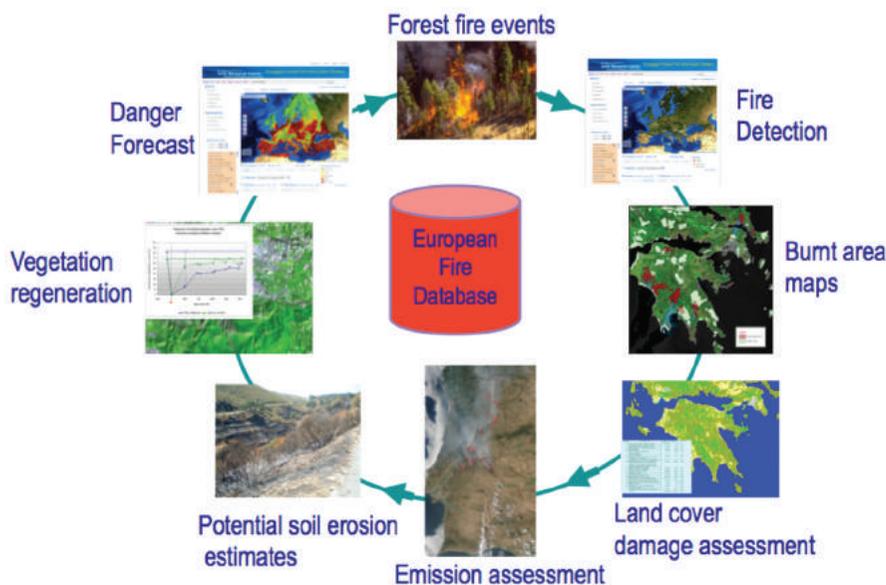
Fire Incidence, Its Determinants and Customary Management in Timor-Leste

Goal: Improved rural livelihood, reduced poverty and increased community resilience to climate risks through community-based fire management

Objective: Increased understanding of fire incidence and its determinants, reinforcing national capacity to address the negative impacts of fire

The Ministry of Agriculture and Fisheries, with technical assistance from FAO, conducted a thematic review on 'fire', in order to support Government efforts in addressing the important issues of slash and burn and uncontrolled or wildfires. The review aims at reinforcing the national capacity to reduce fire incidence and address the negative impacts of fire in Timor-Leste. Specifically, the thematic review has undertaken the following:

▹ Review of the fire-based land management system practiced in Timor-Leste (literature review and field observations). Analysis of the customary norms related to land management. Analysis of the relevant legal and policy framework.

▹ Estimation of the extent and location of fire incidence and its evolution over the past 30 years by using remote sensing technology, especially high-resolution imageries.

▹ Analyze how the incidence of fire may have changed over time and what factors contribute to these changes.

▹ Identify the key drivers of fire at the community level.

▹ Identify existing community mechanisms to reduce the impact of fire incidence on permanent crops and assets.

▹ Identify community perception on the long-term negative impact of the use of fire.

▹ Identify information gaps for additional research and studies.

▹ Identify possible solutions for reducing fire incidences.

This was approached through four outputs:

▹ **Remote Sensing:** Analysis of fire incidence through remote sensing using high resolution imageries and accuracy assessment.

▹ **Customary Land Management:** Analysis of the customary land management system or norms through literature review and field observations.

▹ **Legal and Policy Framework:** Review of the policy, legal and institutional framework through literature review.

▹ **Community Fire Management:** Analysis of fire determinants through community focus group discussions.

The outputs were undertaken through:

▹ Wide consultation of stakeholders.

▹ Direct field observations along transects (12 Municipalities).

▹ Field assessment on community fire management: focus group discussions, semi-structured questionnaires (12 sucos in 9 Municipalities, 384 participants).

▹ Remote Sensing analysis (1991–2020).

▹ Legal and Policy framework analysis.

▹ Extensive literature review.

Part I of the report addresses the fire-based land management and the related customary governance. In particular, it presents the land and climate conditions that determine the 'fire season' and describes the practices of slash and burn, obtained from the literature review as well as extensive field observations

throughout the 2020 fire season. The customary territorial governance and the practice of the tara bandu is also discussed in this part of the report.

Part II analyses the existing legal and policy framework relevant to the issue of fire and identifies gaps in addressing the negative impacts of fire.

Part III of the document presents the remote sensing analysis, based on high-resolution imageries (Landsat 15), to estimate the extent, location and trends of fire incidences over the past 30 years. A discussion on some of the limitations inherent to remote sensing is also presented, particularly related to estimating small scale fire incidents, such as the controlled slash and burn fires used by farmers on crop lands.

Part IV presents a brief analysis on the links that exist between uncontrolled fires and climate change.

Finally, Part V presents the findings from twelve participatory community-based assessments undertaken in nine municipalities across Timor-Leste, involving focus-groups discussions with community, women and youth groups, as well as discussions with key informants. A key component of this section seeks to better understand the existing knowledge of how local communities use and manage fires as well as their perceptions of the negative impacts of the use of fire on the environment and the effects on soil fertility.

Actions to be enhanced were identified based upon the analysis and the consultation with stakeholders. They included:

▹ Finance the implementation of a National Strategy through a concrete program and projects.
▹ Increase the contribution and coordination of several national institutions.
▹ Build a coalition of national and international partners to address the issues of fires impact, damage and loss in Timor-Leste.

Figure 8	View of a slashed and burned field. Uncontrolled fire from slash & burn activities torched the hills surrounding a newly opened field in Cribas (Manatuto, October 2019).

2.2 Near-real Time Tool for Monitoring Air Pollution in Southeast Asia – the Mekong Air Quality Explorer

Southeast Asia is a fire-prone region having a large number of fire occurrences. A notable consequence of agricultural fires, which are the main types of fires occurring in this region, is the seasonal emission of large concentrations of PM2.5 (particles with a diameter of less than 2.5 micrometres) and other suspended materials in the air. The World Health Organization (WHO) in 2019 considered air pollution as the greatest environmental risk to human health with approximately 9 out of 10 people exposed daily to polluted air and, consequently, an estimated 4 million deaths every year globally.

Hence, the interest and sensitivity of authorities and the public has risen in recent years with increasing efforts taking place to monitor and reduce air pollution levels. Since 2019, the SERVIR-Mekong programme

has developed the Mekong Air Quality Explorer, an operational air quality monitoring and forecasting interactive web tool (**Figure 9**). The interface visualizes in near-real time active fire hotspots from the VIIRS satellite and PM2.5 concentration levels from regulatory-grade ground stations in Thailand, while it also has the capability of forecasting PM2.5 concentrations over Southeast Asia for the upcoming 3 days based on the GEOS-5 FP global forecasting model. The system is operational in Thailand and efforts are currently in place to expand to the greater Southeast Asia with added functionalities based on ongoing technical developments and integration of contemporary satellite data, such as the Sentinel-5P and GEMS.

In the context of the planned activities and anticipated future operationalization in the greater ASEAN region,

Figure 9	The graphical user interface of the SERVIR-Mekong Air Quality Explorer. The point data represent PM2.5 concentrations as measured by the ground stations in Thailand and the raster data represent forecasted GEOS-5 PM2.5 concentrations over Southeast Asia.
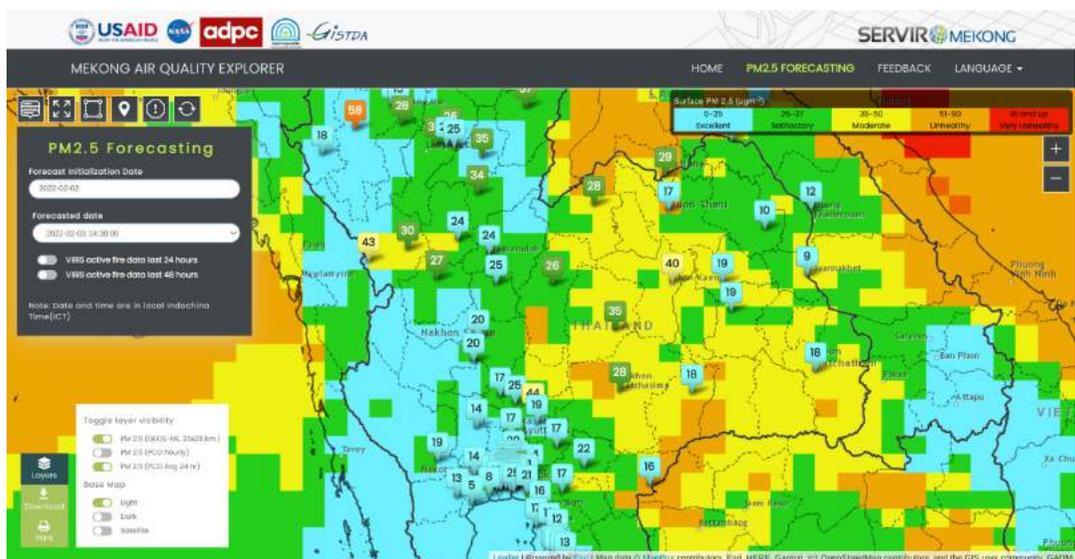
member countries could benefit from adopting the tool as the technological means to monitor and forecast air pollution. At the regional level, related information could assist countries to coordinate and address transboundary haze pollution. whereas at the national level, country-based statistics can provide the means to monitor the short- and long-term development of air pollution. Timely information on air pollution is of paramount importance to citizens, who can protect themselves by reducing exposure to air pollution on time periods with critical levels of PM2.5 concentrations.

2.3 Mobile Applications for Fire Management Operations in Thailand

Thailand is a country with a relatively high ratio of burned area per country size. Most of the fires are prescribed and occur seasonally during and after the harvesting period throughout the country as a convenient means to harvest, clear the land and prepare for the next season. Nevertheless, the concurrent burning of a vast number of agricultural fields triggers detrimental health effects to citizens and poses a difficulty to the authorities to regulate the fire events.

In this framework, two mobile applications (**Figure 10**) targeting fire management activities have been developed in Thailand. First, the Burn Check application, developed by the parties Pollution Control Department, Geo-Informatics and Space Technology Development Agency, Rajamangala University of Technology Lanna, Chaing Rai, and the Thai Health Promotion Foundation is a mobile application for officers and farmers to manage prescribed burning. The farmer requests the allowance for a burning activity in advance and the app, based on forecasted PM2.5 conditions and auxiliary data, provides the allowance if the air pollution is non-critical. Otherwise, alternatives to prescribed burning are suggested. The second application, co-developed by the Chiang Rai Provincial Government, the Rajamangala University of Technology Lanna, Chaing Rai, the Fulfil Social Enterprise and the Asian Disaster Preparedness Center is the Smoke Watch application and provides near real-time satellite observation for fire hotspot monitoring through public participation. The timely reporting of fire events helps authorities to respond rapidly and assess the situation through a graphical user interface. The applications are operational and currently are in the phase of expanding to other geographical areas.

The effort in using satellite technology has now been expanded to the education sector. The Blue School project, initiated by the Thai Health Promotion Foundation, the Fulfil Social Enterprise and the Asian Disaster Preparedness Center has been established to provide low-cost dust sensors for schools as well as the interactive web application to educate school children on how satellite technology can help monitor fires and air quality. This project, apart from schools in Thailand, will cover selected schools in Lao PDR as well.

| Figure 10 | Schematics of the two mobile applications, the Smoke Watch (left) and the Burn Check (right). |

2.4 Sustainable Use of Peatland and Haze Mitigation in ASEAN

In the ASEAN region, peatlands cover approximately 23.6 million hectares, representing 56 percent of global tropical peatlands. It is estimated that ASEAN peatlands store approximately 68 billion tons of carbon, i.e. 14 percent of the global carbon stored in peatlands. In the past few decades, human interventions such as logging, slash and burn, deforestation, drainage for agriculture, and consequently increasing wildfires have turned ASEAN's carbon-rich peatlands into devastating carbon emitters.

Sustainable Use of Peatland and Haze Mitigation in ASEAN (SUPA) will be implemented using a multi-level approach, engaging stakeholders at regional, national, sub-national and local levels. The implementation will be focused on three work areas:

1. trengthening regional cooperation by strengthening ASEAN.
2. Specific support to All Member States for the implementation of ASEAN Peatland Management Strategy (APMS) and National Action Plan (NAPPs).

3. Generating pilot experiences from Indonesia and Malaysia.

It is expected that the ASEAN Secretariat and the ASEAN countries successfully improve sustainable peatland management in the region. This will help the region to reduce emissions from deforestation and degradation of peatlands to mitigate the adverse impact of climate change, manage risk of wildfires and reduce transboundary haze as well as conserve and enhance biodiversity of peatlands.

CONCLUSION
AND WAY FORWARD

3. Conclusion and Way Forward

3.1 Conclusion

This webinar organized by AFoCO, FAO and their partners reflected fire ideas, issues and innovations from the region with updates on progress in research, projects and activities across the region and globally. The key ideas put forward included:

1. Millions of hectares of forests are annually affected by forest fires, pests, diseases, invasive species, drought and adverse weather events and a mutually reinforcing cycle of climate change and wildfire is emerging. Damaging forest and land fires are symptomatic of an imbalance in natural systems exacerbated by human interventions.

2. The data to review and analyse fire occurrences and extent is available at the global level by the Global Wildfire Information System (GWIS). Specifically, GWIS generates Country Profiles that provide a historical overview of fire regimes at country and sub-country level for the period 2002–2019. It includes maps of yearly and monthly burnt areas, burnt area frequency and burnt area seasonality. A new updated version will provide information on the seasonal trends through the weekly reporting of number of fires, burnt areas and emissions estimates. Nations can develop their own data collection and analyses, and that is very useful and welcome as it can be focused on the context and important aspects of fires for the country. Until that is in place, GWIS provides a very sound starting point for Review and Analysis.

3. Asia is a very fire active region and according to

GWIS, an average area of about 560,000 hectares was burned by 2,280 fires in the period 2002–2019. Compared to other continents, Asia is the 4th continent in terms of burned area and has the 3rd highest number of fire occurrences. According to the 2002–2019 data from GWIS, the ratio between burned area and country size is relatively high in AFoCO member countries, with Cambodia, Myanmar, Kazakhstan, Lao PDR, Thailand and Viet Nam having ratios higher than 2.0 and the remaining member countries being less than 1.0. In AFoCO member countries, most of the fires that occurred took place mostly in the mainland Southeast Asia particularly in the Lower Mekong Basin.

4. To manage these forest fires, considerable effort is needed to understand their dynamics and factors in order to identify the potential mitigation to reduce damage and loss. AFoCO countries have been undertaking forest fire research to provide insights and potential solutions for the occurrences of forest fires with universities playing an important role. People ignite most fires in the region, mainly associated with agriculture practices. This suggests that research in the Social Sciences category needs to be emphasized and strengthened as it is currently accounts for only 8 percent of the total publications.

5. In Timor Leste, the thematic review on 'fire' included fire-based land management and the related customary governance known as tara bandu. The existing legal and policy framework relevant to the

issue of fire and a remote sensing analysis of the extent, location and trends of fire incidence over the past 30 years and findings from twelve participatory community-based assessments have been undertaken in nine municipalities across Timor-Leste. This systematic approach to Review and Analyse fire management in Timor Leste is a complete and strong example of this critical step in fire management.

6. Authorities seek to find a way to regulate the burning of agricultural fields so that the amount of smoke does not exceed acceptable limits. Applications developed in Thailand to solve the problem, will likely have wider application, including beyond the region. Officers and farmers can collaborate to manage the area and location of prescribed burning on a given day using the Burn Check app. The Smoke Watch app provides near real-time satellite observation for fire hotspot monitoring through public participation so authorities can prioritise and respond to fires as they are detected. In parallel, SERVIR-Mekong has developed a tool for Thailand that reports PM2.5 concentration levels and forecasts this sort of pollution for the next 3 days.

3.2 Way Forward

The region has good examples of research, operational procedures, agency capacities and national approaches. These insights and activities provide a sound footing for continuing work on fire management in the region and, highlighting case studies from the region, they provide a set of ideas and actions that can be adopted.

It is the case that very good practice exists and has been developed in the countries of the region, with some examples illustrated during this AFoCO webinar. This demonstrates that agencies, networks, research organisations, projects and communities have been able to understand fire management problems and create solutions. What is also observed is that the solutions are not yet widely known or applied and there are further fire management problems that need attention.

The approach to be taken, by AFoCO and others, to close this gap will need to improve cooperation among countries, identify the appropriate levels to address the issues of fire management (regional, national, sub-national and community level) and create a robust connection among those interested to work collaboratively and exchange data, information, methods, approaches and systems.

The next steps may include:
1. Continuing to identify, examine and document existing good practice as was done through this webinar.
2. Enhance cooperation among countries to put in place effective collaboration and exchange, that is useful, builds relationships and is sustained.
3. Ensuring a collaborative effort for integrating fire issues as part of sustainable development among all the sectors involved at landscape level (forestry, agriculture, livestock, protected areas, communities and others).
4. Enabling and reinforcing an integrated framework approach to fire management at local, national and international levels.
5. Linking fire management efforts in the region by creating a regional platform on forest fire management. Along this line, AFoCO could use the Annual Technical Dialogue as a platform for exchanging expertise, experiences, and cooperation as this platform for forest

fire management is non-existence as of this project.

This could be achieved through:

1. Enabling Collaboration and Strengthening Existing Fire Networks.

▷ By identifying and linking up existing fire management related networks and actors in the region, including the Asia Pacific Forestry Commission of FAO, ASEAN including through the SUPA Project, the AFoCO member countries, the past and future participants in AFoCO fire management training and others.

2. Building the Body of Knowledge –

▷ By identifying and linking up existing fire projects in the region, and collating the data, materials, products and findings of past projects

3. Supporting Regional Approaches –

▷ Such as the AFoCO regional project proposal on forest fire management in Mekong Region.

▷ The Sustainable Use of Peatland and Haze Mitigation in ASEAN (SUPA) which is implemented using a multi-level approach, engaging stakeholders at regional, national, sub-national and local levels.

4. Identifying these steps as an example during the Fire Management Forum of the World Forestry Congress

Fires are overwhelmingly human-caused and the underlying factors that influence their numbers, extent and impacts are also human induced. Bringing together the fire management stakeholders, actors and interested parties is at its core a people process of enabling collaboration, strengthening networks, increasing the body of knowledge and ensuring consistent support.

This AFoCO webinar has reinforced that understanding.

MEMO

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Asian Forest Cooperation Organization(AFoCO)

AFoCO is a treaty-based intergovernmental organization that is committed to strengthening forest cooperation and taking concrete actions to promote sustainable forest management and address the impacts of climate change.

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