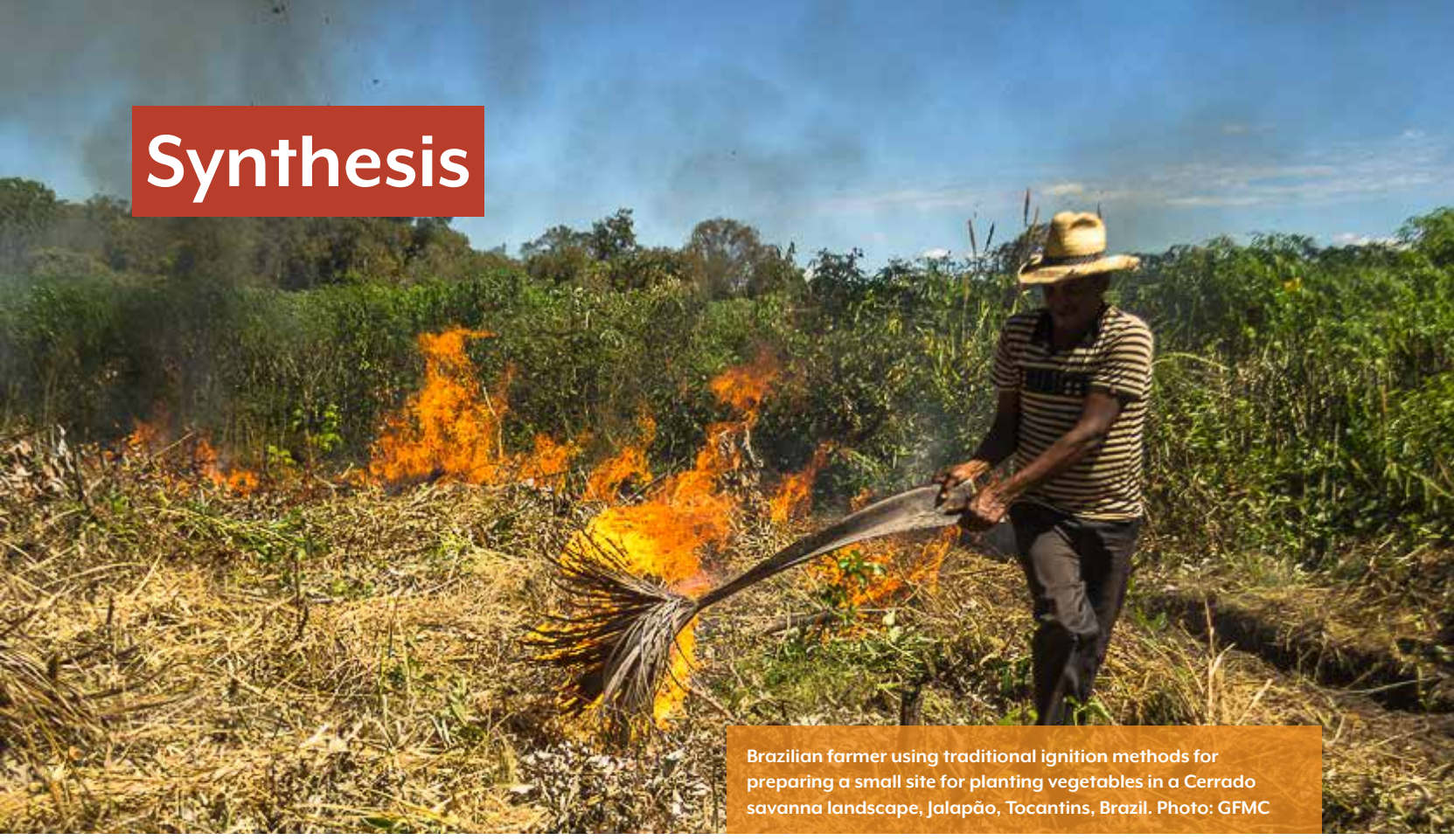
Synthesis



Brazilian farmer using traditional ignition methods for preparing a small site for planting vegetables in a Cerrado savanna landscape, Jalapão, Tocantins, Brazil. Photo: GFMC

The smoke clears... Global experiences in tropical fire management

Nick Pasiecznik, Johann Georg Goldammer, Bibiana Alejandra Bilbao, Atiek Widayati, Harifidy Rakoto Ratsimba, and Rosalien Jezeer

Prologue

The smoke clears... A small group returns to their homes for lunch. A few hectares smoulder, safely. This area won't burn again for some time. Alongside other patches burned at different times, the whole area is safe from the threat of a wildfire. Nutrients are returned to the soil. Fresh shoots will soon emerge for livestock. Snakes have fled from fields and homesteads; cattle ticks are gone, as well as other pests. The land is rejuvenated. This was the traditional way that people across the world managed fire, since the beginning of humanity.

But the first three words may have led readers to expect something quite different — charred remains of houses or whole towns, forests and animals; lives lost; towering flames; cars in queues; millions of dollars in damage; environmental harm; and a massive release of greenhouse gases (GFMC 2013a). Today, this is what we have become increasingly accustomed to reading about in the media from all over the world, and such catastrophic wildfires are predicted to only get worse and more frequent (UNEP 2022). What we are currently doing is clearly not working. We need to do something else, and quickly.

Implementing good prescribed burning practices has been proven to reduce the risks and impacts of extreme wildfires. It is a practice that must be reintroduced as part of coordinated integrated fire management (see Table 1) strategies, which will protect lives, lands and forests, and reduce emissions.

Table 1. Selected key terms used in fire management

Community-based fire management	A fire management system in which a local community (with or without the collaboration of other stakeholders) has substantial involvement in and responsibility for deciding the objectives and practices involved in preventing, controlling and utilizing fires. Often referred to by its acronym, CBFiM.
Controlled fire	Traditional / indigenous practices that are based on inherited experience. This differs from prescribed burning, that is based on advanced fire ecology science. *See also Prescribed burning*.
Firebreak	Any natural or constructed discontinuity that aims to segregate, stop or control the spread of fire, or to provide a control line from which to suppress a fire. It is characterized by a complete lack of combustible material. *See also Fuelbreak*.
Fire management	All activities required for the protection of forests and other vegetation from fire, and the use of fire to meet land management goals. It involves the strategic integration of knowledge — on fire regimes, probable fire effects, values at risk, level of forest protection required, cost of fire-related activities, and prescribed fire technology — into multiple-use planning, decision making, and day-to-day activities to accomplish stated resource management objectives. Successful fire management depends on effective fire prevention, detection, pre-suppression and control, having an adequate fire suppression capability, and consideration of fire ecology and human relationships.
Fuelbreak	Generally wide (20–300 m) strips of land on which less flammable vegetation is maintained and integrated into fire management, or where vegetation has been modified or fuel loads reduced so that fires can be more readily controlled (as distinguished from firebreak). In some countries, fuelbreaks are integrated elements of agroforestry systems that are intensively cultivated, grazed or subject to prescribed burning. Closed forests may contain fuelbreaks known as "shaded corridors," where stands are intensively thinned and pruned. Fuelbreaks also have the advantages of preventing erosion, and offering a safe place for firefighters to work. *See also Firebreak*.
Integrated fire management	A system that includes one or both of the following concepts: (1) integration of prescribed natural or human-caused wildfires and/or planned application of fire in forestry and other land uses in accordance with the objectives of prescribed burning; and/or (2) integration of fire management activities and use of the capabilities of rural communities/land users to meet land management objectives.
Landscape fire	A fire burning in vegetation of natural and cultural landscapes, e.g., natural and planted forest, organic terrain (such as peatlands), shrub, grass, pastures, agricultural lands, and peri-urban areas, regardless of ignition sources, damages, or benefits. *See also Wildfire*.
Prescribed burning	Controlled use of fire to reduce fuels (in either their natural or modified state), under specified environmental conditions, which allows the fire to be contained to a predetermined area and at the same time to produce the required intensity of heat and rate of spread to attain planned resource management objectives. Early burning is a form of prescribed burning conducted early in the dry season before leaves and undergrowth are completely dry and/or before leaves are shed, as a precautionary measure against more severe fire damage later on. *See also Controlled burning*.
Wildfire	Any unplanned or uncontrolled fire burning in vegetation of natural, cultural, industrial, and residential landscapes, which regardless of ignition source (i) may require suppression response, or (ii) other action according to agency policy, e.g., allowing the fire to freely burn as long as it meets land management objectives. *See also Landscape fire*.
Wildland fire	A North American term used internationally, "wildland" includes all burnable vegetation resources, including managed forests and plantations. Since "wildland" does not have a corresponding term in languages other than English, alternative terms are preferred (vegetation or landscape fire, or specific terms such as forest, grassland, agricultural or pasture fires).

Box 1. Issue highlights

Tropical Forest Issues No. 61 (formerly *ETFRN News*) includes 26 articles, including contributions from 100 co-authors (Pasiecznik and Goldammer 2022). Following a call for abstracts reviewed by a seven-strong panel of experts, case studies were selected from 15 countries in tropical America, Asia and Africa, along with articles summarizing the ecology, management and concepts related to fire management. This synthesis draws out common lessons and recommendations.

Highlights include the following insights. Local participation is crucial, for all parties to share their perceptions of the problem, and to jointly design and implement fire prevention and suppression. The importance of indigenous and traditional knowledge of fire management emerges strongly, especially in Latin American articles. Innovative cases are presented, such as the use of agricultural fuelbreaks, with potential for scaling, if land rights are secured. Equitable landscape governance as seen in indigenous territories was also importance for successful fire management. Capacity development for fire management is also needed at all levels, from national and subnational coordination to community volunteers — and not just for dedicated fire brigades. Where lacking, national integrated fire management strategies, policies and action plans must be developed, with cross-sector collaboration, clear roles and responsibilities, and resources for effective fire prevention and suppression. What is also clear is that "no fire" policies introduced in many countries have been counterproductive, and have actually contributed to more intense wildfires. Thus a shift is urgently needed, from a focus on suppression to one on prevention and integrated management, including the controlled use of fire. Finally, expansion of international efforts is needed, building on well-established organizations and networks, for generating, collating and sharing experiences.

As the smoke clears, we see the urgent need to better acknowledge and incorporate the knowledge and practices of the people described at the start of this story. The use of prescribed fire is just one subject highlighted in this review (see Box 1). It does not intend to fan the flames of polarized debates but does aim to put out the embers that underlie the misinformation that continues to support the prevalent mindset of decision makers.

Fire management terminology

To avoid confusion and ensure clarity it is essential to have agreed terminology, and in multiple languages. The generally accepted global fire management glossary (GFMC 1999) includes terms in Spanish, French and Russian (FAO 2010). This was revised and updated from the first multilingual consent-based Wildland fire management terminology, in English, French, German, Italian and Spanish (FAO 1986). Over the past 20 years, fire management terminologies have been published for Europe, Australasia, North America and Central Asia (for all available glossaries, see GFMC 2017). The terms in Table 1 are based on those in published glossaries.

The history of "no fire" policies

Hunters, farmers, shepherds and other land users all over the world have routinely used fires to manage vegetation throughout history of humanity. Today, the prevailing perception of land management authorities seems to be that "all fire is bad." What happened to cause this seismic shift in thinking? That story starts 200 years ago. Much has been written on this and there are numerous versions of historical events (Pyne 2021); though some may argue the details, the following provides an indication of how this change in mindset occurred.

In temperate and Mediterranean Europe, natural (lightning-caused) fire is not a factor that has shaped natural ecosystems. However, the use of fire in land management has a long history and has significantly shaped cultural landscapes, including ecosystems of high conservation value. However, a complex mix of cultural and power relationships led to the emergence of the view that fire use by land users should be discouraged.

During the era of European colonialism, indigenous fire practices were largely replaced by unsustainable burning by settlers, and in some cases traditional practices were even outlawed, perhaps as a way to exert control and power over indigenous peoples. Prohibitions continued as countries gained independence, and bans even expanded, such as in Latin America in the 1900s, with the implementation of "zero fire" or "zero burning" policies [see 2.1]. In Brazil, the Forest Code of 1934 was the basis of the country's fire prohibition policy, which considered traditional fire practices as an enemy to be fought [2.2]. In South and Southeast Asia, the "fire schism" in India, Indonesia and Myanmar (Burma) was reviewed (Goldammer 1993).

Community member in Ecuador conducting prescribed fire . Photo: Amazonía sin Fuego Programme

During this time, the extent and severity of wildfires in some countries coincided with a number of significant changes in land ownership and use, and migration. These changes included both the settling of "new land," especially in the tropics, and the abandonment of rural areas, which was common in the Mediterranean, for example. A major factor was the use of exclosure measures that gave ownership of large tracts of previously communal land to individuals (or companies), and that limited or even prohibited access by local people. This was a common occurrence during the colonial period, alongside the discouraging or banning of traditional burning practices. There was also extensive clearing of forests for the expansion of agricultural and pastoral land, and for new settlements.

The cultural value of fire became lost in many parts of the world, the less people saw fire. And since the 1800s, first in Europe, then across the world, those who benefitted most from land-use changes also appeared to be those who proposed that all fire was "bad." Today, even after a single generation, children are growing up without even seeing the benign use of fire, and are likely to believe the new narrative. In parallel, more people have moved to urban areas, and there have been movements for increased conservation (land needs protecting, fencing, keep people out, let nature take over), but nature burns, naturally. Most recently are concerns regarding carbon emissions, and they seem to oppose the use of any fire. However, as with the misplaced aims of those concerned with conversation regarding fire use, climate change mitigation also would benefit from judicious use of prescribed fire, which reduces the risks of catastrophic wildfire.

Today, the wider reintroduction of prescribed fire to reduce wildfires is promoted by many. This is a challenge to established patterns of land management. However, in the face of ever greater and more frequent extreme wildfires, the pressure is on governments across the world to make this change. In the USA and Australia, for example, there are decades of experience in bringing back prescribed burns (e.g., Pyne 2021). The same trend is observed in Europe, particularly in the management of cultural landscapes (GFMC 2013b). And after the unprecedented wildfires of recent years, further reconsideration of increasing the use of prescribed fire in land use management could be expected.

The emergence of tropical fire science

The earliest scientific work in the understanding of fire was related to the chemistry of combustion, with Antoine Lavoisier's work, which began in 1772, and Joseph Priestly's discovery of oxygen in 1774. This was followed only much later by advances in the ecology of fire and by much more interest in fire management, with developments throughout the 1900s coalescing into a deeper understanding of the role of fire in tropical landscapes (e.g., Nye and Greenland 1960; Goldammer 1988; Steensberg 1993).

The first major step toward combining the previously fragmented knowledge of fire in the tropics and

subtropics into a transdisciplinary, interdisciplinary, holistic science and approach came in 1989, at the Third International Symposium of Fire Ecology (Goldammer 1990). This highlighted that at least 600 million hectares of tropical and subtropical forest, savanna, bushland and grasslands were then affected by fire each year, and that the area of uncontrolled wildfire was increasing, due in part to the conversion and clearing of forests. The impacts were already evident — severe forest degradation, loss of species, and soil erosion leading to siltation and flooding in lowland areas — and were also seen then as a source of smoke particles, CO_2 and other trace gases impacting atmospheric stability and global climatic change (Crutzen and Goldammer 1993).

There were significant advances in the subsequent three decades, with fire science emerging as a transdisciplinary discipline. Overviews of the current state of knowledge on the role and history of fire in tropical landscapes [1.1] and fire management practices [1.3] are summarized in this volume, alongside the related roles of organizations and people that link the two components [1.2].

In parallel, developments fundamental to fire management have occurred. The field of remote sensing, with the availability of ever-higher-quality satellite imagery, allows users to detect active fires and determine burned areas. However, such data still requires ground-truthing to confirm its validity — or increasingly, the use of drones — to improve the accuracy of the resulting information [4.7]. The misinterpretation of "hotspots" also needs to be addressed (see Box 2). Nonetheless, when these measures are combined, and use the latest computing technology, monitoring systems can be developed that are of great use to land managers in planning fire prevention and suppression actions [4.3].

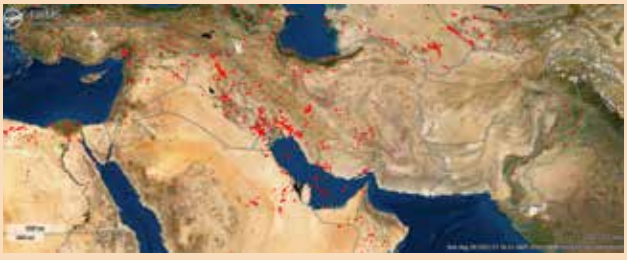
The re-emergence of traditional knowledge

The value of traditional knowledge of fire use is a recurring theme throughout this volume. In certain regions, this traditional use has been acknowledged for some time, such as with the firestick community in Australia, and in North America, where traditional knowledge has been drawn on for the partial reintroduction of prescribed burning (Pyne 2021). In the tropics, however, the value of this knowledge is only now re-emerging. This volume provides a rich source of evidence that supports the need to work closely with indigenous peoples and local communities, and learn

Box 2. Not all hotspots are wildfires

Online fire information systems can generate maps that supposedly display only active fires. However, satellite data shows all high-temperature events — active vegetation fires, yes, but also industrial combustion and heated surfaces. Screenshots show (a) a global map with active fires as red dots, often referred to as "hotspots," a term that leads to further misinterpretation of the true nature of fires. Zooming in on sub-Saharan Africa (b) has the appearance of a burning subcontinent, but is merely a composite of many thousands of small-scale agricultural fires, among wildfires in open lands and forests. In the Middle East (c), many red dots are gas flares.

Satellite-derived information about active fires becomes more valuable when it is supported by land cover map overlays; e.g., the ESA Worldcover dataset (10-m resolution). Such layers allow users to carry out more reliable and detailed analyses, such as evaluating environmental impacts and risks, and determining priorities for management, related to land coverage and the types of vegetation involved.



from their age-old practices, in order to manage fire effectively.

In South America, this is seen clearly in articles from Venezuela [2.1]. Brazil [2.2], Mexico [2.3, 2.7], Argentina [2.4], and Bolivia [2.6; 2.8] A particularly pertinent example in seen in Venezuela, where patch mosaic burning by the indigenous Pemón people in the country has been assessed in long-term scientific trials and proved to be effective in reducing wildfire risks, and is now being taught to firefighters by the Pemón [2.1]. In Brazil, prescribed fire has been shown to have positive effects on faunal diversity [2.9]. Results from Brazil and Australia also prove that implementing prescribed burns based on traditional indigenous practices effectively reduces the spread and number of wildfires, along with the resulting greenhouse gas emissions (Mistry et al. 2018; Russell-Smith et al. 2013).

The importance of the cultural aspects of fire also comes out strongly in a number of articles, especially for Mexico [2.3; 2.7]. These two articles are the first publications to use the term "pyrobiocultural" — incorporating the concepts of biocultural landscapes and biocultural diversity. When analyzing the important roles, uses, benefits and impacts of fire in a landscape, it seems appropriate to have a specific term that implicitly integrates the diverse social, cultural, environmental and economic components of fire [2.3].

The need for supportive policies

Effective and supportive government policies are crucial in reducing wildfire risks. This is particularly noted in articles from Asia. The benefits from policies and regulations and their enforcement are evident in Viet Nam [3.2], where the number of fires and the total area burned in 2018 was one-third of the totals 15 years previously. The area under plantations has been increasing at the same time; protecting commercial plantations was an important incentive for the government.

In Indonesia, the massive application of fire in land-use change and the resulting wildfires in 2015 led to the establishment of new bodies and to the enactment of the Forest and Land Fire Prevention and Suppression regulation and associated regulatory instruments and technical guidelines [3.1]. The focus was specifically on preventing further peatland fires, which caused severe smoke pollution throughout the region, and which released millions of tonnes of CO_2. There have also been advances at the provincial level, such as the Directive and Provincial Guidelines for Fire Prevention, enacted in West Kalimantan in 2020 [3.5]. Also in Indonesia, since the enactment of Law No. 32 in 2009 and the use of evidence from satellite images and ground verification in court cases, most cases against those who caused illegal fires have been won. That has led to a large reduction in illegal fires [3.3].

The importance of a national fire management strategy is highlighted for Nepal [3.6]. And where polices are lacking, it is notable that national needs analyses saw a national strategy as the principal and overarching requirement. This was the case in Ecuador [2.5], Ethiopia [4.4] and Uganda [4.6]. Furthermore, since wildfires do not respect boundaries, the need for more regional coordination is clear, with positive advances in South Asia [3.6], Eastern Africa [4.7], and South America [2.1, 2.5].

Community inclusion

Most contributions stress the importance of involving local communities in fire management planning, prevention and suppression. In Latin America, most of the cases emphasize community involvement, specifically of indigenous groups (see above). In Africa, notable articles are from Ghana, where a private plantation company works with local communities to protect its plantations, along with farms, villages, natural forest and communal land [4.1], and where an NGO has reduced wildfire risk through inclusive fire management [4.5]. Also in Africa, the innovative approach of using agricultural firebreaks has proved effective in Madagascar, thanks to working with communities to achieve mutual benefits [4.2]. In Asia, community involvement is emphasized as key in Thailand [3.4] and Nepal [3.6] and is a cornerstone of reducing fire risk in Indonesia [3.1; 3.5].

The Global Fire Monitoring Center (GFMC) portal on community-based fire management (CBFiM) (https://gfmc.online/manag/cbifm.html) reveals rich expertise in community inclusion and participatory fire management. Here it can be seen that advancements in applying the principles of CBFiM have been made in the tropics. This is opening a window of opportunity for non-tropical countries to also benefit from these experiences.

Landscape governance

Strongly linked to the success of active community involvement in planning and implementation, is that land ownership, access and resource use rights are clear. Landscape governance is particularly important over large areas of savannas and forest lands that are (or were) under de facto common or community ownership. Two cases from Bolivia show this need clearly, and how the formalization of Indigenous territorial rights and

governance were key to improving fire management [2.6, 2.8], The importance of respecting indigenous or local communities' territorial governance systems was also explicit elsewhere in the Americas, notable in Argentina [2.4], Brazil [2.2], Mexico [2.3] and Venezuela [2.1]. Securing tenure rights was also observed as key for the success of agricultural firebreaks in Madagascar [4.2], and for community land management in Thailand [3.4] and was implicit in others.

To successfully reduce fire risk, a landscape vision is needed that incorporates the varied perspectives of all those living or working within that landscape. This can be achieved using a framework of integrated landscape approaches that simultaneously support development, conservation and climate objectives (Chavez-Tafur and Zagt 2014), and that can also reduce wildfire risk. This also needs to include the governance of land-use change, especially regarding conversion of forest or savanna for plantations, cultivation or grazing. In order to better address the causes of wildfires, landscape approaches must recognize the relationship between fire and society and consider the complex interactions between the different factors and actors behind the use of fire.

Capacity strengthening at all levels

A common theme in many articles is the need to strengthen capacity at all levels. At the level of national and regional governments, there is a need for an improved understanding of the role of fire, the value of local knowledge, and the benefits of integrated fire management, in order to reduce wildfire risks. This need for capacity strengthening is not limited to ministries responsible for forestry and the environment; it also includes ministries of agriculture, health and social affairs, among others.

National fire agencies and their regional and local staff would benefit from training in new technologies, and in the use of traditional fire management. Capacity strengthening is especially required at the local level, where community volunteer brigades may have no experience in preventing or suppressing fires. Training is an essential prerequisite to ensure personal safety as well as effectiveness. All those who will be active in fire suppression require training in the appropriate equipment; this equipment must also be provided.

Combining approaches

Effective integrated fire management requires a combination of these elements — fire science, traditional knowledge, supportive policies, community inclusion, landscape governance, and capacity strengthening — as well as active interaction with policy makers. How this is done will of course depend on the specific situation in each place. The diversity of experiences presented in this volume provides a range of examples.

In Indonesia, integrated landscape approaches — supported by policies and with the full participation of communities — are proving effective in reducing wildfire risks while also restoring peatland areas [3.1]. The articles

Training in fire related policies and regulations in Ghana. Photo: Rosa Diemont

from Ghana provide examples of combinations of various elements, such as communities partnering with a private timber company [4.1] and an NGO [4.5]. In Thailand, community-based management of both fire and water is helping to decrease wildfire risks, following ethical approaches promoted by the king and the adoption of technology for improved monitoring of air quality [3.4].

In Bolivia, integrating people, knowledge and good practice is paying dividends [2.6], as is basing fire management on indigenous governance systems [2.8]. In Venezuela, fire science is proving that traditional burning practices are effective; indigenous communities and firefighters are sharing knowledge and skills [2.1]. In the Cerrado savanna of Brazil, institutional partnerships support the development of research and the improvement of tools for integrated fire management activities [2.2]. In Ecuador, the government has taken the lead, with international support, incorporating the five components discussed above: fire science, traditional knowledge, supportive policies, community inclusion, landscape governance, and capacity strengthening [2.5]. This approach is also seen in Mexico, where it shows the potential to reduce the risk of wildfires in a national park [2.3], and has been adopted to reduce smoke and air pollution in Mexico City [2.7].

Each situation requires different components in different proportions, to be applied at different times. In terms of the benefits of integrated fire management (IFM), and the practices to employ when applying IFM approaches, a toolbox of approaches is well summarized in the introduction [1.3]. The introduction also provides numerous source publications that go into much more detail on each approach.

The review of people and organizations involved in improved fire management [1.2] proposes three fundamental requirements before deciding on engagement methods: (i) evaluating the natural and ecological aspects of fire in the landscape; (ii) understanding the institutions in charge of fire management, for prescribed fires or wildfires; and (iii) working with communities, listening to them and understanding how they interact within the landscape. The article also notes, however, that considering just these three factors before making fire management decisions could give an incomplete impression of what is required, with the reality being much more complex.

Implementation on the ground must be informed by good fire science and thorough field experience by those making decisions. These actions must be well coordinated and adequately resourced at the local and district level, within the framework of a comprehensive cross-sector national policy and implementation strategy. Only when all these components are in place will integrated fire management be effective.

Recommendations

The effects of wildfires — and the measures needed to manage them — are as varied as the people and landscapes that they affect. The following recommendations summarize the immediate needs, from international to landscape level.

International level

- Fire management must be acknowledged as a cross-cutting, interdisciplinary science and practice that advises and informs decision making in international debates, agendas and actions.
- Implementing integrated fire management is urgently required and must be encouraged by international organizations across sectors and governmental agencies.
- An international framework for integrated fire management must be established, based on proven and innovative principles of fire management and governance (see Council of Europe 2022).

Regional level

- Intersectoral and intercultural platforms between countries should be supported, for exchanging information, experiences, tools and capacity building in fire management.
- Resources should be provided to existing and active regional networks and centres, to increase information sharing on fire occurrences, resources and disaster-response capacities.
- Since fire impacts (including air pollution) are cross-border issues, improved regional coordination is required, including mutual cross-boundary assistance for managing wildfires.

National level

- National fire management strategies, policies and regulations — implemented in a coordinated manner — must underpin all efforts to reduce wildfire risks.
  - » Where these measures already exist, they should be revised as necessary in the light of new knowledge, with adequately resourced action plans adapted to local contexts, and involving knowledge and practices from local communities as well as professional expertise

  - » Where these measures do not yet exist, countries should develop them as a matter of urgency in an inclusive, participatory and intersectoral manner, including all relevant ministries, local governments, community organizations, NGOs, research institutions, and the private sector, where applicable.
- Wildfires are disasters that affect every aspect of life, and risk reduction needs to be incorporated into planning by ministries of agriculture, forestry and the environment, as well as those responsible for health and infrastructure, among other sectors.
- Countries need to urgently consider the application of integrated fire management as a component of the actions needed to meet their nationally determined contributions (NDCs).

Landscape level

- Communities, especially in fire-prone areas, must be encouraged to take responsibility for fire management in their jurisdictions, including the use of traditional practices, supported by the provision of training and equipment.
- External support for capacity strengthening, especially for community volunteer brigades, is essential. This must include training in fire prevention and suppression, among other skills. Adequate and appropriate equipment must also be provided.
- Addressing wildfires, landscape approaches must recognize the relationship between fire and society, and consider the complex interplay between the actors, factors and fire.
- Successful models of wildfire-resilient landscapes that are locally managed for production and conservation must be documented, replicated and scaled.

Conclusions

Conclusions from many articles in *Tropical Forest Issues* No. 61 are supported by evidence gathered in past decades that fire exclusion alone has not reduced wildfire risk. Far from it, in fact; it can result in higher fuel loads, which increase the risk of more catastrophic fires (e.g., Bilbao et al. 2020; Pyne 2021). However, some still incorrectly see fire exclusion policies as the best option, so there is an urgent need to change this paradigm.

The challenge ahead is to convince sectoral actors to break free of institutional silos and move towards horizontal, cross-cutting cooperation and shared responsibility in addressing the complex realities of integrated fire management. This must be accompanied by changes in national and international approaches to fire management, and land managers, project managers, officials and politicians must take into consideration the overwhelming evidence that supports integrated fire management when they develop and implement more effective fire management plans. The media can also become a great ally in this process, by not simply reporting on catastrophic wildfire events, but by communicating pioneering and successful experiences on implementing integrated fire management.

The articles add to the expanding global knowledge on integrated fire management. They show how fire science, traditional knowledge, supportive policies, community inclusion, landscape governance and capacity strengthening, when suitably combined, will lead to a future with less destructive fire, in part by encouraging the wise use of benign fire. The fire management expertise presented in this volume, opens the door to new and promising solutions to climate change mitigation and adaptation, by learning from and preserving cultural heritage and diversity and developing future-oriented nature-based solutions. Importantly, fire management globally may benefit from the experiences in tropical countries.

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