

REVIEW

Climate Change and Social Forestry: An Overview of CIFOR Research on Enhancing Resilience in Boreal and Tropical Forest Landscape

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Abstract

The climate crisis highlights the importance of forests in both mitigating and adapting to climate change, as well as in supporting the UN's Sustainable Development Goals (SDGs). To promote the better understanding and valuing of the critical role forests play, and to develop holistic approaches to protecting and maintaining them, the Center for International Forestry Research (CIFOR) has adopted the mission "to bring scientific knowledge to bear on major decisions affecting the world's tropical forests and the people who depend on them". This paper highlights an important topic in CIFOR's research portfolio – forests' diverse roles in climate change mitigation and adaptation and how forest governance ensures the equitable and sustainable wellbeing of people, both locally and globally. As one of the founding donor countries of CIFOR, the Government of Japan has consistently supported CIFOR's research through Japanese scientists collaborating in research projects and/or serving as members of CIFOR's Board. This paper, therefore, specifically highlights research projects funded directly by the Government of Japan, in particular.

Discipline: Forestry

Additional key words: Central Kalimantan, CGIAR, forest fires, Khabarovsk, Sabah

Introduction

The current climate crisis highlights once more the importance of forests for a sustainable future (Palahi et al. 2019). The science is clear. Forests are of critical importance in delivering the UN Sustainable Development Goals (SDGs), from food security (SDG2) to clean water (SDG11), responsible consumption and production (SDG12) and climate action (SDG13) (Monument & Kleyman 2018).

Forests are Earth's largest terrestrial carbon sink, as well as a source of precipitation and renewable biological resources. Yet, forests remain undervalued and

underappreciated. There remains a need to further our science-based understanding of the state of forests, threats to their maintenance, and long-term holistic approaches to their governance that integrate climate change mitigation and adaptation. This includes an understanding of the politics that might enable or constrain action to reduce deforestation and forest degradation (Palahi et al. 2019). To this end, the Center for International Forestry Research (CIFOR) adopted the mission "to bring scientific knowledge to bear on major decisions affecting the world's tropical forests and the people who depend on them" (CIFOR 2021a) thereby aiming to inform government officials, policymakers and resource managers and support

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their day-to-day management decisions as well as long-term policies governing forest use.

Governing forests, however, requires considering forests as part of a complex mosaic landscape; an array of socio-ecological systems interacting with the governance of forested landscapes. It requires a multi-sectoral and integrated approach linking the many different, and often competing, uses to ensure sustainability (Reed et al. 2015). CIFOR's research is, therefore, not confined to the physical aspects of forests, but efforts to understand institutions, policies and politics, as well as the economics of forest use. CIFOR research is also typically carried out with and through research partners and the involvement of various stakeholders in the different issues studied. The research is funded by a diversity of donor bodies, including the Japanese government.

The Government of Japan has played an important role in CIFOR's history, especially during the organization's early years. Japan was both one of the founding countries of CIFOR and its biggest initial donor (Kobayashi 1998). Professor Satohiko Sasaki from Tokyo University and Professor Yoriko Meguro from Sophia University both served as members of CIFOR's Board in the early days, and researchers from the Forest and Forest Product Research Institute (FFPRI) and Japan International Research Center for Agricultural Sciences (JIRCAS) were involved in the organization's earliest research activities. Some examples of Japanese scientists involvement in CIFOR's work include Dr Shigeo Kobayashi (FFPRI) and Mr Nobuhiko Kabo from the Ministry of Agriculture, Forestry and Fisheries government of Japan (MAFF), who initiated an international collaborative research project entitled 'Rehabilitation of Degraded Tropical Forest Ecosystems' with country partners in seven countries from 1996 to 1999 (Kobayashi 1998), before Dr Takeshi Toma (FFPRI) succeeded in extending this to a second phase (2001–2005) to conduct research on forest fires in degraded forests, with East Kalimantan as one of the project's study sites. More recently, Dr Gen Takao has conducted GIS-centered analysis under the theme of 'Sustainable Utilization of Diverse Forest Environmental Benefits' during 2006–2009 (Takao 2007), with Dr Ken Sugimura and Dr Masatoshi Sasaoka conducting research on ecosystem services, tourism and ecological anthropology after 2011. Currently, Professor Kaoru Kitajima from Kyoto University serves as a board member for CIFOR, and Dr Daisuke Naito has been coordinating international collaborative projects funded by the Japanese government since 2014.

This paper presents an overview of some of CIFOR's research on climate change mitigation and adaptation, social forestry, forest fires and social impacts. The first section presents the Global Comparative Study

on Reduced Emission from Deforestation and forest Degradation (REDD+). The subsequent sections present more specifically CIFOR's work that has been funded by the Government of Japan. The presented information originates mostly from unpublished project reports and CIFOR's website.

Climate change mitigation: The Global Comparative Study (GCS) on REDD+

REDD+ emerged as a global forest-based climate change mitigation initiative in 2007. It is based on the core idea of providing rewards for efforts to reduce greenhouse gas emissions from forests (Angelsen 2008). As an idea, REDD+ can be considered a success story (Angelsen et al. 2012, Angelsen et al. 2018), but in practice, REDD+ has not succeeded in halting forest loss, constrained by weak governance and lack of good data (Angelsen 2009) and uncertain future financing (Angelsen et al., 2018). However, REDD+ has contributed to promoting forests as part of the solution to climate change and, as a result, was incorporated into Article 5 of the Paris Agreement. More than 55 countries explicitly mention REDD+ in their Nationally Determined Contributions (NDCs) (Pham et al. 2018). Finance is still far from secure, but other global initiatives have emerged. The private sector, for example, has promoted zero deforestation initiatives, and countries have included climate-smart agriculture on their agendas. Tenure and indigenous issues have been brought into the open (Angelsen et al. 2018). Yet, many issues remain unresolved. The result-based payment scheme needs further development and to be embedded in a larger programmatic approach to the complexity of land-use decision making. This will require better coordination and ownership, as well as more secure long-term funding. But more importantly, national governments need to be willing to implement bold policy reforms, integrate forests into national planning, and change fundamental economic incentives for land-use decisions (Angelsen et al. 2018).

CIFOR has a long history of research on the causes of deforestation and forest degradation, and this body of work has continued under the Global Comparative Study (GCS) on REDD+ in the context of climate change mitigation. Although not the only climate-focused work at CIFOR, the GCS-REDD+ is the largest and longest-running. Funded by the Norwegian Agency for Development Cooperation (NORAD), the study was initiated in 2009, when most REDD+ activities were first initiated. Three phases of research have now been completed, covering overall design issues and building strong research-based knowledge, including on evolving policy processes and the actions of early starters in developing REDD+

policies and measures for transformational change. When REDD+ was implemented, CIFOR also included research on the actual impacts of REDD+ policies and measures, as a basis to achieve results in the broader context of landscape management, livelihood objectives and equity considerations (CIFOR 2021c). Over 10 years of research has resulted in many reports and publications, among others, a series of REDD+ books published by CIFOR translated into Japanese by Dr Toma and others. Under a fourth phase in 2021, CIFOR will continue to work on issues related to REDD+, such as the links to politics, finance, and how policies might better integrate the knowledge generated from research. As before, this research will be in collaboration with partners co-producing the science.

Collaborative research on climate change and social forestry

From swampy mangroves to hilly swidden landscapes, across Southeast Asia local people are managing forests in multifunctional landscapes. These forests provide invaluable ecosystem services and products, thereby contributing to incomes, subsistence and energy needs, and shaping the cultural identity of local people. Yet all over the world, governments have taken away the control and management of forests, including decisions on their use. Indeed, most forests are now ‘political forests’ (Peluso & Vandergeest 2020), where local people have no or only limited rights. At the same time, it is generally accepted that forests have multiple uses and values, and need to be governed not only for economic purposes but also to fulfil social and environmental needs.

With the current climate change crisis, forests have become even more relevant as a means for mitigation and adaptation (Locatelli et al. 2011; Palahi et al. 2019). Forests are often located in areas where local people, often ethnic minority groups, have traditional rights to the land and resources. Therefore, understanding how these local people manage their resources through different social forestry regimes, leading to different sets of social, cultural, environmental, and development outcomes, can help inform the design of mechanisms such as REDD+. There have only been a few research projects that have explicitly focused on social/community forests, but issues related to social forests are part of almost all of CIFOR’s work. There is, for example, a large ongoing body of work on tenure issues, on social learning and adaptive management, gender and multistakeholder processes, participation and decentralization of forest governance. CIFOR’s research in this area has always had a strong focus on rights and equity, and has included research

on governance systems and models, multistakeholder programs and social learning.

As mentioned earlier, CIFOR and the Japanese government have a long history of collaborative research, and over the years, Japan has funded much research on the topics of forest protection and rehabilitation. Earlier research projects, focused on forest rehabilitation in the Philippines (Chokkalingam 2006a) and China (Chokkalingam 2006b), were implemented in collaboration with Japanese researchers. The comparative study of forest governance in Sabah, Malaysia and a comparative study on the impact of fires in Russia and Central Kalimantan. These two projects are elaborated further below.

The ASEAN-Swiss partnership for social forestry and Climate Change (ASFCC) is one of the few CIFOR research projects that explicitly mentions social forestry. This was a long-term (2010–2020) research project and included the direct involvement of ASEAN and individual ASEAN country ministries in charge of social forestry. The project aimed to strengthen social forestry policies throughout ASEAN. CIFOR’s contribution to this overall goal was to conduct research that would inform policies and practices, linking mitigation and adaptation to climate change in the context of social forestry, and thereby support the ASEAN Working Group on Social Forestry, the ASEAN Secretariat, as well as network partners, in developing appropriate and effective social forestry programs.

The ‘partnership’ aspect of the project’s title refers to CIFOR’s collaboration with an NGO (the Non-Timber Forest Product Exchange Program, NTFP-EP), other research organizations (the Center for Forests and People (RECOFTC), the World Agroforestry Centre (ICRAF) and the South East ASEAN Center for Graduate Study and Research in Agriculture (SEARCA), and the ASEAN Working Group on Social Forestry (AWG-SF). At a country level, the research was conducted in collaboration with local institutions and or organizations. Through this research, CIFOR attempted to understand how swidden communities are managing and using their land and forest resources, how they participate in the social networks that are within their broader social economic-political contexts, and how migration has influenced and affected land and forest use.

Common findings across the research in Indonesia, Laos, Vietnam, Malaysia (Sabah) and Myanmar during 2009–2020 suggest that social forestry can counter the trend towards simplification of the landscape, erosion of traditional ecological knowledge and livelihood systems, and loss of diversity. Providing access and rights to resources empowers communities and can contribute to improved forest governance, thereby supporting local

livelihoods, forest conservation, and climate change mitigation and adaptation. Yet, governments appear to underappreciate the diversity and dynamism of social forestry. Likewise, information flows to inform local people need to be improved including through alternative networks.

Research and practice under ASFCC have contributed to the development of a variety of approaches and models for empowering and engaging local people in the sustainable use and management of forest and natural resources. These approaches include: agroforestry for forest landscape restoration; promoting better marketing of non-timber forest products (NTFP) through innovative local certification systems; establishment of NTFP enterprises and networks that help conserve and better manage resources; and climate change/ecosystem-based adaptation for community's conserved areas. Since 2014, ASFCC work in Sabah, Malaysia has been supported through funding from the Ministry of Foreign Affairs (MoFA), Japan. Here, the project compiled a Sabah profile on the governance of forest and forest resources, and conducted field-level studies in the district of Tongod, Sabah. Research work included a series of workshop and meetings, fieldwork and stakeholder interviews focused on forest, land and resource governance; one study also focused on jurisdictional approaches to climate change.

1. Comparative study of forest governance in Sabah, Malaysia

Tropical forests in Southeast Asia contain high amounts of carbon and biodiverse ecosystems, supporting many communities that are dependent on forest biodiversity-related ecosystem services. However, extensive commercial logging and expansion of oil palm plantations have caused drastic changes in the forest landscape, contributing to increasing CO₂ exposure. In response, various forest conservation measures, such as REDD+ and forest certification, have been implemented. Forests are expected to play an important role in climate change mitigation and adaptation. REDD+'s role in developing countries was acknowledged within the Paris Agreement and the initiative reached implementation phase in 2020. The Green Climate Fund (GCF) has played a key role in facilitating transformational change so as to achieve the Paris climate goals. The Government of Japan has contributed USD 1.5 billion to the GCF, which supports developing countries in reducing greenhouse gases and adapting to climate change. REDD+ and other climate change mitigation and adaptation activities should be implemented through collaborative decision making and provide proper benefit-sharing mechanisms. However, few studies have developed methodologies to measure the

impact of such forest management initiatives on policy and local governance.

The project consisted of two main activities. The compilation of a report: 'Governance of forest and land use in Sabah, Malaysia: Actors, drivers, and institutions' and field level studies on how local people are impacted and involved by state forest governance. These two activities are further described below.

(1) Compiling the Sabah profile on forest governance

The Sabah profile: Governance of forest and land use in Sabah, Malaysia: Actors, drivers, and institutions' is a state-level study on the contextual conditions that drive changes occurring in the forested landscape, and discusses how governance of forest and land is organized. This comprehensive profile is intended to provide a better overall understanding of the trajectory of change in Sabah's forests and land use, the way they are being used, the development of social forestry, and climate change mitigation efforts.

Expansion of oil palm is the main driver of land-use change, but initiatives such as certification processes, the Heart of Borneo (HoB), payment for ecosystem services (PES), social forestry, and the presence of a REDD+ project are aimed at ensuring sustainable forest governance. The profile includes a discussion on Sabah's REDD+ program, initiated in 2011, which aimed to develop a sub-national REDD+ strategy transforming land use to sustainable development and sustainable forest management, through results-based payments. REDD+ in Sabah, however, is still more a series of pilot projects funded by the European Union and managed as technical projects (Moeliono et al. 2020), quite separate from sustainable forest management. Overall, economics is considered the driving force for development and as a result commercial crops are adopted into restoration programs. Oil palm, as explained earlier, earns the government the most revenue, and the drive for economic profitability remains high, as profit from converting forest to palm oil greatly exceeds the potential revenue of conserving the forest through, for example, the REDD+ mechanism or carbon market (Butler et al. 2009, Fisher et al. 2011, Graham et al. 2016). Areas with high oil palm suitability will require high carbon prices and carbon stocks for REDD+ to work (Abram et al. 2016). On the other hand, the costs of negative environmental impacts have yet to be accurately calculated (Fisher et al. 2011). Results will be published as a CIFOR working paper.

(2) Assessing the impact on smallholders and forest communities

To study how land use is governed and changes at local scale, the project conducted focus group discussions and household surveys in order to understand the impacts of communities on land use changes in several villages.

Field research was carried out in two villages in Tongod District, Sabah in 2018 and 2019. Tongod District is part of the HOB initiative, with the study villages located on the fringe of a State Forest Reserve and connected by the Kinabatangan River. Tongod District was established as a separate district from Kinabatangan in 1999, and covers an area of 1,029,385ha, some 775,597 ha of which is forest (CIFOR 2021b). From 2001 to 2018, significant land use and subsequent land cover change occurred (CIFOR 2021b) (Table 1).

During the data collection conducted in the villages, gender and age were disaggregated in focus group discussions, followed by household interviews with the community members. Focus group discussions focused on describing the communities' territories, land use and livelihoods. A historical timeline of land and land-use changes was compiled, and the impact of climate change on their resources, health and livelihood was discussed.

The survey team consisted of representatives from CIFOR, Sabah Forestry Department, PACOS Trust, and Universiti Malaysia Sabah (UMS). The first survey was in K village, Kinabatangan, in February 2018. K village consists of some 81 households of Orang Sungai and other three ethnicities, scattered in several locations adjacent to an oil palm plantation and a forest reserve. The main village is accessible through waterways of the Kinabatangan River (six or seven hours from Sandakan), or crossing D forest reserve (five hours drive from Sandakan), or through backways which were previously logging roads, and often impassable during the rainy

season. People in this area used to work in logging companies, either as loggers or traders. After the logging industry slowed down, those who had money bought land in Bukit Garam and moved out to that area. In the 1980s, there were about 500 households in the whole village, but today the population has dwindled to only 81 households. Most are farmers supplementing their livelihoods with hunting and fishing, selling their surplus to Bukit Garam about four hours away by boat. Women grow vegetables for their own consumption, while some of the men collect scrap metal from abandoned logging sites to sell, or make boats to sell using logs carried by floods; one boat sells for anywhere between RM 900–2,000. In 2012, the government introduced cocoa, provided planting material and guaranteeing marketing through a government agency. As only people with land titles were eligible to join the program, the communities tried to apply for the land title of a forested land (2,000 ha), but so far without success. Limited sources of livelihood have caused many young people to migrate to town for higher education and work. Overall, land remains at the center of socioeconomic activities. Customary practices and investments in land, such as paddy farming, swidden and its fallow lands, a cemetery and fruit trees are traditional means of conveying land rights of the community. Yet legally, in Sabah, unless a plot of land is warranted with a physical deed, the land is considered state land; customary lands can be confiscated if the owner does not acquire his or her right to the native title (Dayang Norwana et al. 2011). However, the allocation of available lands tends to favor commercial development

Table 1. Land cover change in Tongod District, 2001–2018

Year	Industrial oil-palm plantation (ha)	Industrial pulpwood plantation (ha)	Forest on mineral soil (ha)	Other non-forest (ha)
2001	27,978	529	943,550	57,328
2002	36,339	529	936,625	55,891
2003	40,559	529	932,334	55,963
2004	46,134	529	924,334	58,388
2005	50,242	529	914,762	63,851
2006	54,949	529	901,953	71,953
2007	60,358	1,116	892,340	75,571
2008	68,543	2,134	877,703	81,005
2009	76,328	3,873	861,288	87,897
2010	81,332	5,290	850,573	92,189
2011	86,802	6,002	843,094	93,487
2012	92,558	7,267	833,385	96,174
2013	94,694	9,123	828,692	96,877
2014	100,150	10,505	815,908	102,822
2015	101,671	12,032	804,819	110,863
2016	103,471	12,292	789,647	123,975
2017	106,005	12,292	781,530	129,558
2018	107,983	12,292	775,597	133,513

Source: CIFOR (2021b)

instead of acknowledging the customary rights of communities (Sabah Lands and Surveys Department 2010). Consequently, land is often ‘developed’ without the community’s consent. Looking at multiple development interventions in one village (i.e., public facilities, agriculture and forest conservation) and analyzing their impact on community land ownership, landscape and land use change, and livelihoods, we found that development interventions might bring ‘economic’ development, but at the same time may see the community dispossessed of its lands. Thus, an effective form of Free, Prior and Informed Consent (FPIC) is crucial in enforcing a community’s rights and encouraging a system that ensures a community’s involvement.

In M village, the field survey started in July 2019. Focus group discussions were conducted, followed by household surveys. A total of 41 households were interviewed. M village has some 60 households made up of Orang Sungai, Kalabuan and Murut ethnicity. The village current settlement was established in 1969, and is located within and close to a forest reserve. People’s livelihoods consist of swidden and tree crops, supplemented with hunting, fishing, and making handicrafts out of bamboo and rattan. A logging road connects the village to Keningau District. A massive flood occurred in 1972, and in 1984 the village was hit by a big forest fire. In 1984, a neighboring forest reserve was gazetted, with the community claiming not to have been given prior information. In 1986, Sabah Foundation distributed teak seedlings, but little improvement was seen in communities’ livelihoods. In the 1990s, oil palm companies started to plant oil palm, encroaching on the community’s land. Around the same time, a UNDP sponsored project allocated land for rubber plantations only if local people were willing to participate. The rubber was not a success, as local people lacked tapping skills, and when the area burned, local people established their own oil palm in its place.

Results show that the livelihoods of communities in Tongod District are precarious. In both areas, people’s livelihoods consist of a portfolio of swidden, cultivating tree crops and vegetables, and cash labor. Like most rural villages in Sabah, ownership of land is still regulated through customary practices. Yet, unless a plot of land is warranted with a physical deed, the land is recognized as state land, whereby anyone can apply for land separation (Lunkapis 2015). Between the forest reserve and the oil palm plantations, access to land is limited. Of various development interventions, only the cacao plantation seems to have had any degree of success, primarily because marketing was ensured. In general, marketing in the villages is constrained by lack of infrastructure.

Social forestry in Sabah has been adopted as part of the

state’s sustainable forest management strategy to achieve environmental, economic and social objectives. However, there is a gap in translating the social forestry concept to activities within the sustainable forest management approach, and a lack of continuity due to intermittent funding. To strengthen the role of local communities in sustainable forest management through social forestry, there is a need for a platform enabling open discussion among relevant stakeholders, increasing awareness about the benefits of social forestry, and securing adequate funding to conduct social forestry activities. On the other hand, local communities also continue to practice their traditional governance systems to ensure sustainability of resources. Although acknowledged by the state, these practices are not integrated in the state-sponsored social forestry programs and continue to operate in parallel. More in-depth discussions can be found in the CIFOR info briefs by Ibrahim et al. (2020) and Johnlee et al. (2020).

Study of the socio-ecological impacts of forest fire in boreal and tropical forests and peatlands

Boreal and tropical forests are the most important terrestrial carbon sinks, and thus can play a significant role in mitigating climate change (Palahi et al. 2019). Both these ecosystems also contain large areas of peatland. The main challenge to these fragile ecosystems is the large-scale conversion of forests and peatlands deemed necessary for economic development, often using fires to clear the land. Yet, forest-dependent communities typically benefit least from large-scale commercial production, and there is increasing urgency to seek climate-resilient livelihoods for small-scale foresters and forest-dependent communities. The increasing incidence of fires in high carbon forests and peatland drives, and is driven by, climate change. Such fires have an impact beyond country boundaries. Forest fires in the Russian Far East, for example, directly affect northern parts of Japan. To better understand the dynamics of fires and their impact on local communities and the ecosystem, the Ministry of Agriculture, Forestry and Fishery, Japan funded projects focusing on forest and peatland fires in the Russian Far East and Indonesia. The project started in 2017 and consisted of interdisciplinary research, teaming experts from Japan and CIFOR with in-country partners.

Research sites in Far Eastern Russia and Indonesia were chosen as representing changing systems of livelihoods and resource management in forested and peat areas, as specifically influenced by forest fires, changing livelihood options and resource management trends. The project aimed to provide input to support the design of policies and practices that deliver effective and

efficient outcomes for climate-resilient livelihoods, while ensuring equitable outcomes, including co-benefits such as effective adaptation. It has been implemented through local partnerships, with CIFOR leading, managing and coordinating project activities. A summary of findings from each study site is presented below.

1. Case study from Khabarovsk, Far East Russia

According to the Russian Federal Forest Service, 80% of the forest fires that occur throughout Russia are attributed to human causes, mostly originating from logging concessions. The Russian Federation Forest Code, revised in 2006, shifted the responsibility of forest preservation and restoration from the Forest Service to the felling operators, who therefore must conduct forest fire extinguishing efforts (Russia Forest Service 2018). However, other fires, caused by hunting or people using the forests, roads, railway networks, fire mismanagement and illegal felling, fall beyond the concession holders' responsibility. Forest fires significantly affect the lifestyles of indigenous and local communities in the northern regions of the country and Far Eastern Russia, and whose livelihoods and culture are connected with the utilization of these ecosystems' natural resources. Frequent fire events, therefore, not only influence 'food source' productivity and food security, but also threaten the social welfare of local communities.

In recent years, many regions of Russia, including the Khabarovsk Krai, have faced the increasing incidence of wildfires. Changes in climatic conditions (an increase in the frequency of low-snow winters, a long period of inter-seasonal droughts), an increase in the accessibility of forests by the public, and the widespread use of dry grass burning in agriculture, have led to a significant increase in the number of fires and their scale.

According to state statistical data, as of 1 January 2020, 737,140 ha (93.6%) of Khabarovsk Krai is part of the Forest Fund, of which 579,109 ha (78.6%) are considered forest land, including 511,523 ha (88.3%) that are actually covered by forest. Thus, forests cover 66.5% of the entire region (511,520 ha). However, the human population density in 2020 was low: a mere 1.67 people/km². The northern parts of the region are almost entirely uninhabited (0.03 people/km²). Such an abundance of forests in the region, with many mires and marshlands, creates favorable conditions for natural fires. Forest fires are the main factor reducing and ecologically degrading forests in Khabarovsk Krai. In an average fire season, the forested area affected by fire exceeds the area cut down annually many times over. In 2019, the area affected by fire was about 300,000 ha, while wood harvesting impacted an area of about 88,000 ha. The protection of forests and

peatlands from fires is therefore one of the most important priorities facing the region's forestry sector. A solution is needed, both to prevent excessive greenhouse gases being emitted into the atmosphere, and to protect rural settlements and economic and infrastructure facilities from fire. It is important to note that this problem has domestic and international aspects, as atmospheric smoke pollution crosses borders. Thus, the complexity of preventing and eliminating wildfires means that regional attention to this issue is a necessity, but even more so, those living in small settlements directly adjacent to forest and mire areas (or peatlands) must be involved. These recommendations provide an overview of the legal framework for fire control, the causes and the consequences of fires, and local residents' opportunities to counteract this danger.

In 2019, sociological and geo-ecological studies were conducted within Lower Anyui, in order to assess the degree of fire impact on the livelihoods of the local population living in forested areas (Chakov et al. 2019). Using remote sensing data, published and cartographic materials, the studies resulted in a modern landscape map (at a scale of 1: 200,000), identification of territories with different impacts, and the multiplicity of wildfire effects (1975–2018), and an estimate of the natural resource potential of ecosystems. The study also revealed the most severe impact of fires on plain meadow-mire geosystems with a relatively low resource potential of non-timber resources. The pyrogenic influence on the state of wildlife resources was revealed, with a reduction in the number of game animals and birds, habitat degradation, and food supply deterioration.

A socio-economic study was conducted in four villages in Nanai District. The questionnaire highlighted the frequency of visits to natural sites and their impacts on ecosystems; the impact of fire on livelihoods; respondents' assessments of the current environmental situation related to fires, and any further action required. Study results revealed the significance of traditional activities in the lives of the population (e.g., fishing, hunting and gathering wild plants). The deterioration of the ecological state of ecosystems was noted along with the quantity and quality of their resources; the main factors behind ecosystem degradation and ways to solve forest fires were also determined. The data showed that annually repeated fires produce a depressing effect on the natural restoration course of the wetland phytocenoses, which ultimately results in radical changes in their structure and reduces their biodiversity. Regular fires have a particularly catastrophic effect on moss cover, the restoration of which, even under favorable conditions, can delay for many decades.

2. Case study from Central Kalimantan, Indonesia

Forest and peatland fires and haze are regular occurrences when the dry season hits Indonesia. They not only cause environmental damage and pollution but result in huge economic losses. Indeed pollution by the fires and its impact is shown to be a serious hazard (Hayasaka & Sepriando 2018, Hayasaka et al. 2014). El Nino is often considered the cause of forest and peatland fires in Indonesia. This natural phenomenon results in long droughts due to reduced rainfall. Usually, this happens every three or eight years, as in 1997 and 2015. However, El Nino is only one factor, because forest and peatland fires are closely related to human activities and unsustainable agriculture. The million-hectare peatland development project in Central Kalimantan (Mega Rice Project) is an example of how policies encouraged huge forest land cover changes in the mid-1990s. Prior to 2016, where the Peatland Restoration Agency was established by a presidential regulation, there was no policy that focused on restoring burned areas, especially peatland areas, after fires. A 2020 presidential regulation expanded post-fire restoration sites in mangrove areas.

This study was carried out in Central Kalimantan

Province from 2018 to present. The total area of the province is 153,564 km², with more than 20,000 km² covered by peatland. In the last decade, 2015 and 2019 were the top forest and peatland fire years in Central Kalimantan. The total number of fire hotspots in peak season (September/October) reached 20,045 and 10,065, respectively. Major hotspots occurred in peatland areas, where the most vulnerable area was the ex-Mega Rice Project area, a 1 million ha of peatland cleared for rice cultivation during the Suharto years (Yulianti & Hayasaka 2013; Yulianti et al. 2012). Susetyo et al. (2020) reveals that burned area correlated with the total number of hotspots in Central Kalimantan. Table 2 shows the area of secondary swamp forest (including peat swamp forest) decreased from 26,639 km² to 17,019 km², but the swamp scrub increased from 17,449 km² to 20,828 km². Further, average peat loss within regenerating forest areas, cleared forest areas and degraded forest areas reached 44.2 cm, 32.1 cm and 53.9 cm, respectively (Kusin et al. 2020). We can therefore conclude that forest and peatland fires are one of the driving forces behind land use and land cover changes and peat layer loss in Central Kalimantan.

Table 2. Land use land cover change in Central Kalimantan, 2009–2019

	2009	2019
Land categories	area (km ²)	area (km ²)
Secondary Dry Forest	53,871	42,598
Secondary Swamp Forest	26,639	17,019
Bush	21,587	11,629
Swamp Scrub	17,449	20,828
Primary Dry Forest	12,717	10,727
Dry Land Agriculture	10,169	14,745
Plantation	7,110	19,290
Rice Field	2,496	1,509
Open Area	2,374	3,158
Plantation Forest	1,248	1,701
Settlement	735	732
Secondary Mangrove Forest	451	227
Mining Area	435	1,289
Transmigration	401	176
Primary Swamp Forest	366	325
Fishpond	50	114
Primary Mangrove Forest	50	17
Mixed Dry Land Agriculture	-	4,617
Airport/Port	-	2

Source: Yulianti & Adji (2021)

Conclusion

This paper highlights just a small part of CIFOR's research on climate change and social forestry. Organized under different topics at different times, CIFOR's research has consistently examined how forests and forest resources are governed for people's equitable and sustainable wellbeing. Tenure issues have been an important part of the research portfolio, and are linked to studies on deforestation and its underlying causes, forest fires, climate change and political economics. The past ten years have also seen increased attention on issues of climate change and how forests play a role in mitigation and adaptation.

One important global issue which remains to be fully understood is that of forest and peatland fires. In future, forest fires are expected to increase due to global warming, as well as contributing to it. Boreal and tropical forests and peatlands are high biodiversity and carbon areas, supporting the livelihoods of local forest-dependent communities and the wellbeing of society in general. On the other hand, large-scale conversion of forests and peatlands is often considered necessary for economic development, and often determines how resources are governed. This growth pattern, favoring short-term economics, could be detrimental to countries that have made nationally determined contributions (NDCs) to the Paris Climate Agreement, and can undermine the goal of keeping global warming below 1.5 degrees. A better understanding of changes in social and ecological systems within these contexts can both identify opportunities for success in reaching NDC targets, and support broader global climate change goals. Further studies on mitigation and the impact of fire on health are still required. The continuing support of the Japanese government to implement international collaborative research is thus very important to facilitate climate-resilient livelihoods. Such research includes investigating the way fires occur and spread, analysis of social and ecological systems, measurement of air pollution, and impact on society and health. Furthermore, due to the impact of COVID-19, the double disaster of COVID-19 infections and forest-fire-related smoke damage is anticipated, and urgent measures are being taken. COVID-19 is also impacting inhabitants of remote forested areas where social forestry is practiced, and where forests function as a safeguard for secure rural livelihoods. Continuing collaboration to research the role of forests in climate change and safeguarding human wellbeing remains necessary, to support the more sustainable governance of landscapes.

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