DOI: 10.17528/cifor-icraf/008971

# Fire prevention and peatland restoration

## Community-based action in the digital age

Herry Purnomo[1,2], Dyah Puspitaloka[1], Lila Juniyanti[1,3], Sonya Dyah Kusumadewi[1], I Wayan Susi Dharmawan[3]

1 CIFOR-ICRAF
2 Corresponding author: Herry Purnomo, h.purnomo@cifor-icraf.org
3 National Research and Innovation Agency

Close up of Liberika coffee seed
Ricky Martin/CIFOR-ICRAF

### Key messages

- Peatland restoration efforts should accommodate the development of business models with specific jurisdictions of intervention to clarify target participants, expected investments and beneficiaries/users of environmental services.
- Augmented participatory action research (PAR) emphasizes the importance of digital technologies and local facilitation for cost-efficient restoration and impact monitoring.
- Actions on fire prevention and peatland restoration are connected to and strengthened by jurisdictional sustainability leadership and policies.
- The essence of action research is positioning researchers inside the system and theorizing findings using a constructivist perspective.
- Fire prevention and peatland restoration should focus on capacity, adaptation and resilience building for local actors on the ground.

## Introduction

Forest and land fires are driven by sociopolitical and economic factors (Purnomo et al. 2017, 2019). Devastating fires in Indonesia in 2015 were categorized as a national disaster, causing significant environmental degradation and economic losses amounting to USD 16.1 billion (Glauber and Gunawan 2016). Emission reduction efforts were hampered with approximately 822,736 million metric tons of carbon dioxide equivalent ($MtCO_2e$) emitted in 2015 forest and land fires (MoEF 2020). In 2019, severe fires laid waste to 1.65 million hectares (ha) of forests and agricultural land (MoEF 2020), resulting in economic losses of USD 5.2 billion and USD 157 million in direct damage to assets (World Bank 2019). These forest and land fires also had significant health impacts, including in neighbouring countries, with toxic haze causing respiratory tract infections and other ailments.

To address the forest and land fires, the Government of Indonesia strengthened fire prevention efforts. The President immediately establish Presidential Instruction No. 11/2015 on strengthening of forest and land fire control with focus on prevention, management and recovery. He also established a Peat Restoration Agency through the Presidential Instruction No. 1/2016 with target to coordinate the restoration efforts of two million hectares of peatland. The Agency mainstream and implement the 3Rs approach that focuses on rewetting, revegetation and revitalization of livelihood. In the following year, the Government established a Grand Design for fire prevention (Coordinating Ministry for Economic Affairs et al. 2017). The efforts resulting the decline of forest and land fires occurrence, according to Sipongi (fire monitoring system) of MoEF (2023).

From 2018 to 2020, with support from Temasek Foundation (TF) and Singapore Cooperation Enterprise (SCE), the Center for International Forestry Research (CIFOR) worked with the University of Riau's Centre for Disaster Studies (PSB UNRI) in developing an enhanced community-based fire prevention and peatland restoration model under a framework of participatory action research (PAR) in Indonesia's Riau Province. Conducted in Dompas Village, Bengkalis Regency, this first phase of this PAR project proved a success with community groups in Dompas being equipped with improved knowledge, techniques, managerial skills and networks.

The second phase of the project involves scaling up sustainable business models in Siak Regency to support the Green Siak and Green Riau sustainable jurisdiction initiatives. Approximately 57% of Siak Regency comprises peatlands. Our spatial analyses show forest and land fires in Siak from 2014 to 2019 occurring in areas with medium to high percentages of peatland cover. The most recent fires in Siak, in 2020 and 2021, accounted for 4–5% of all forest and land fires in Riau (MoEF 2023).

## Case studies on community-based action

### Southeast Asia

The Association of Southeast Asian Nations (ASEAN) and its member countries have developed regional-level agreements, strategies and programmes to counter forest and land fires and peatland degradation. The ASEAN Agreement on Transboundary Haze Pollution and ASEAN Peatland Management Strategy (APMS) were followed up with the establishment of an ASEAN Task Force on Peatlands and various programmes on capacity building and regional coordination. Fire prevention activities have included developing early warning and fire danger rating systems; implementing the APMS and a programmatic approach to combatting forest and land fires in the Mekong region; rehabilitating peatlands in the Raja Musa Forest Reserve in Malaysia; and surveying previously unidentified peatlands across Southeast Asia (APFP-SEApeat 2013, 2015).

Many programmes foster community participation through incentives, as shown in the buffer zone of U Minh Thuong National Park in Vietnam (APFP-SEApeat 2013); improving awareness of protecting wetlands and facilitating peatland restoration (APFP-SEApeat 2016); and capacity building through joint training for fire care community groups in Riau (APFP-SEApeat 2015). These initiatives and regional coordination have encouraged the development of country-level national action plans; regulations for peatland protection and integrated management; and identification of peatland ecosystems in Myanmar, Laos and Cambodia (APFP 2011; ASEAN Secretariat and the Global Environment Centre 2015).

### Malaysia

Malaysia's peatlands play critical roles as providers of resources and ecosystem services for Indigenous Peoples and local communities (IPLCs).

Communities living near the Raja Musa Forest Reserve, for instance, benefit from the timber and non-timber forest products (NTFPs), water for irrigation, food, freshwater fish and other environmental services its peatlands provide (Nath et al. 2017). Peatlands in Southeast Pahang serve as grounds for hunting and gathering resources, including fish (Sundari 2005 in Tan et al. 2021; Hamzah 2014). Other examples include ethnic Berawan fishers practicing traditional fishing using *selambau* stationary lift nets in Loagan Bunut National Park, and community-based ecotourism in Kampung Ampangan near the Raja Musa Forest Reserve (APFP-SEApeat 2014).

A focus on community participation has been a consideration in restoring degraded peatlands. In Kuala Selangor, for instance, multistakeholder support has enabled local communities to backfill drainage canals, replant trees, become more aware of the benefits of protecting peatlands, and develop more sustainable alternative livelihoods through agrotourism development (Dahalan et al. 2016 in Alam et al. 2021; Nath et al. 2017 in Alam et al. 2021). In north Selangor, the community-based organization Friends of North Selangor Peat Swamp Forest has built communities' awareness by encouraging them to play active roles in peatland restoration, fire management and patrolling (Alam et al. 2021), and develop alternative livelihoods (IFAD 2014 in Terzano et al. 2022).

At the national level, the Government of Malaysia adopted its National Action Plan on Peatlands in 2011. Issues associated with peatlands have also been internalized in national policy on biodiversity. The Government of Malaysia has set aside North Selangor Peat Swamp Forest for conservation; nominated Maludam National Park in Sarawak as an ASEAN heritage park; is enforcing reduced impact logging (RIL) in Southeast Pahang; and is enhancing use of the country's Fire Danger Rating System (FDRS). Government commitments and initiatives, as shown in Malaysia's regulatory framework, support land managers including Indigenous Peoples and local communities to manage peatlands more sustainably (ASEAN Secretariat and Global Environment Centre 2015).

**Figure 1. Coffee and rubber agroforestry in Dompas in 2022, two years after project completion**
Photo by Perdana Putra/CIFOR

## Indonesia

Indonesia hold the largest shares of peatland in Southeast Asia, amounting 24.67 million hectares of peatland (MoEF 2017). Peatlands in Indonesia have enormous potential to contribute to carbon storage and global climate mitigation, and to the livelihoods of surrounding communities. Indonesia is considered the most developed country in Southeast Asia in terms of pioneering and modelling sustainable peatland management and restoration through its introduction of the 3Rs (rewetting, revegetation and revitalization of livelihoods) approach to restoration (Terzano et al. 2022).

There are many sustainable peatland management initiatives and practices in Indonesia. The buy living trees system, for example, provides conditional cash transfers by involving local communities in Kalimantan in the reforestation of peatlands (Terzano 2022). Communities in West Kalimantan are also developing agroforestry by combining peatland tree species with crops such as corn, chili and groundnut (Sanudin and Fauziyah 2021). In Jambi, communities have developed *Desa Hijau* or green village groups to restore peatlands (Brotosusilo et al. 2021). In South Sumatra, partnership schemes involve companies giving local communities incentives to plant trees and permitting them to utilize the trees they plant (Purnomo et al. 2014; Sayer et al. 2021). In the same province, communities living near peatlands have also developed agrosilvofishery systems to provide alternative livelihoods and mitigate slash and burn practices (Budiman et al. 2020).

Many peatland management initiatives have also been carried out in Riau, the province with the largest area of peatlands in Indonesia. Communities in Pelalawan Regency are growing peat-adapted commodities such as areca nut, liberica coffee and pineapple, and processing them to produce food products with added value (Antriyandarti et al. 2019; Ariyanto et al. 2019). In addition, a community group in Bengkalis Regency is developing a peat arboretum for educational and tourism purposes (Zulkarnaini et al. 2020).

Community members in Meranti Village in West Kalimantan practice local wisdom in managing peatlands by building tebat canal blocks and growing sago, rubber and areca nut through social forestry schemes by considering local knowledge passed down from generation to generation (Utami

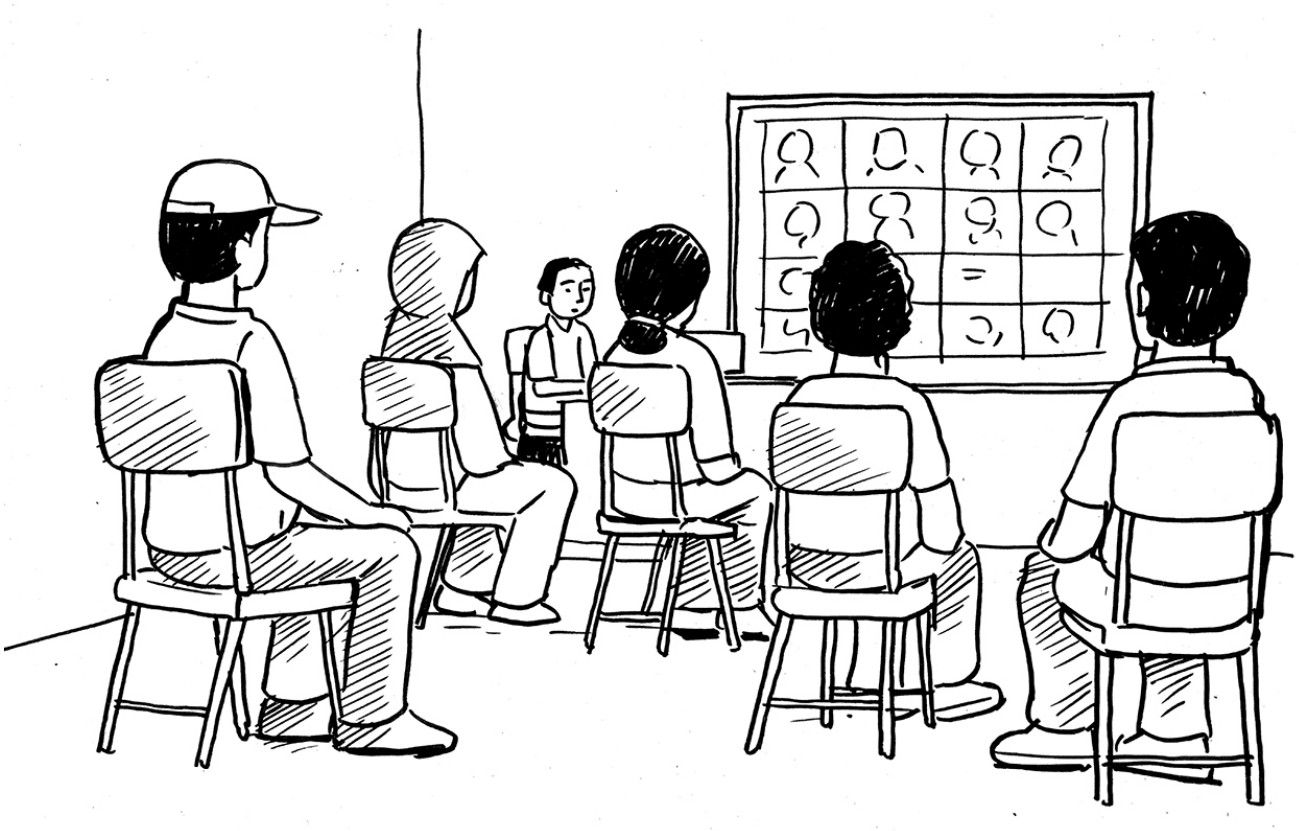

Figure 2. Augmented PAR encourages local communities to adapt to new technologies
Illustration by Komarudin

and Salim 2021). An important thing in all these community-based peatland restoration initiatives has been a focus on restoring social capacity and resilience, as reflected through participation, networking, cooperation, local institutions, rules of action, social and life norms and values.

### Bengkalis Regency

CIFOR and its research partner, the University of Riau's Centre for Disaster Studies, conducted participatory action research (PAR) on community-based fire prevention and peatland restoration in Dompas Village, Bengkalis Regency from 2018 to 2020 (Purnomo and Puspitaloka 2020). Community groups in Dompas identified peatlands as sources of food and fresh water, as carbon sinks, habitats for flora and fauna, and areas for farming. Much of the village's peatland area was degraded and fire prone. Through the PAR, community groups comprising fire care community (MPA), family welfare empowerment (PKK) and farmer groups, as well as households in Dompas were actively engaged in managing action arenas covering a total area of 11.1 ha. Common visions for business models and collaborative actions were agreed upon during the PAR planning phase. These were directed by action plans and implemented by land managers in action arenas representing different land ownership types and environmental conditions. By considering the biophysical characteristics of their action arenas, managers determined appropriate interventions and institutional strengthening measures, and established business model plans for their arenas. The community groups co-led the construction of canal blocks and reservoirs (*perigi*), grew crops and trees (Figure 1) using zero-burning land preparation techniques, and monitored progress using the Community-Based Peatland Restoration Monitoring System (CO-PROMISE).

### Siak Regency

CIFOR and research partners, the University of Riau's Centre for Disaster Studies and Sedagho Siak, are conducting augmented PAR in Kayu Ara Permai and Penyengat villages in Sungai Apit Subdistrict, Siak Regency, Riau Province from 2021 to 2023. An advantage of augmented PAR is that its processes are influenced by knowledge from multiple sources connected through digital technology (Figure 2), whereas traditional PAR's focus on direct interaction can result in limited geographical coverage and limit collective actions only to those able to meet directly. Communities in the two villages

Figure 3. Digital paperless survey
Illustration by Komarudin

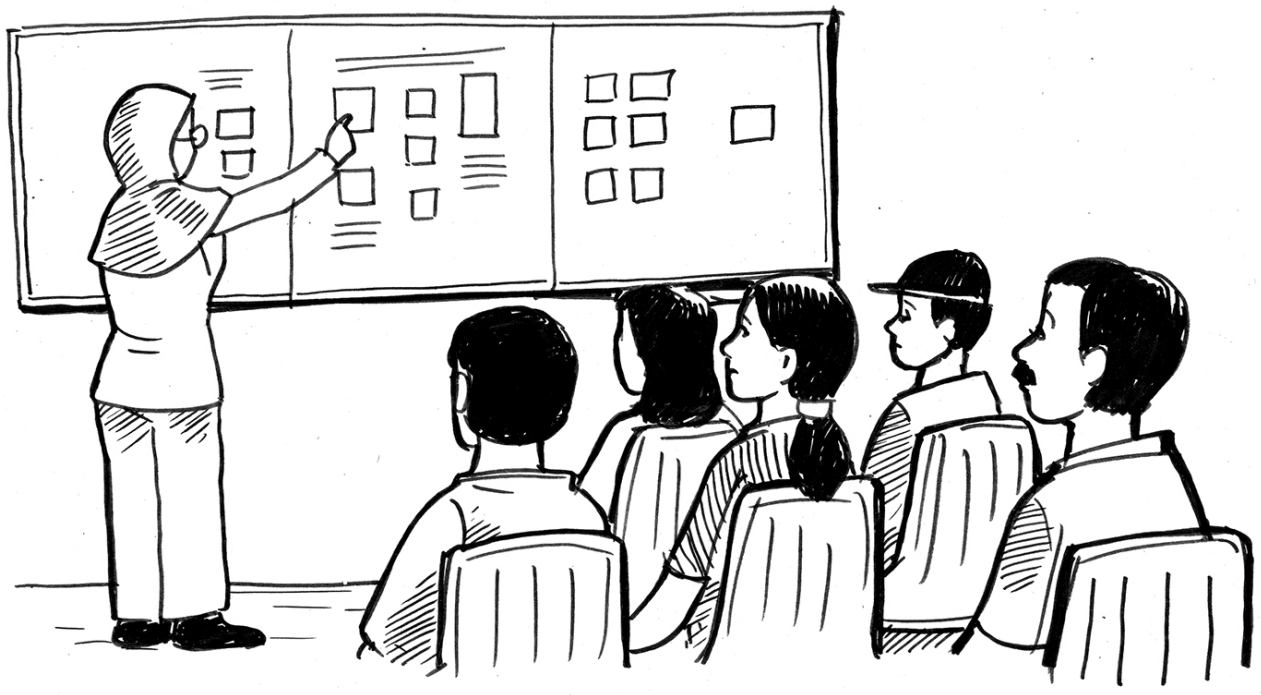

**Figure 4. Developing business models with local community groups.**
Illustration by Komarudin

identified peatlands as potential sources of livelihoods, including farming, ecotourism and fisheries, but also noted that many areas of peatlands are degraded and abandoned with increased forest fire risk. Community groups involved in the augmented PAR, consisting of fire care community (MPA), farmer, women's farmer and conservation groups, as well as indigenous youth organizations, are actively engaged in managing nine action arenas covering a total of 8.45 ha across the two villages, with an additional four action arenas established in community home gardens.

On-the-ground activities being implemented within the augmented PAR framework consist of four phases: reflection and co-elevation; co-creation and planning; connected actions; and co-monitoring and learning.

1. Reflection and co-elevation
   Activities began with communities reflecting on current conditions, problems and potential solutions through co-elevation to secure a more holistic understanding. To ensure all co-researchers had a comprehensive understanding of the prevailing situations, we collected baseline data and information by conducting interviews and paperless digital surveys of institutions, households, commodities and business potential, value chains and biophysical conditions in the peatland ecosystems (Figure 3).

2. Co-creation and planning
   This phase employed focus group discussions (FGDs) with the following themes: developing a shared vision; selecting action arenas and action arena managers; developing landscape/biophysical engineering plans; developing business models and cost-benefit sharing mechanisms (Figure 4); and developing activity timelines. During this phase we used the video conferencing application Zoom and the online discussion tool Miro. The FGDs were supplemented with field visits and interviews for follow-up and data collection.

3. Connected actions
   Activities being carried out in action arenas include the 3Rs: rewetting through the construction and repair of canal blocks; revegetation (replanting) through cultivation training and nursery construction, clearing land without burning, and planting selected trees and commodities; and revitalization

of community livelihoods through the implementation of goods- and services-based business models (Figure 5).

4. Co-monitoring and learning
The online Community-Based Restoration Monitoring System (CBRMS) facilitates participatory monitoring by community groups using handheld devices, which they use in monitoring tree growth, peat groundwater levels and subsidence, and environmental conditions (Figure 6 and 7).

**Central Kalimantan**

Peatlands support the daily needs of many people in Indonesia, including those in villages in Central Kalimantan, the province with the third largest area of peatlands in Indonesia at around 4.6 million ha (MOEF 2017). Community members in villages in Pulang Pisau Regency have developed a rubber business model on peatlands with average peat depths of two metres by maintaining groundwater levels at 1.5 metres below the peat surface to ensure optimum rubber crop growth (Djaenudin et al. 2021)the condition of peatlands continues to be degraded due to uncontrolled use and fires on peatlands and forests areas. The socio-economic revitalization of community is one of the efforts to restore the degraded peatlands. This revitalization is required as the utilization of peatland by the community is still traditional, so the added value of land use products, until now has not been created optimally. Therefore, a land-use business approach that is appropriate with the capacity of the community and available natural capital is needed. This approach will improve community livelihoods and contribute positively to economic, social, and environmental development. This paper aims to identify the features of paludiculture products cultivated by the community and develop a featured product business model. Research locations are in Buntoi and Mantaren 1 Village. Data collection is carried out through in-depth interviews and focus group discussions. Respondents are farmers, traders, industry players, and the government. The data analysis used is descriptive data analysis and canvas business model (CBM). Some farmers there have also adopted the *surjan* or raised bed farming

Figure 5. Community groups managing agroforestry business models in business-scale action arenas
Illustration by Komarudin

**Figure 6. Tree monitoring using the CBRMS system**
Illustration by Komarudin

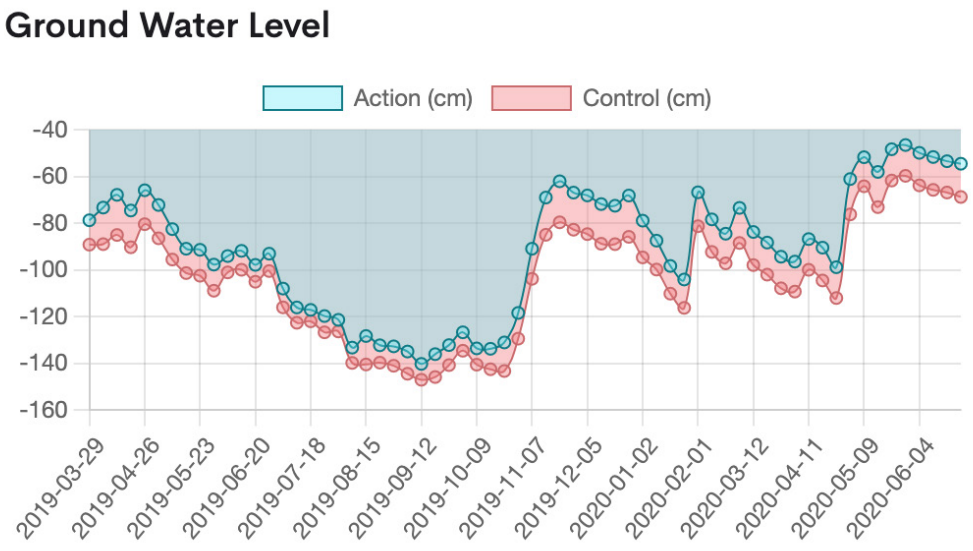


**Figure 7. CBRMS facilitates the monitoring of rewetting intervention impacts on groundwater levels in peatlands**
Source: CBRMS Dashboard (https://data.cifor.org/cbrms/)

technique, planting in mounds of peat that extend to the heights and widths of crops being planted (Sakuntaladewi et al. 2022).

In Ketapang Regency, NGOs are helping villagers secure community forest rights through *Hutan Desa* or village forest schemes, and developing forest carbon pools for villagers (Bos et al. 2020). Other activities in restoration projects include establishing an agroecological school for farmers; facilitating the development of a coconut sugar businesses; providing access to microfinance; and establishing community groups and forums (Puspitaloka et al. 2021).

Paludiculture and inclusive value chain development can also result in sustainable livelihoods and climate-resilient peat areas (van der Meer et al. 2021). In the former Mega Rice Project (MRP) area, dams have been built to enable water tables in degraded peat domes to rise permanently, and allow the regrowth of vegetation (Ritzema et al. 2014). Native tree species showing promising growth in the ex-MRP area are *Shorea balangeran*, *Adenanthera pavonina*, *Dacryodes rostrata* and *Lithocarpus dasystachyus* (Lampela et al. 2017)Indonesia in the degraded peatland of the Ex-Mega Rice area and along the degraded margins of the river Sabangau. Seed material collected from local forests was grown in a field nursery and planted 6–11 months later in the field. Growth and mortality of the seedlings and environmental variables (water table, temperature. While a wide choice of commodities is available for replanting, it is essential to choose combinations that can provide maximum benefits to communities (Lestari et al. 2021).

## Recommendations

1. It is essential to define biophysical and jurisdictional units for peatland restoration to be effective. It is also necessary to determine the appropriate scale for peatland restoration to allow local community participation. Scale has a significant impact on who stakeholders can involve: if it is too large, private sector operators will have more means than communities to participate; if it is too small, it will be less effective in biophysical terms.

2. The private sector plays a key role in buying products and services from restoration efforts. Steady revenue streams will provide tangible benefits to communities and make them willing to sustain restoration efforts and the products they yield.

3. Researchers must understand the strengths and limitations of being inside and outside a community system (constructivism and positive realism, respectively). Inside they are relevant, but can be biased by community needs, whereas outside they can be neutral, but less relevant to the needs of communities.

4. We should be careful when scaling-up restoration efforts as every community and restoration site is different. It is better to connect restoration efforts to innovations in different sites with dissimilar characteristics (connect the dots).

5. Communities should develop their own institutions to manage and sustain restoration actions and their resulting products and services. Such institutions can take the form of forest farmer group associations, which are grass-roots organizations recognized by the government.

## Acknowledgements

This policy brief constitutes part of the Participatory Action Research Project on Scaling-Up Community-Based Fire Prevention and Peatland Restoration in Siak District supported by Temasek Foundation (TF) and Singapore Cooperative Enterprise (SCE). We would like to thank our research partners from the University of Riau's Centre for Disaster Studies (PSB UNRI) and Sedagho Siak, as well as all action arena managers in Kayu Ara Permai, Penyengat and Dompas villages. We also wish to thank the regional governments of Riau Province, Siak Regency and Sungai Apit Subdistrict, and the Tasik Besar Serkap Forest Management Unit, the Peatland and Mangrove Restoration Agency (BRGM) and the National Research and Innovation Agency (BRIN).

## References

Ministry of Environment and Forestry. 2023. *Luas kebakaran hutan*. Accessed 21 August 2023. https://sipongi.menlhk.go.id/

Ministry of Environment and Forestry. 2020. *Luas kebakaran hutan*. Accessed 30 June 2020. https://sipongi.menlhk.go.id/

Purnomo H, Shantiko H, Sitorus S, Gunawan H, Achdiawan R, Kartodihardjo H, Dewayani AA. 2017. Fire economy and actor network of forest and land fires in Indonesia. *Forest Policy and Economics* 78:21–31.

Purnomo H, Okarda B, Shantiko B, Achdiawan R, Dermawan A, Kartodihardjo H, Dewayani AA. 2019. Forest and land fires, toxic haze, and

local politics in Indonesia. *International Forestry Review* 21:1–15.

Purnomo H and Puspitaloka D. eds. 2020. *Pembelajaran pencegahan kebakaran berbasis masyarakat*. Bogor: CIFOR.

Glauber AJ, Gunawan I. 2016. The Cost of Fire: An Economic Analysis of Indonesia's 2015 Fire Crisis. The World Bank. http://pubdocs.worldbank.org/en/643781465442350600/Indonesia-forest-fire-notes.pdf (Accessed 15 June 2020).

World Bank. 2019. Indonesia economic quarterly report, December 2019. Jakarta: World Bank Indonesia.

APFP-SEApeat. (2013). ASEAN Peatland News 2013.

APFP-SEApeat. (2015). ASEAN Peatland News 2015.

APFP-SEApeat. (2015). ASEAN Peatland News Quarter 3 2015.

APFP-SEApeat. (2014). ASEAN peatland News September 2014.

APFP-SEApeat. (2016). ASEAN Peatland News Quarter 1 2016.

ASEAN Peatland Forests Project. 2011. Peatlands in Southeast Asia-a profile. Malaysia: ASEAN Secretariat and Global Environment Centre.

ASEAN Secretariat and the Global Environment Centre. 2015. Best management practices for communities living on peatlands.

Nath TK, Dahalan MPB, Parish F, Rengasamy N. 2017. Local people's appreciation on and contribution to conservation of peatland swamp forests: experience from Peninsular Malaysia. Wetlands 37:1067–1077. DOI: 10.1007/s13157-017-0941-1.

Sundari R. 2005. Conservation and sustainable use of peat swamp forests by local

communities in South Eas Asia. Suo 56, 27–38. in Tan, Z.D., Lupascu, M., Wijedasa, L.S. (2021). Paludiculture as a sustainable land use alternative for tropical peatlands: A review. Science of the Total Environment 753. https://doi.org/10.1016/j.scitotenv.2020.142111

Hamzah KA. 2014. Assessment of Best Management Practices of Peatlands in Malaysia. ASEAN Peatland Forest Project.

Dahalan MP, Manaf MBA, Rahman BHA, Khalid SMA, Sukri AM, Yusoff DM, et al. 2016. Implementation of integrated management plan for North Selangor Peat Swamp Forest 2014-2012. In paper presented at 15th International Peat Congress, Serawak, Malaysia, August 15-19. in Alam MJ, Nath TK, Dahalan MPB, Halim SA, Rengasamy N. 2021. Decentralization of forest governance in Peninsular Malaysia: the case of peatland swamp forest in North Selangor, Malaysia. Natural Resource Governance in Asia.

Nath TK, Dahalan MPB, Parish F, Rengasamy N. 2017. Local peoples' appreciation on and contribution to conservation of peatland swamp forests: experience from Peninsular Malaysia. Wetlands, 37, 1067-1077. in Alam MJ, Nath TK, Dahalan MPB, Halim SA, Rengasamy N. 2021. Decentralization of forest governance in Peninsular Malaysia: the case of peatland swamp forest in North Selangor, Malaysia. Natural Resource Governance in Asia.

IFAD. 2014. Terminal Evaluation Report ASEAN Peatland Forests Project: Rehabilitation and Sustainable Use of Peatland Forests in Southeast Asia. International Fund for Agricultural Development, Rome. in Terzano D, Attorre F, Parish F, Moss P, Bresciani F, Cooke R, Dargusch P. 2022. Community-led peatland restoration in Southeast Asia 5Rs approach. Restor Ecol.

Ministry of Environment and Forestry. 2020. Laporan Inventarisasi Gas Rumah Kaca dan MPV. Accessed from: https://www.bps.go.id/statictable/2019/09/24/2072/emisi-gas-rumah-kaca-menurut-jenis-sektor-ribu-ton-co2e-2000-2019.html

Coordinating Ministry for Economic Affairs, Ministry of National Planning and Development, Ministry of Environment and Forestry. 2017. Grand design pencegahan kebakaran hutan, kebun dan lahan 2017-2019.

CIFOR-ICRAF. (2023) Global Wetlands. https://www2.cifor.org/global-wetlands/# (22 August 2023).

Terzano D, Attorre F, Parish F, Moss P, Bresciani F, Cooke R, Dargusch P. 2022. Community-led peatland restoration in Southeast Asia 5Rs approach. Restor Ecol.

Brotosusilo A, Anita Rouly V, Pricilia CC. 2021. Community involvement in peatland management: Social intervention approach and environmental law. IOP Conf Ser Earth Environ Sci. 716(1). doi:10.1088/1755-1315/716/1/012084.

Sanudin, Fauziyah E. 2021. The effect of extension on community knowledge in peatland management: Case study in Rasau Jaya Village, Kubu Raya, West Kalimantan. IOP Conf Ser Earth Environ Sci. 648(1). doi:10.1088/1755-1315/648/1/012170.

Budiman I, Bastoni, Sari EN, Hadi EE, Asmaliyah, Siahaan H, Januar R, Hapsari RD. 2020. Progress of paludiculture projects in supporting peatland ecosystem restoration in Indonesia. Glob Ecol Conserv. 23:e01084. doi:10.1016/j.gecco.2020.e01084.

Antriyandarti E, Sutrisno J, Rahayu ES, Setyowati N, Khomah I, Rusdiyana E. 2019. Mitigation of peatland fires and haze disaster through livelihood revitalization: A case study in Pelalawan Riau. J Phys Conf Ser. 1153(1). doi:10.1088/1742-6596/1153/1/012131.

Ariyanto DP, Sumarno, Supriyono, Yunus A, Pudjiasmanto B, Rahayu, Widijanto H, Suntoro. 2019. The productivity increasing of peatlands on community land by multi-cropping model in Riau Indonesia. IOP Conf Ser Earth Environ Sci. 393(1). doi:10.1088/1755-1315/393/1/012103.

Zulkarnaini, Meiwanda G, Lubis EE, Nasution MS, Habibie DK. 2020. Peatland Management Based on Education for Sustainable Development (ESD). J Phys Conf Ser. 1655(1). doi:10.1088/1742-6596/1655/1/012142.

Utami W, Salim M.N. 2021. Local wisdom as a peatland management strategy of land fire mitigation in meranti regency, Indonesia. Ecol Environ Conserv. 27:S127–S137.

MoEF [Ministry of Environment and Forestry. (2017). Decree of the Minister of Environment and Forestry of the Republic of Indonesia Number SK.130/MENLHK/SETJEN/PKL.0/2/2017 concerning Determination of National Peat Ecosystem Function Map.

Djaenudin D, Indartik, Suryandari EY, Parlinah N, Salaka FJ, Kurniawan AS, Iqbal M. 2021. Business model for community featured products in peatlands: Case study of Pulang Pisau Regency. In: IOP Conference Series: Earth and Environmental Science. Volume 917.

Sakuntaladewi N, Rachmanadi D, Mendham D, Yuwati TW, Winarno B, Premono BT, Lestari S, Ardhana A, Ramawati, Budiningsih K, et al. 2022. Can We Simultaneously Restore Peatlands and Improve Livelihoods? Exploring Community Home Yard Innovations in Utilizing Degraded Peatland. Land. 11(2):1–22. doi:10.3390/land11020150.

Bos AB, Sy VD, Duchelle AE, Atmadja S, de Bruina S, Wunder S, Herold M. 2020. Integrated assessment of deforestation drivers and their alignment with subnational climate change mitigation efforts. Environmental Science and Policy 114 (2020) 352–365. https://doi.org/10.1016/j.envsci.2020.08.002

Puspitaloka D, Kim YS, Purnomo H, Fulé PZ. 2021. Analysis of challenges, costs, and governance alternative for peatland restoration in Central Kalimantan, Indonesia. Trees, For People. 6. doi:10.1016/j.tfp.2021.100131.

Van Der Meer PJ, Tata H, Rachmanadi D, Arifin YF, Suwarno A, Van Arensbergen P. 2021. Developing sustainable and profitable solutions for peatland restoration. In: IOP Conference Series: Earth and Environmental Science. volume914.

Lampela M, Jauhiainen J, Sarkkola S, Vasander H. 2017. Promising native tree species for reforestation of degraded tropical peatlands. For Ecol Manage. 394:52–63. doi:10.1016/j.foreco.2016.12.004.

Lestari S, Winarno B, Premono BT, Syabana TAA, Azwar F, Sakuntaladewi N, Mendham D, Jalilov S. 2021. Opportunities and challenges for land use-based peatland restoration in Kayu Labu Village, South Sumatra, Indonesia. IOP Conf Ser Earth Environ Sci. 917(1). doi:10.1088/1755-1315/917/1/012021.

Sayer J, Boedhihartono AK, Langston JD, Margules C, Riggs RA, Sari DA. 2021. Governance challenges to landscape restoration in Indonesia. Land use policy. 104 June 2020:104857. doi:10.1016/j.landusepol.2020.104857.

Ritzema H, Limin S, Kusin K, Jauhiainen J, Wösten H. 2014. Canal blocking strategies for hydrological restoration of degraded tropical peatlands in Central Kalimantan, Indonesia. Catena. 114:11–20. doi:10.1016/j.catena.2013.10.009.

CIFOR | World Agroforestry | PSB UNRI | Sedagho Siak | TEMASEK FOUNDATION | SCE SINGAPORE COOPERATION ENTERPRISE

cifor-icraf.org/CBFPR

cifor.org | worldagroforestry.org

**CIFOR-ICRAF**

The Center for International Forestry Research (CIFOR) and World Agroforestry (ICRAF) envision a more equitable world where trees in all landscapes, from drylands to the humid tropics, enhance the environment and well-being for all. CIFOR and ICRAF are CGIAR Research Centers.

CGIAR