Lessons on
Community-Based Fire Prevention and Peatland Restoration

Editors:
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CIFOR

World Agroforestry

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Center for International Forestry Research (CIFOR)
World Agroforestry (ICRAF)

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Introduction

Land and forest fires continue to be regular occurrences. They were worse in 2019 compared to the previous year. Devastating fires in 2015 affected a total area of 2.6 million hectares (ha), and having resulted in economic losses of USD 16.1 billion, led to increased awareness of the necessity to take large-scale and systematic preventive measures to combat forest and land fires. Despite such fires bringing huge economic and environmental losses to society, and significant detrimental impacts on health, education and transportation, some parties still benefit economically from them as they facilitate and accelerate land preparation for agriculture. Consequently, any efforts to transform the way communities and corporations operate must be carried out rationally by understanding situations on the ground and people's needs for decent livelihoods.

Though fires occur on mineral and peat soils, peatland fires are much more difficult to extinguish, and produce many more emissions. Current legislation permits agriculture on shallow peatlands, but such cultivation should be directed towards practices that are appropriate to moist wetland ecosystems. Meanwhile, deep peat and peat domes should be used as conservation areas, without eliminating the income sources they provide for local communities. Such communities should be the main actors in peatland restoration and conservation efforts. A community-based land and forest management approach should be the new direction for fire prevention and peatland restoration. For any transformation to be successful, it is not enough for communities to share knowledge, it is crucial for them to experience firsthand how to prevent fires and carry out peat restoration on a true economic scale. Fire prevention and peatland restoration are complex issues, and the knowledge necessary for conducting them effectively is not always appropriate or available. This is where Participatory Action Research (PAR) comes in.

The Center for International Forestry Research (CIFOR), in collaboration with the University of Riau (UNRI), the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and Gadjah Mada University (UGM), and with funding support from the Temasek Foundation (TF), conducted research to understand the causes of forest and land fires, and PAR with local communities on fire prevention and peatland restoration through a programme managed by the Singapore Cooperation Enterprise

(SCE). The research was conducted in Riau Province, Indonesia. Its PAR segment was conducted in Dompas Village, Bukit Batu Subdistrict, Bengkalis Regency from 2018–2019 in collaboration with the village's Fire Care Community group or *Masyarakat Peduli Api* (MPA), the Dompas Village Government, and other community groups. The outcomes of this research are summarized and packaged for easy understanding as lessons 1–9 in this publication entitled Lessons on community-based fire prevention and peatland restoration. Research outcomes were also presented in workshops in Bengkalis Regency on 28–29 August 2019 to secure feedback from local-level stakeholders, and in Pekanbaru, the provincial capital, on 24 October 2019 to obtain input from the provincial and national levels. This feedback and input was combined with contributions from practitioners and academics involved in the review process during November and the book review workshop on 3 December 2019.

This handbook was born out of Participatory Action Research (PAR) we conducted in Dompas Village to support a gradual change in local community behaviour towards land clearing without burning. Through this PAR, in which knowledge development and behavioural change occurred almost simultaneously, we researched, facilitated and mainstreamed zero-burning land management by assisting the local community in selecting and implementing alternative, fire-free methods for land clearing; developing sustainable business models as integral parts of fire prevention and peatland restoration efforts; and facilitating co-learning.

Together with partners, through this PAR we facilitated a series of activities, studies and discussions with the local community through a repeated cycle of 'reflection', 'planning', 'action' and 'monitoring' in seven 'action arenas' in Dompas Village. In these action arenas, which were identified and selected in a participatory manner together with the community, community groups developed sustainable business models for fire prevention and peatland restoration. The arenas were located in peatland areas with unique biophysical characteristics, which fell under four forms of land management: public, private, co-management, and home garden. The biophysical, social and economic conditions of each action arena were carefully studied. We worked together to determine roles and responsibilities; establish cost-benefit sharing mechanisms; and plan what commodities and business models to develop, as well as any necessary landscape engineering, etc. These plans were then followed up on with collective actions comprising canal blocking to rewet or moisten peat; tree planting; fish farming; establishing pineapple, liberica coffee and rubber agroforestry systems; developing hybrid coconuts in community home gardens; and strengthening community institutions and farmer groups. Monitoring was carried out in and by the community using biophysical and socioeconomic indicators.

This book is intended as a means for sharing knowledge and experience from research and PAR with the ultimate aim of aiding future community-based fire prevention and peatland restoration efforts. In its present form, it is not intended to be a comprehensive guide to fire prevention. Nevertheless, by sharing the results of this research, we hope the knowledge and experiences this book provides can complement similar endeavours, and be scaled up to other regions, by considering prevailing biophysical, social and economic contexts.

This book comprises the following nine lessons, which can be read sequentially or independently of each other:

- Lesson 1: Participatory Action Research (PAR) theory and implementation for community-based fire prevention and peatland restoration
- Lesson 2: Changes in burning behaviour and fire prevention in Riau
- Lesson 3: Sustainable community business models for fire prevention and peatland restoration
- Lesson 4: Canal blocking and groundwater level monitoring systems
- Lesson 5: Zero-burning land preparation for forest and land fire prevention
- Lesson 6: Planting on peatlands
- Lesson 7: Strengthening fire care community groups: Lessons from Participatory Action Research
- Lesson 8: Establishing a forest farmer group institution in Dompas Village
- Lesson 9: The Community-Based Peatland Restoration Monitoring System (CO-PROMISE)

Ultimately, we hope this book will prove useful for practitioners, professionals, extension workers, companies, community assistants, non-governmental organizations, donors and various levels of government. As this book is far from being perfect, we welcome constructive feedback and criticism for improving any future editions.

Bogor, 1 January 2020

The authors

Foreword

Given the Asia region is vulnerable to both natural and human-made disasters, our societies must be better prepared. Encouraging international exchanges and enhancing regional capabilities in disaster preparedness are key focus areas of the Temasek Foundation. Since problems faced by one community can also affect others, as neighbours and friends in the region, it is important for us to share and exchange ideas, work together and learn from one another.

This handbook presents experiences and lessons learned through research and on-the-ground efforts under the Community-Based Fire Prevention and Peatland Restoration Programme. Bringing together experts and partners from Asia and beyond, the programme focuses on developing community-based models and ideas on fire prevention and peatland restoration in Indonesia.

I am extremely grateful to all partners involved for their enthusiasm, leadership and contributions to the success of this programme. These partners are the Center for International Forestry Research (CIFOR); the University of Riau's Centre for Disaster Studies (PSB UNRI); Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia; Gadjah Mada University (UGM) and Singapore Cooperation Enterprise (SCE).

We hope this handbook can provide a useful reference for communities facing similar problems, and can also serve as a springboard for more collaborative discussions and ideas on fire prevention and peatland restoration.

Benedict Cheong
Chief Executive
Temasek Foundation International

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This book is the result of Participatory Action Research (PAR) conducted on community-based fire prevention and peatland restoration. We are grateful for the active participation of all the action arena managers in Dompas Village, especially the Dompas Ghedang Cemerlang forest farmer group, the Dompas Fire Care Community (MPA), community groups in Bukit Batu and Siak Kecil subdistricts in Bengkalis Regency, as well as the Dompas Village Government, Bukit Batu Subdistrict Government, Bengkalis Regency Government, Riau Provincial Government, and the Bengkalis Island Forest Management Technical Implementation Unit (UPT KPH). We would also like to thank the Peatland Restoration Agency (BRG), Worldwide Fund for Nature (WWF) Riau, the Bengkalis Regency Government Environment Office and the Riau Provincial Disaster Management Agency (BPBD) for their cooperation in implementing the PAR and dissemination workshops, and to those who have helped with this research, including respondents in Bengkalis, Siak and Pelalawan regencies.

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Summary

Lessons from Community-Based Fire Prevention and Peatland Restoration is based on a Participatory Action Research (PAR) case study conducted in Riau Province, Indonesia by the Center for International Forestry Research (CIFOR), the University of Riau's Centre for Disaster Studies (PSB UNRI), the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and Gadjah Mada University (UGM). The results of this study suggest that PAR can answer the need to understand site-level dynamics and make changes simultaneously. With PAR, communities act as research partners in working together to understand problems, finds solutions, and implement, monitor and evaluate them.

Entitled **Participatory Action Research (PAR) theory and implementation for community-based fire prevention and peatland restoration**, this book's first lesson provides summaries of the concepts, philosophical foundations and steps involved in applying the PAR approach, and includes methods that can be used in achieving its goals. The lesson provides guidelines for researchers, practitioners and academics on conducting Participatory Action Research at a local level so it can produce clear results and impacts both during and after a project implementation period.

Recognizing the importance of sustaining the results and impacts of fire prevention projects and programmes, this book's second lesson, entitled **Changes in burning behaviour and fire prevention in Riau**, focuses on alternative zero-burning land clearing practices. It highlights the importance of remembering that such practices require significantly more labour and financial resources, and that since the strict ban on burning was implemented, farmers have been forced to equip themselves with new knowledge and skills to meet the higher costs associated with labour, equipment/machinery and chemical inputs. As poor farmers are more severely impacted by having to adopt zero-burning practices, the key to ensuring successful and sustainable outcomes and impacts of fire prevention programmes is helping villagers adapt to zero-burning land management, while providing them with means to enhance their livelihoods.

Business model formulation is an integral part of efforts to create sustainable alternative practices through PAR. Business models are often associated with setting up large-scale enterprises, but how such models can be applied at local levels and used by communities to develop micro- and small-scale enterprises is still not widely known. This book's third lesson, entitled **Sustainable community business models for fire prevention and peatland restoration**, shares our experiences facilitating community groups in Dompas Village in compiling and piloting business model canvases for ecotourism, and liberica coffee- and pineapple-based agroforestry. Tools for business model formulation facilitate the processes of identifying and mapping community ideas, so with a focus on fire prevention and peatland restoration we suggest an updated business model framework and tool called the Sustainable Business Models for Communities (SBMC) canvas.

Controlling groundwater levels and hydrological conditions is another crucial aspect of fire prevention and peatland restoration. This book's fourth lesson, entitled **Canal blocking and groundwater level monitoring systems**, provides a tool to guide the construction of high quality and durable canal blocking and backfilling installations, which have already proved beneficial for various parties. Canal blocking is intended to increase groundwater levels in areas where canal bulkheads are located. We document previous projects, where in many instances, much of the damage to rewetting infrastructure installations had occurred due to inadequate planning and a lack of awareness raising and discussion processes, and conclude that such infrastructure development should prioritize participatory processes. Using the PAR framework, we outline a series of guidelines on canal blocking and monitoring its impacts in rewetting drained peat. This tool was compiled based on the results of trials conducted in Dompas Village.

In addition to peat soil rewetting, the action arenas in Dompas Village also had to be prepared to support successful cultivation of commodities selected by community groups. In this book's fifth lesson, entitled **Zero-burning land preparation for forest and land fire prevention**, we share experiences in facilitating fire-free land preparation for sustainable management. Changing community behaviour to use alternative zero-burning land preparation methods is a crucial part of fire prevention. Land preparation by burning is often practiced because it is deemed quick, cheap and easy. However, its negative impacts are often not well realized or understood. Although more expensive, fire-free land preparation provides long-term benefits, such as higher available nutrient values in soil, and wood and other waste that can be utilized to provide added value. In addition, fire-free land preparation is more environmentally friendly, and does not cause smoke haze, health problems and disruptions to transportation.

In the context of peatland restoration, the stage subsequent to land preparation is replanting or revegetation; a process which is conveyed in this book's sixth lesson, entitled **Planting on peatlands**. In this chapter we describe field trials conducted in Dompas Village in the context of fire prevention and peat restoration. In addition to restoring the functions of peatland ecosystems, replanting efforts also focused on revitalizing community livelihoods. Field trials were conducted in action arenas covering 11.1 ha using commodities and business models selected by community groups. We share guidelines on cultivating liberica coffee, pineapple and hybrid coconut on peatlands based on training activities presented during the PAR.

Preparedness in surrounding communities is an integral part of fire prevention on peatlands. Fire Care Communities or *Masyarakat Peduli Api* (MPA) are collections of volunteers concerned about controlling forest and land fires. Though MPAs are recognized as the frontline in fire prevention and suppression, they face numerous constraints that prevent them from functioning optimally. These constraints include weak organizational capacity, limited equipment and facilities, and lack of financial support. Through this book's seventh lesson, entitled **Strengthening fire care community groups: Lessons from Participatory Action Research**, we share our experiences and lessons learned from PAR with five MPAs in Bengkalis Regency, Riau Province. Looking in more depth at the roles, functions, structures and workings of these MPAs, these lessons are intended to help stakeholders meet the technical, procedural and administrative requirements necessary to enable MPAs to play more effective roles in fire prevention and management.

During the PAR, CIFOR and villagers in Dompas became aware of the necessity to establish forest farmer group (KTH) institutions as a formal requirement for being allowed to operate on state forest estate land. The establishment and strengthening of these institutions was an essential element of PAR implementation for fire prevention and peatland restoration. In this book's eighth lesson, entitled **Establishing a forest farmer group institution in Dompas Village**, we document PAR processes and outcomes in establishing and strengthening community institutions to play important roles as drivers of community economic empowerment, fire prevention and peat restoration at the site level. This documentation is expected to be beneficial for activists and development partners involved in empowering rural communities.

Finally, to sustain the impact and results of the programme, monitoring was crucial for evaluating its successes and shortfalls in order to improve subsequent activities. PAR, processes and results were monitored in a participatory manner with community groups through a community-based monitoring system. In this book's ninth lesson, entitled **The Community-Based Peatland Restoration Monitoring System (CO-PROMISE)**, we share our experiences in building and using this system for monitoring

restoration activities on peatlands. CO-PROMISE is designed to be user friendly without compromising data quality. It facilitates periodic monitoring, where measurement data can be stored, displayed on its dashboard, and adapted to user needs. CO-PROMISE facilitates various forms of monitoring based on the 3Rs (Rewetting, Revegetation and Revitalization of community livelihoods) restoration approach. Through the system, all measurement information and monitoring results are supplemented with location coordinates and presented visually.

This book contains the first loop of the iterative PAR process and summarizes its reflection, planning, action or implementation, and monitoring phases by focusing on different interrelated topics within the overall process. Lessons 1 to 9 are summaries of these integrated processes in community-based fire prevention and peatland restoration, carried out within a framework of Participatory Action Research.

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List of abbreviations

3Rs	Rewetting, Revegetation and Revitalization of livelihoods
AA	Action Arena
ACM	Adaptive Collaborative Management
APL	Other land use area (outside the forest estate)
BBSLDP	Agricultural Land Resources Research and Development Centre
BMC	Business Model Canvas
BPBD	Regional Disaster Management Agency
BRG	Peatland Restoration Agency
BUMDes	Village-owned enterprise
CBMPT	Circular Business Model Planning Tool
CIFOR	Center for International Forestry Research
CO-PROMISE	Community-based Peatland Restoration Monitoring System
CO_2	Carbon dioxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSO	Civil Society Organization
CSR	Corporate Social Responsibility
FAO	Food and Agriculture Organization
FGD	Focus Group Discussion
Gapoktanhut	Forest farmer group association
GPS	Global Positioning System
HTI	Industrial plantation forest
IAD	Institutional Analysis and Development
ID	Identity (unique identification)
ISO	International Organization for Standardization

Kemenko	Coordinating ministry
KHG	Peatland hydrological unit
KTH	Forest farmer group
KUBE	Joint Business Group
Menko	Coordinating minister
SCE	Singapore Cooperation Enterprise
SES	Social-ecological system
SOP	Standard operating procedure
SVLK	Indonesia's timber legality verification system
SMEs	Small and medium enterprises
TF	Temasek Foundation
TLBMC	Triple Layered Business Model Canvas
ToC	Theory of Change
UAV	Unmanned Aerial Vehicle
UPT KPH	Forest Management Technical Implementation Unit
URL	Uniform Resource Locator
ZOPP	*Zielorientierte Projektplanung*

Lesson 1

Participatory Action Research theory and implementation for community-based fire prevention and peatland restoration

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1.1 WHY PARTICIPATORY ACTION RESEARCH?

The global community is facing three major problems: food availability and access; poverty; and environmental degradation, including peatlands. As many as 822 million people in the world suffer from chronic hunger, and around two billion people are malnourished (FAO 2019). Around seven million hectares (ha) of the world's forests are deforested every year (FAO 2016). The Earth's temperature continues to warm, and could increase by four degrees Celsius by the end of the twenty-first century (World Bank 2012). At global, national and local levels, we are racing against time to improve the situation. Scientists, activists and practitioners around the world are contributing to solving food problems, eradicating poverty and improving the environment. The question is, how can these be done efficiently and effectively?

Many parties hope for forest, peatland and environmental sustainability, which are frequently conveyed by governments, communities, non-governmental organizations (NGOs), activists and forest observers throughout Indonesia and the world. However, deforestation continues at a rate of 0.5 million ha per year. The fire and haze disaster in 2015 resulted in losses of hundreds of trillions of rupiah, and forest and land fires are a regular occurrence to this day. Persistent hydrometeorological disasters and human-elephant conflicts are examples of poor forest and environmental governance.

The necessity to manage natural resources, which many people are dependent on, in a sustainable and environmentally sound manner is a constitutional mandate. Article 33 paragraph 4 of the fourth amendment to the 1945 Constitution states, "The national economy shall be conducted by virtue of economic democracy under the principles of togetherness, efficiency, justice, sustainability, environmental insight and autonomy, as well as by safeguarding the balance between progress and national economic unity." The Constitution mandates that forest, land and peatland governance must be designed for economic progress, environmental sustainability and social justice.

There have been many ideas, narratives and arguments on how development can run without causing negative impacts on the environment and society, as well as how efforts to prevent environmental damage can be carried out effectively. However, these ideas, narratives and arguments rarely cover the complexities unique to individual sites, regions or communities. Further, arguments and claims of truth or success of an initiative are not accompanied by evidence or facts from the field, so lessons that arise are frequently difficult to follow and disseminate. This can result in ideas or narratives being unable to achieve their purpose or even becoming irrelevant. Similarly, research findings and recommendations may not be relevant or implementable on the ground. In such cases, it is not easy to imagine the public being convinced by their findings and following their recommendations. Therefore, levels of community participation should be adjusted to the objectives of the research.

Participatory Action Research (PAR) can answer these problems. PAR has a long history, and has been practiced by social scientists to help solve practical problems in war situations in Europe and America. Some scientists claim PAR originated with the work of Kurt Lewin in the 1940s (Reason and McArdle 2004). The first characteristic of PAR is its participatory nature, wherein research is carried out by the main researcher in collaboration with community groups as co-researchers to understand problems and seek solutions. The second characteristic is that PAR is action-oriented. The solutions identified are implemented jointly in the field. Reason and McArdle (2004) concluded that PAR is conducted by, with, and for people, rather than merely being research on the people. This means communities actively experience and participate in implementation during the research period, allowing them to assess the viability and effectiveness of proposed solutions to identified problems. Firsthand experience and active involvement in the learning process are far more profound and convincing than simply listening to others. By the time PAR has been completed, it has frequently already yielded outcomes and impacts on a small scale. Although not covered by PAR, scaling-up will certainly be necessary for increased impact.

Forest and land fires are national issues that need to be addressed by all parties. Purnomo et al. (2017a) stated that fires are started intentionally in an organized manner to secure maximum profits from crop cultivation. This organized crime is exacerbated by political contestation during regional elections (Purnomo et al. 2019). It is doubtful that government action alone can reduce fires, given the benefits certain actors gain from using fire, and their complex relationships with local elites. All stakeholders, including central and regional governments, private sector companies, non-governmental organizations (NGOs) and civil society organizations (CSOs) must act together to prevent fires. Communities are key to doing so at the village level, and this is something that needs to be understood in greater depth.

Research that emphasizes outputs in the form of scientific reports and articles is highly useful in understanding systems, communities and their interactions. However, there is a need for research that not only seeks to understand the underlying causes of fires, but also explores how behavioural changes among various actors, especially communities and nearby stakeholders can be achieved and encouraged to promote fire prevention efforts and enhance livelihoods. The key factors are clear community participation and instilling a sense of ownership in research and intervention processes, with communities being the main drivers, or at the very least, research partners.

This chapter outlines PAR concepts, its philosophical foundations, and steps involved in applying the PAR approach, including methods that can be used in achieving its goals. PAR is an inclusive process, whereby communities identify and analyse problems, and act to find solutions and promote social, economic and political transformation (Selener 1997). PAR is a means for simultaneously understanding problems and transforming behaviour.

This chapter was prepared based on a case study of the Community-based Fire Prevention and Peatland Restoration project in Riau Province, Indonesia – a Participatory Action Research project funded by the Temasek Foundation (TF). The project was jointly implemented by the Center for International Forestry Research (CIFOR) and the University of Riau's Centre for Disaster Studies (PSB UNRI) during 2018–2019. The purpose of this chapter is to offer a comprehensive guide for researchers, private sector operators, communities, NGOs, government officials and practitioners on conducting action research at the local level to generate tangible results and impacts, not only during project implementation, but after projects end.

1.2 FOUNDATIONS AND IMPLEMENTATION OF PARTICIPATORY ACTION RESEARCH

1.2.1 Foundations of participatory action research

Collaboration between stakeholders can occur naturally when individuals are unable to pursue goals on their own (Ossowski 1999). The praxis of collaboration is influenced by social dynamics. A vital dimension of social interaction is the way individuals justify their actions to others. Boltanski and Thévenot (2006) argue that these justifications fall into six main logical categories, exemplified by six authors: *civic* (Rousseau), concerning common interests and goals; *markets* (Adam Smith), concerning utilities; *industry* (Saint-Simon), concerning efficiency to achieve goals; *domestic* (Bossuet), concerning relationships; *inspiration* (Augustine), concerning values; and fame or *reputation* (Hobbes), concerning a person's good name. The authors show how these justifications can contradict each other as people race to legitimize their views.

Regarding communication between actors, Habermas (1987) states that communication becomes problematic if rational instrumentality rivals rationalization of value. Habermas (1987) further elaborates communicative action strategies to facilitate communication on different rational perspectives. Communicative action is defined as a way to achieve mutual understanding in the social sphere (Habermas 1987). Action can communicate rationality and present mutual understanding between actors, which then leads to agreement. We hypothesize that in the complexity of fires and peatland restoration, communicative action between parties is one way to advance collaboration and action. Communication between stakeholders can change their preferences and create common values. Perception is not preformulated, but rather constructed by social dynamics.

Pruzan (1994), as quoted in Gamborg (2002), proposed three fundamental steps, namely *stakeholder identification, value sharing* and *criteria* to meet the conditions referred to by Habermas (1987) for practical discourse towards communicative action. PAR is a process whereby community members identify problems, collect and analyse information, and act on problems by finding solutions and encouraging social and political transformations (Selener 1997). Transformation is the goal of Adaptive Collaborative Management (ACM) defined by Colfer (2005). Kusumanto et al. (2005) presented an example of the ACM process in Sumatra that used PAR as a research framework to increase the capacity of stakeholders. Through PAR, local communities could act collectively and participate in decision making processes related to their forests and land. PAR is performed through an iterative series of reflection-planning-action-monitoring phases (Henocque and Denis 2001).

PAR is closely related to general systems theory, complexity theory, communicative action (Habermas 1987), socioecological systems (SES), and institutional analysis and development (IAD) from Ostrom (2007, 2010). General systems theory posits the existence of isomorphisms between different disciplines, and natural and social systems. The pattern of solution of one particular discipline may apply to other disciplines as well. Forest conservation, for example, has similarities and problems similar to marine conservation and mine management. Role strategies can also apply in the business world. Properties at the system level appear and may be incomprehensible from their components. Complexity theory originated from the failure of linear predictions based on the Newtonian paradigm. Given the many uncertainties, system behaviour is unpredictable, and therefore learning and adaptability become the core centre of system management, including natural resources and ecosystems. Action communication underscores the importance of action as a medium for reaching agreement. Well-communicated actions will trigger reactions and reciprocal actions, which will then formulate social agreements and institutions. SES uses a framework that explains how nature, management, governance, actors and politics are connected and interact.

The IAD framework provides guidance on the key institutional, technical and participatory aspects of an intervention in a community that manages resources together, and how shared problems can be solved. A core part of the IAD framework is the *action arena* element, which includes action situations and actors. Action situations refer to social spaces where actors interact with each other, solve problems together and exchange goods or services (Ostrom 2007, 2010). Through this framework, the analysis stage is carried out using the action arena as a unit of analysis and systematically following the decision making path, which involves pre-planning, planning and execution or implementation stages, and how a project can be sustainable. The different interests of parties involved in the action arena are discussed, and activity plans are drawn up based on agreement between those parties.

Habermas (1968) divides science into three paradigms: *positivism* (empirical-analytical/instrumental knowledge); *interpretive/humanistic* (hermeneutic knowledge or interpretative knowledge); and *critical* (emancipatory knowledge). The third (critical) paradigm champions a holistic approach and avoids deterministic and reductionistic ways of thinking. This paradigm then contributes greatly to Action Research also known as PAR. The implementation of PAR, referring to Reason and Torbert (2001), rests on epistemological assumptions that state that the purpose of research, and academic discourse is not just to describe, understand and explain the state of the world, but rather how to change it. According to Saidi (2015), the critical paradigm encourages researchers to be able to change reality in a participatory and emancipatory way, namely liberating participation. In this context, critical social theory is used to drive change.

1.2.2 Theory of Change

PAR is applied in line with a Theory of Change (ToC), a fundamental component of all research approaches. The ToC outlines the theoretical framework for understanding and achieving desired changes during or after project implementation. In research, the attainment of a ToC may or may not be realized; and both are subject to scientific findings. The ToC provides a clear depiction of the sequence where a research activity produces outputs, which in turn contribute to outcomes and an impact (Figure 1.1). Numerous outputs can contribute to achieving an outcome, and numerous outcomes can work to produce an impact.

Research **activities** are what researchers actually do, such as collecting data, conducting Focus Group Discussions (FGDs), analysing data, and engaging with communities, policymakers and NGOs. Research activities synthesize or triangulate data and information collected and produce **outputs**. These outputs, which can take the form of journal articles, research reports, policy briefs and academic manuscripts, are communicated to influence the intended users or beneficiaries together with outputs from other studies to produce **outcomes**. Significant outcomes will change the behaviour of target users, such as communities, government officials or private

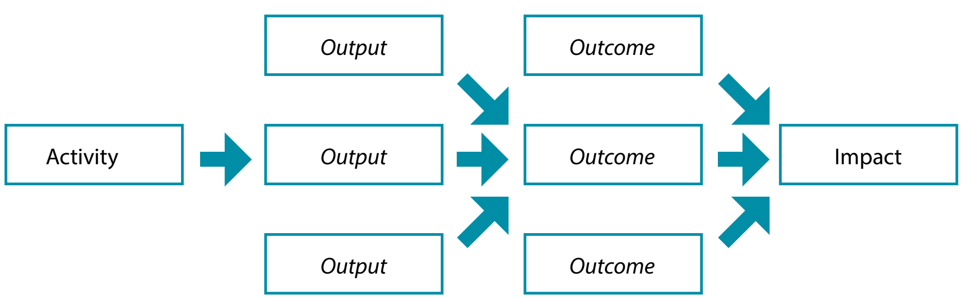

Figure 1.1. Linear relationship between a research activity, its outputs, outcomes and impact

sector actors, to contribute to intended impacts. **Impacts** are long-term changes at the site level, such as enhanced local community or government revenues, more forest cover, or improved environmental services. Your research outcomes are not alone in making changes.

PAR is needed when community involvement is key to identifying and solving a problem. The community becomes the centre for transformation. In PAR, human-centred transformation occurs not only in identifying problems and solutions, but also takes place in real arenas. PAR is more than participatory research; it is action research conducted in a participatory manner. Action research ensures that research outcomes can be monitored during the research itself. PAR treats participants, including farmers, the commercial sector, NGOs and governments as research partners. It makes them want to know about new methods and knowledge to better understand the problems they face and act iteratively to bring about improvements.

Systematic implementation of PAR has produced numerous success stories, including in integrated pest management in Java (Röling and van de Fliert 1994). Communities and farmers should be facilitated so they can become researchers who solve their own problems. PAR can encourage communities, governments, the commercial sector and NGOs to change practices and policies radically and in a timely manner for better livelihood and natural resource outcomes. Such changes can enhance livelihoods, well-being, justice and environmental conservation at both local and national levels, and ultimately contribute to improvements on a global level.

PAR is transdisciplinary; it integrates multidisciplinary approaches, such as social, economic, political, biological and physical approaches, and local and global wisdoms. PAR requires enough time and facilitation to work with communities in understanding problems, finding solutions, working at the site and policy levels, and carrying out social transformation. It is particularly suitable for developing countries, where scientists are not only required to publish in quality international journals, but must make changes on the ground to improve people's well-being, improve stakeholder governance capacity, and improve forests and the environment.

We have conducted PAR in the contexts of strengthening partnerships between communities and timber plantation companies in South Sumatra; strengthening wooden furniture producer institutions and facilitating the drafting of a regional regulation (*Perda*) in Jepara, Central Java; and advocating for fire prevention and facilitating legal drafting of a draft regional regulation (*Raperda*) in Riau Province. The research outcomes narrated in these regional regulations have upscaled the impacts of PAR projects that focused only on specific areas, thereby ensuring the sustainability of their research outcomes.

In South Sumatra, partnerships between communities and timber plantation companies were strengthened by developing communication through multistakeholder forums; ensuring all stakeholders were appropriately represented; balancing power between stakeholders; strengthening stakeholder agreements for legalization; and ensuring reinforcement from outside parties. Without such improvements, the partnerships would merely have been a company contributions (charity), and ultimately become unsustainable with the potential for a reversion to the bloody conflicts that had occurred in the past. Binding designs and agreements are imperative in horizontal stakeholder partnerships for landscape management.

In Jepara, small and medium wood furniture producer enterprises needed to strengthen themselves by forming a formal association as a legal entity. The association improved the bargaining positions of these SMEs in facing markets, large entrepreneurs, exporters and government. It has enabled them to participate in and market their products through local, national and international trade shows. It has also enabled them to obtain SVLK timber legality certification, thereby freeing them from due diligence requirements when exporting to markets in the European Union. This institutional strengthening has enhanced association members' revenues and well-being, and enabled them to enjoy political and financial support from the local government as stipulated in the regional regulation (Purnomo et al. 2009a, 2009b, 2011, 2014a).

1.2.3. Phases of Participatory Action Research

PAR is executed through an iterative series of initiation or reflection, planning, intervention or action, and monitoring phases (Henocque and Denis 2001; Purnomo et al. 2014a) as illustrated in Figure 1.2. Researchers work in facilitation groups to assist stakeholders in recognizing their problems and recommending solutions. In the 'reflection' phase, researchers establish communication through field visits, identifying stakeholders and consulting with them. Baseline surveys are conducted to understand biophysical, social and livelihood conditions. During this phase, issues facing communities are identified together. During the planning phase, with facilitation from researchers, communities then formulate plans to address identified issues. Sets of indicators for monitoring implementation or action are designed in a participatory manner.

The first phase of action research is 'Reflection' on the problem at hand and the desired goal. This phase involves conducting baseline studies, market and supply chain/commodity value surveys, biophysical surveys to determine conditions on the ground, consulting with stakeholders, and reviewing relevant state-of-the-art science. Analyses are performed to determine how systems work, and to identify issues that significantly affect the output of those systems. During this phase, it is crucial to understand incentives that can enable the community to be willing and able to participate fully in the research.

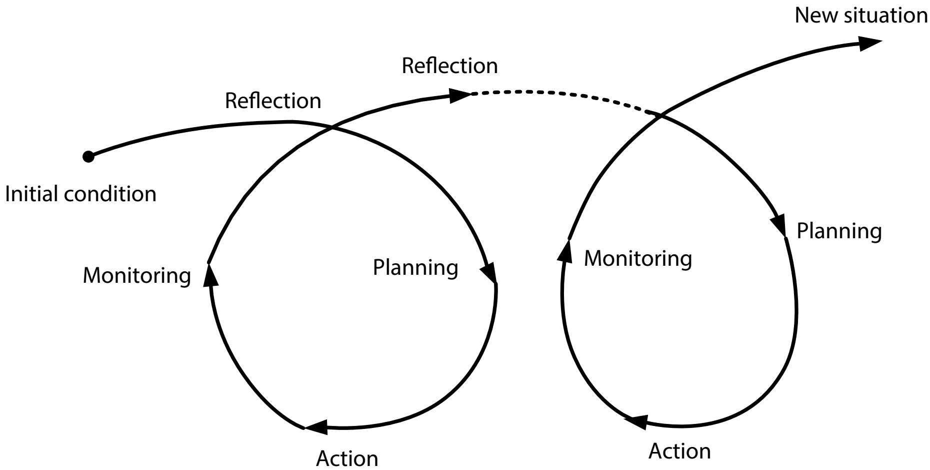

Figure 1.2. Cycles in the PAR loop from the initial condition to the new situation

The second phase involves 'Planning' interventions and actions that can leverage the system in accordance with the desired objectives. These interventions are like hypotheses that required testing, which means there are no guarantees that planned actions will produce the expected outcomes. If this condition is not met, then it is not action research, but development.

The third phase, which involves 'Action' where interventions are implemented and hypotheses tested, will generate data that should be monitored.

The fourth phase, involves systematic 'Monitoring' of action-sensitive system performance indicators. Data collected from monitoring is used to test whether the hypothesized action can produce the desired outcome. How far the goal can be approached in one action research loop is summed up in this phase, which determines whether a further action research loop will be necessary, commencing with a further 'Reflection' phase.

1.3 PARTICIPATORY ACTION RESEARCH FOR FIRE PREVENTION AND PEATLAND RESTORATION IN BENGKALIS REGENCY, RIAU PROVINCE

1.3.1 Fire and peat restoration

Indonesia's tropical peatlands are one of the country's main sources of emissions, accounting for 57.5 gigatons of carbon (Page et al. 2011). Around 43% or 6.4 million ha of Indonesia's peatlands are on the island of Sumatra (Ritung et al. 2011). Many of these peatlands are degraded and fire prone, particularly during long dry seasons. Causes of peatland degradation in Sumatra include conversion for plantations (Miettinen et al. 2016). Ministry of Environment and Forestry data[1] shows forest and land fires on 2.6 million ha of land in Indonesia in 2015. These fires resulted in losses of USD 16.1 billion, equivalent to IDR 221 trillion (Glauber et al. 2016). They resulted in 24 fatalities and 103,000 premature deaths (Koplitz et al. 2016). Greenhouse gas (GHG) emissions from the 2015 fires were estimated at 1.5 billion metric tons of carbon dioxide equivalent ($MtCO_2e$) (Field et al. 2016).

These devastating forest and land fires were the starting point for intensifying fire prevention and peatland restoration efforts in Indonesia. In 2016, the Peatland Restoration Agency (BRG) was established through Presidential Regulation No. 1/2016, as a non-structural institution directly accountable to the President. BRG was assigned the task of coordinating and facilitating peatland restoration in seven priority restoration provinces in Indonesia, one of which was Riau. With a mandate to restore two million hectares of peatlands, BRG formulated and began implementing strategic plans and work programmes. Its main policy direction and strategies included the 3Rs (Rewetting, Revegetation and Revitalization of livelihoods), as well as other complex issues, including policy and institutional strengthening. These underpinned the establishment of work programmes, such as the Peat Care Village, and Peatland Restoration Promotion and Education programmes, which included peatland farmer field schools and various forms of training. Other activities to increase public awareness included the Peatland Community Jamboree, involving religious leaders, and youth camping programmes.

Another effort involved the formulation of a 'Grand Design' for forest and land fires in 2017 containing a coordination framework for controlling forest, plantation and land fires with planning and budgeting coordinated by the Ministry of National Development Planning (Bappenas) and the Ministry of Finance. In parallel, several ministries/ agencies, local governments, the armed forces and the police undertook preventive actions coordinated by the Coordinating Ministry for Economic Affairs; management

1 http://sipongi.menlhk.go.id/hotspot/luas_kebakaran

Figure 1.3 Large-scale forest and land fires cause financial losses and directly impact communities

coordinated by the Coordinating Minister for Political, Legal and Security Affairs; and recovery and impact management coordinated by the Coordinating Minister for Human Development and Culture. These efforts, which accorded with Presidential Instruction No. 11/2015, focused primarily on preventive measures.

The Grand Design incorporated findings from research by Saharjo (2003), Tacconi (2003), Syaufina (2008) and Purnomo et al. (2016), which all stated that forest and land fires are caused by human activities. Purnomo et al. (2016) classified three networks of corporate bodies, capital owners (*cukong*) and individuals linked to forest, plantation and land fires in Indonesia. With these in mind, policy directions and strategies formulated in the context of preventing forest, plantation and land fires contained cross-sectoral, integrated and comprehensive aspects, with five main elements: economic incentives and disincentives; handling social institutions; law enforcement and synchronization of laws and regulations; infrastructure development; and strengthening early fire suppression (Medrilzam et al. 2014).

Enabling factors that contributed to a reduction in fire affected areas over the subsequent few years were more favourable climate conditions, law enforcement and fire prevention efforts. Data from the Ministry of Environment and Forestry's SiPongi forest and land fire monitoring system shows the annual average area affected by fires from 2016 to 2018 falling by 86% compared to 2015. However, in 2019 the fire affected area reached 857,755 ha, an increase of 62% on the previous year. The situation was exacerbated by global warming. Since 1980, fire seasons have been getting longer in a quarter of the world's vegetation covered areas (Gray 2019). In addition, fire incidence will be greater with a warmer and drier climate (De Groot et al. 2013). Given the size and complexity of the problem of fire prevention and peatland restoration, serious cooperation of all parties, including governments, the private sector, NGOs, universities and national and international research institutions is vital. Cooperation also defines shared values for better partnerships, as defined by Arnstein (1969).

CIFOR is collaborating with the University of Riau's Centre for Disaster Studies, village governments and community-based groups in conducting a PAR project on fire prevention and peatland restoration in Riau. This collaboration is supported by funding from the Temasek Foundation (TF). The PAR allows communities to have a better understanding of degraded ecosystems (Santana 2006). This participatory approach also provides certainty over long-term commitments to rural restoration and development programmes through a bottom-up approach, which promotes democratic values, rather than a more authoritarian top-down approach (Global Institute for Sustainable Forestry 2006).

Figure 1.4. In PAR, communities are research partners

1.3.2 Implementation of Participatory Action Research

As part of the project, PAR was conducted from 2018–2019 in Dompas Village, Bukit Batu District, Bengkalis Regency, Riau Province (Figure 1.5). Field trials focused on seven action arenas covering an area of 11.1 ha (excluding Action Arena 7 which was located on community home gardens). Discussions and dissemination also took place in satellite villages, namely Sukajadi, Buruk Bakul, Sungai Pakning, Sejangat, Pakning Asal and Tanjung Belit. Discussions, dissemination and field trials were carried out within a participatory action research framework, comprising four phases: reflection, planning, monitoring and action. The main objective of PAR in Dompas Village was to reduce fires by restoring peat and enhancing community livelihoods.

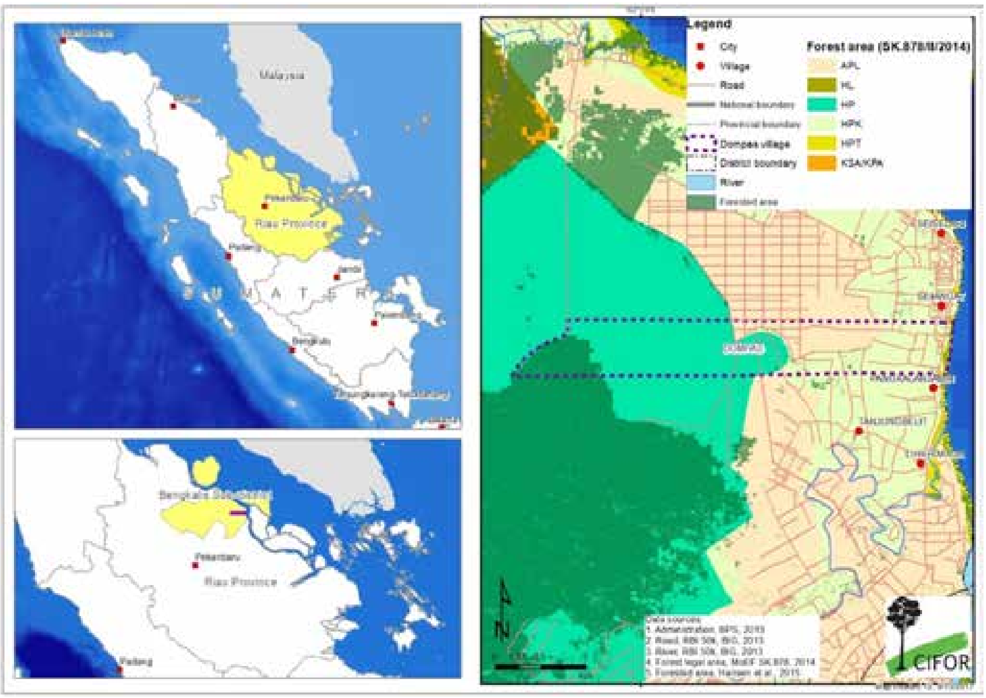

Figure 1.5. CIFOR and PSB UNRI PAR sites in Bengkalis District, Riau Province

Reflection phase

The reflection phase was aimed at identifying and understanding best practices in fire prevention and peatland restoration, including documenting baseline data. It involved identifying conditions/problems through focus group discussions (FGD) and interviews; collecting baseline data through household surveys in intervention villages and control sites in satellite villages; and conducting institutional surveys of Fire Care Community (MPA) groups and village governments. Baseline data was also collected on peat depths to produce peat maps. Other activities during the reflection phase included a literature review and site-level FGDs and field observations with community groups to identify business opportunities (Figure 1.6). Outputs from this reflection phase were a database of baseline data, peat depth baseline maps, and discussion and study outcomes, which provided input for the subsequent planning phase.

Figure 1.6. Researchers and communities interacting as research partners is a crucial element of PAR

The results of the reflection phase showed the population in Dompas Village being predominantly ethnic Malay; and the village having a variety of valuable tree species, including *meranti (Shorea spp.), ramin (Gonystylus spp.), suntai (Palaquium spp.),* durian (*Durio spp.), mentangor (Callophyllum spp.)* and *medang (Cinamomum spp.)*, but populations of these species declining. Various species of fauna, including agile gibbon *(Hylobates agilis)*, siamang *(Symphalangus syndactylus)*, silvery lutung *(Trachypithecus cristatus)*, long-tailed macaque *(Macaca fascicularis)* and pig-tailed macaque *(Macaca nemestrina)*, were often found in the village's forest and plantation areas. Protected species including Sumatran tigers *(Panthera tigris sumatrae)* and sun bears *(Helarctos malayanus)* had also been reported in the area.

According to Minister of Forestry Decree No: SK.878/Menhut-II/2014, Dompas Village comprised 1,129 ha of other land use areas (APL), 59 ha of protection forest, 3,856 ha of permanent production forest, and 1,682 ha of convertible production forest. The village landscape comprised primary and secondary forests, mixed plantations, rubber and oil palm monoculture plantations, and scrub or burnt land (Figure 1.7). FGDs indicated rubber plantations being a primary source of income for the local community. Though smaller in size than the village's oil palm plantations, its rubber trees were of a productive age with high yields. The village's landscape was dominated by two large-scale commercial concessions: an oil palm plantation and an acacia pulpwood concession. Other significant livelihood sources for villagers were labouring clearing land in oil palm plantations and working for a mining company.

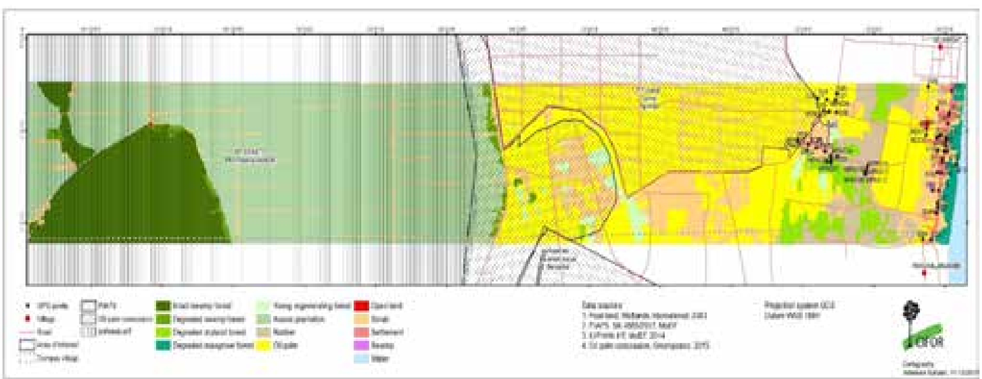

Figure 1.7. Map of land cover in Dompas Village

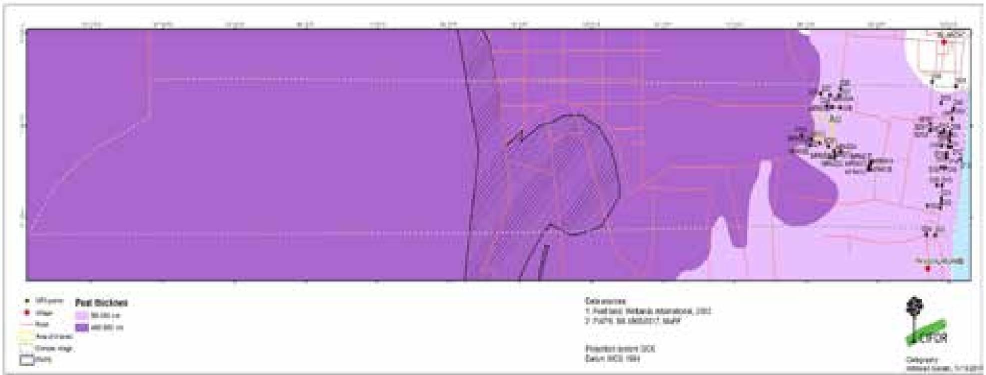

Figure 1.8. Peat depth map from Wahyunto et al. (2003)

The peatland map from Wahyunto et al. (2003) in Figure 1.8, showed 1,132 ha of peatlands in the Dompas Village area having depths of 50–100 cm, and 5,594 ha having depths of 400–800 cm. Almost 70% of the deep peat was located in permanent production forest estate, while residential areas and small-scale smallholder plantations were on shallow peat with depths of 50–100 cm. However, the results of peat mapping conducted by CIFOR during the PAR showed some smallholder plantations being on deep peat with depths exceeding 400 cm. The intensive human activities on deep peat increased the urgency to mitigate peat degradation and fire risk.

Participatory mapping was undertaken with Dompas villagers to identify areas that had been affected by fire. Information from the community showed most areas in Dompas Village having been affected by forest and land fires. More than half the households (57%) in Dompas Village stated that forest and land fires occurred on their land in 2017, while almost half the households (46%) said their land was at high or very high risk of fire. However, most households were unaware of the causes of the forest and land fires.

Community members felt that PAR could provide them with knowledge and experience, and trigger a transformation to livelihoods based on more environmentally friendly practices. The PAR also accommodated proposals from community members, the village head and village government officials, and community leaders.

Planning phase

The planning phase was aimed at developing action plans, dividing roles and responsibilities, and determining cost and benefit sharing (Figure 1.9). It involved a series of FGDs with the following themes: business models; division of roles and responsibilities; cost and benefit sharing; and formulation of action plans. It resulted

Figure 1.9. Crucial elements of action planning were awareness of ecological conditions and business opportunities

in agreements on the management of action arenas, where: the Fire Care Community (MPA) group would manage a multipurpose planting and fishing ecotourism model on 2.2 ha of village-owned land referred to as Action Arena 1; the women's group and a men's farmer group would manage pineapple and multipurpose tree agroforestry models on 3.3 ha and 3.2 ha of co-managed land referred to respectively as Action Actions 2 and 3; farmer family groups would manage liberica coffee and rubber agroforestry business models on 2-ha areas of private land referred to as Action Arenas 4, 5 and 6; and more than 300 households would plant hybrid coconuts in their home gardens, which were referred to collectively as Arena Action 7.

Action phase

The action phase was aimed at implementing the action plans formulated during the planning phase. Activities applied in some action arenas were: rewetting through the construction and repair of canal blocks; revegetation through cultivation training and building nurseries, clearing land without burning, and planting selected trees and commodities; revitalization of community livelihoods through the implementation of goods- and services-based business models; and institutional strengthening through the establishment of forest farmer groups (KTHs) and facilitation and strengthening

Figure 1.10. Business-scale action in the field

of action arena management and MPA groups. In addition, support was provided for forest and land fire patrols in Dompas Village, and forest and land fire suppression in satellite villages.

Monitoring phase

The monitoring phase was aimed at gauging medium- and long-term outcomes and impacts. In this phase, monitoring tools such as equipment for measuring groundwater levels and bar codes for crop inventory were installed (Figure 1.11). An online monitoring system was created and is accessible through the project website at: https://cifor.org/CBFPR. The system facilitated easier monitoring of groundwater levels in control and intervention areas in action arenas, as well as crop planting numbers and survival rates. Monitoring and data collection, including on any social and/or economic changes, were carried out in a participatory manner with the Dompas Village community.

Figure 1.11. Actions were monitored in a participatory manner with the community

1.4 LESSONS LEARNED TO ACCELERATE FIRE PREVENTION AND PEATLAND RESTORATION

PAR has advantages over conventional research that can be used to accelerate fire prevention and peat restoration. These advantages are as follows:

1. PAR is transdisciplinary in nature; it integrates approaches from various disciplines and draws on both local and global wisdom.
2. PAR is an effective means for researchers to be actively involved in fire prevention and peat restoration.
3. PAR is scientifically sound and can facilitate more rapid transformations on the ground. It produces scientific publications in quality journals, with quality comparable to conventional research.

4. PAR is intensive, so research must focus on specific problems, levels and areas.
5. PAR yields outcomes within the research period, whereas conventional research outcomes potentially occur after research has ended. Community members involved in PAR can gain experience in creating, working on and monitoring their business models.
6. PAR is more time consuming than conventional research, which generally revolves around data collection, analysis and publication. It requires more than just data collection, and necessitates facilitation so communities can be a key element in the research. Ideally, PAR should be conducted over a period of three years or more.
7. Donors often prefer PAR because its impacts can be immediate and they can see tangible changes occurring on the ground.

1.5 CONCLUSION

Governments, communities and donors want research that makes a difference. There is an urgent need for change, so it is time for research to produce not only reports and publications, but real tangible outcomes and impacts too. Research conducted with full participation and an action-oriented approach is the solution. PAR is designed to bring real change on the ground. It enriches research approaches in the fields of natural resource and environmental management, including fire prevention and peatland restoration. Peatland restoration must be understood as a joint effort by all stakeholders to improve and manage water and ecosystems sustainably within individual peatland hydrological units (KHG). A fundamental element of peatland management, as mandated by Government Regulation No. 57/2016, is the determination of cultivation and protection zones in peatland areas. In cultivation zones, peatland restoration is targeted at water management, while in protection zones it is aimed at water conservation. PAR is generally more costly and time consuming than conventional research, but its outcomes and impacts are more immediate. PAR necessitates high intensity interaction with communities, policymakers and the business world, but if we genuinely desire a transformation that brings about tangible improvements, then all of these are prices worth paying.

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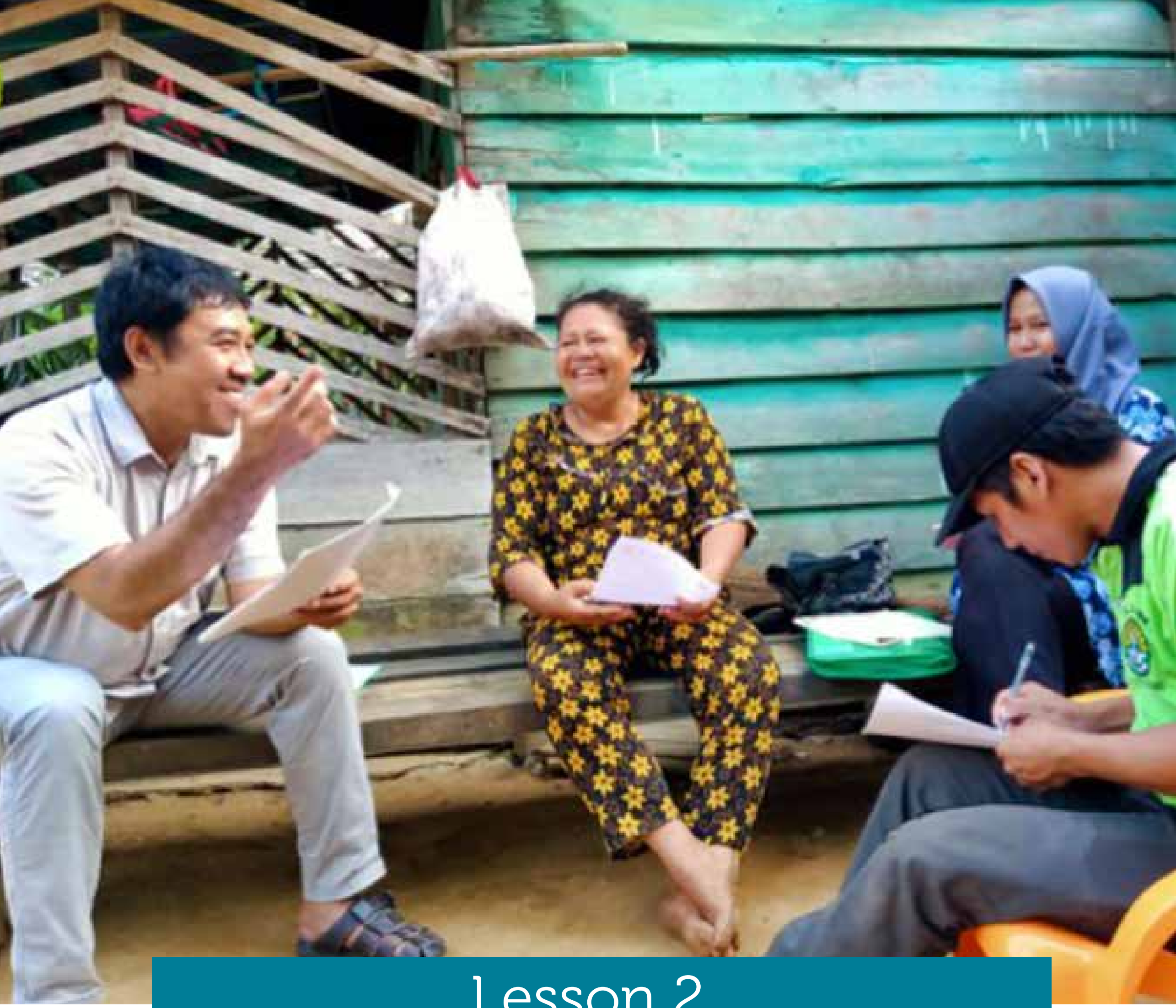

Lesson 2

Changes in burning behaviour and fire prevention in Riau

Murni Po, Daniel Mendham, John Gardner, Eko Hardiyanto,
M. Gunawan Wibisono and Muhammad Mardhiansyah

2.1 SUMMARY

Changes in burning behaviour and fire prevention are important parts of efforts to reduce fires and haze in Indonesia. Fire prevention demands a change in communities and farmers' mindsets, norms and practices to ensure sustainability and embed 'zero-burning' behaviour into the daily lives of community members. Two studies into the burning and non-burning behaviour of farmers in Indonesia's Riau Province found farmers being less likely to use fire to clear land than they had been two years earlier, when around 50% of farmers were still burning (Rohadi 2017). This indicates that farmers feel responsible, as do governments and local forestry companies, for preventing peatland fires. A Presidential Instruction prohibiting burning for land clearing, followed by strict enforcement by the government and military, were major factors influencing people's behaviour, and zero-burning had become the norm. Farmers accepted zero-burning land management practices and assumed almost everyone had done so. They considered themselves able to manage land without burning and felt they already had the necessary support to do so independently.

However, farmers involved in our research seemed not to have internalized the intrinsic values of applying zero-burning management practices on their own land, as indicated by Relative Autonomy Index (RAI) scores. They felt burning to be a justifiable means for clearing land if they could do so without punishment. They still considered burning more practical than other alternatives in land clearing, saying it cuts down on labour costs, facilitates planting processes, minimizes disease outbreaks and increases soil fertility. They were also quite clear in saying they would return to their burning practices if the Presidential Instruction's ban were lifted.

Alternative zero-burning practices require far greater labour and financial resources than burning, and some farmers cannot afford the associated costs. Since the strict ban on burning was imposed, farmers have been forced to equip themselves with new knowledge and skills, and bear higher labour, equipment, machinery, herbicide and fertilizer costs to make ends meet. Farmers in our study often asked for support to help them manage their land without burning. Support in the form of equipment, machinery, fertilizers and herbicides to control weeds is essential for farmers, as is information on how to manage land without burning. Though more than half of participants wanted access to heavy machinery, small capacity machines are likely to be more effective in helping farmers become skilled at clearing land, and increasing their self-reliance.

Poor farmers are more severely affected by the need to adopt zero-burning practices. Therefore, fire prevention programmes that help villagers adapt to zero-burning land management, such as the *Desa Bebas Api* or Fire-Free Village programme, will be essential for helping villagers get through the transition to zero burning in the future. Programmes that can upskill farmers and help them manage their land independently

without burning are vital to complement the zero-burning policy. In addition, the central government's *Masyarakat Peduli Api* (MPA) or Fire Care Community programme, which involves groups of volunteer firefighters in communities, has increased awareness of the importance of fire prevention. Some farmers considered the programme beneficial, saying fires could often be extinguished rapidly. Levels of awareness were significantly higher among villagers where forest-based companies were implementing fire prevention programmes, and community members found these programmes highly beneficial. Ensuring the sustainability and continuity of such fire prevention programmes is crucial in order to realize forest fire-free regions.

Key highlights

This research looked at ongoing norms and the burning and zero-burning practices of farmers in Riau Province. Its main findings include:

- In research sites there have been changes in cultural norms related to burning. In the past, communities considered the use of fire in land management to be acceptable and in accordance with their cultural practices. With the Presidential Instruction banning burning, farmers in the region have shifted away from suing fire. They accept zero-burning practices and hope community members will no longer use fire in managing their land.
- Instilling new cultural norms around the zero-burning message will be critical for moving forward in fire prevention efforts. Zero-burning behaviour among farmers needs to be echoed further for the transition to a zero-burning norm to continue.
- A lack of cost-effective zero-burning land management practices hinders farmers' transition to a zero-burning norm. The continued presence of haze is another hindrance and can lead to a greater tendency to use fire, with farmers saying, "If someone else is still burning, then why don't I?"
- Farmers' adoption of zero-burning practices was due to external pressure – namely to comply with the President's ban on burning and out of fear of punishment if caught not doing so. If external factors are eliminated, farmers will return to burning, as long as there are no viable zero-burning alternatives they can apply.
- Ongoing assistance to help farmers improve their capacity to manage land independently without the use of fire is essential for ensuring sustainable zero-burning behaviour.
- More transformative changes to farmers' systems and livelihood choices are needed. Farmers need support and training on peat rewetting to transform their fields for perennial crops that do not require land clearing and the use of fire. Livelihood improvement options that enable farmers to make effective use of land for decent incomes are also urgently needed.

2.2 INTRODUCTION AND METHODOLOGY

Peatland fires in Indonesia, particularly in Sumatra and Kalimantan during the dry season, are a major cause of haze that impacts human health and regional economies. The haze triggers local disasters with significant economic, social and health implications, both in Indonesia and neighbouring countries. Peatland fires are often started by community members, and can quickly burn out of control producing huge volumes of thick haze as the peat burns. Large fires were a rare occurrence in the past, but due to widespread clearing and draining of peatlands for agricultural and plantation forest development they have become widespread, particularly during exceptionally dry years. Fire prevention is recognized as being key to reducing uncontrollable and costly forest and land fires. Though fire prevention programmes using various approaches have been piloted in several villages in Riau, there has been no concerted effort to ascertain how such programmes can change community mindsets and behaviour.

Two studies were conducted in 2019 to understand the burning behaviour of communities in several villages in Riau Province, some of which were participating in fire prevention programmes organized by two large forestry and plantation companies. The research team worked with farmers in villages participating in fire prevention programmes (programme villages), and farmers in other villages where no such programmes were being implemented (control villages). The first was a scoping study, which involved one-hour semi-structured interviews with 49 farmers in eight villages in Pelalawan Regency, Riau. The aim of this first research phase was to ascertain farmers' understanding of why people inside and outside their villages had – in the past – or have now chosen to apply burning or zero-burning practices. The second phase of the research involved 30- to 45-minute interviews with questions based on information secured during the first phase. This allowed researchers to quantify villagers' decisions to apply burning or zero-burning land management practices, and determine how community value systems and beliefs have influenced those decisions. These interviews were conducted in 16 villages in Pelalawan, Siak and Bengkalis regencies. Another aim of the second phase was to determine the effectiveness of elements of fire prevention programmes in changing community behaviour. A total of 160 interviews were conducted during this second phase.

2.3 RESULTS

Participants from programme villages said they had relied more on burning practices before the burning ban was imposed, while only around two-thirds of participants in control villages had used fire before the ban. Despite common reasons for using fire, programme participants were more likely to view burning as a means for clearing and fertilizing land, and removing large logs. Participants in control villages tended to regard burning as a tradition and a natural way to manage their land. Farmers in both programme and control villages believed practicality and community beliefs to be the main triggers for burning, and both said burning is still practiced for:

- clearing land;
- saving on labour costs;
- facilitating planting;
- minimizing disease outbreaks;
- increasing soil fertility.

Factors such as age, ethnicity, education level, gender, head of household, or labour needs had not contributed to their past burning behaviour. Landowners were more likely to use fire to clear land in the past, but today burning behaviour has changed. At the time of the survey, very few farmers in control or programme villages admitted to burning land anymore. Their main reason for stopping was a fear of being caught and punished by the authorities. Other lesser reasons were farmers worrying about fires changing direction and affecting their neighbours' land, or worrying about the severe impacts haze can have on their health and the health of others, and the effects of fire on the environment.

High-level interventions from government agencies, extension officers and the military were another factor, as participants recalled their presence in villages urging communities to stop burning. In addition, participants in both programme and control villages were highly familiar with the government's Fire Care Communities volunteer firefighting programme, and found it beneficial. As expected, privately funded programmes were significantly more familiar and considered more useful in programme villages than in control villages. Nevertheless, it is important to note that farmers were unable to differentiate clearly between different fire prevention programmes. They tended to use generic terms such as 'promotion' or 'extensions' in referring to both government and private sector programmes. More importantly, both programme and control villages accepted the Presidential Instruction prohibiting burning, and its subsequent enforcement by military personnel, and said it had been highly successful in preventing fires.

Generally, it was not possible to attribute the farmers' shift to zero-burning behaviour to just one programme or one part of a programme. The government's ban on burning focuses on a complete halt to the use of fire. It is important to note that until now, government fire prevention programmes have tended to focus more on increasing the capacity of farmers to deal with fires, rather than changing intrinsic behaviours around burning by helping them transition to zero-burning land management practices. This contrasts with the private companies' programmes, which were specifically designed to support farmers and increase their capacity to manage land without fire. These programmes also raised awareness about the adverse effects of haze, and offered opportunities for farmers to adopt alternative land management practices by providing them with agricultural

assistance. As farmers depend on land for their livelihoods, increasing their capacity to live off land without burning is an important step in reducing their burning behaviour.

Respondents pointed out that using alternative land management practices is dependent on financial capacity. They said the ban on burning had inadvertently caused social inequality, as poor farmers with smaller land areas and lower financial capacity had since had fewer options in managing their land. There were some reports of farmers abandoning land as they were unable to manage it without burning. Respondents reported that wealthier farmers could use machinery to clear land, buy herbicides to control weeds, and use fertilizers to secure better yields from their fields. For poor farmers, however, the use of fire can save time and labour costs, and the resulting ash can be used to “fertilize” their land. This may be the only cost-effective option to them. Participants in the study specifically requested more extension training to help them manage land without burning. Government and private company support in providing machine tools, fertilizers, seeds and herbicides was also of special note.

Managing land without burning had proven a challenge for many farmers. One reported trying and failing to grow rice on 10 hectares of land, while others said their crops had been affected by disease outbreaks. Many participants in the study said they had changed their cropping systems to oil palm and/or rubber since the fire ban was imposed. We asked them about their zero-burning land management practices, and the three things most often cited in both programme and control villages were:

- Cutting and stacking plant material;
- Using herbicides to control weeds;
- Changing planting systems from annual to perennial crops like oil palm and rubber.

We also found farmers would immediately return to using fire if the ban on burning were lifted, as they were still faced with a lack of alternative options for reliable and cost-effective land management. In addition, there was a strong belief that burning is not only an economical way to clear land, but can also promote growth and keep plants free from disease.

Participants felt that responsibility for preventing fires rested with themselves, local forestry companies and governments at the central, provincial and local levels. Most participants were of the opinion that industrial timber and palm oil plantation companies no longer used fire to clear land, saying it was more likely that people in other villages were doing so. These findings are important because the sense of responsibility the communities had towards fire prevention programmes have helped motivate them to feel responsible for preventing fires and improving their zero-burning behaviour.

Participants in both programme and control villages felt they had been helped in carrying out zero-burning activities in their communities, and felt capable of managing their land without fire. However, most participants said they still required further assistance to implement zero-burning land management practices, and support with machinery, fertilizers and herbicides. Using the Relative Autonomy Index from Ryan and Deci (2000), the research found farmers' zero-burning behaviour had yet to become autonomous. This indicates that zero-burning behaviour still needs to be maintained by external factors like burning bans and agricultural assistance until such time that it becomes mainstreamed into farmers' thinking and practices.

2.4 RECOMMENDATIONS

Key recommendations from our research are as follows:

- Maintaining a ban on burning is critical until zero-burning behaviour becomes more autonomous and sustainable.
  - There is currently an invisible demand for burning that could lead to a return to burning on a large scale if the ban is lifted.
- Government programmes such as MPA were widely acknowledged among communities in our survey. Therefore, developing such programmes to access networks in villages is a good way to embed sustainable zero-burning practices.

- Raising awareness of the health impacts of haze is important, but that alone is not enough to bring about behavioural change. Haze is taken for granted as part of life in local communities. Often the adverse effects of haze are not immediately visible to communities, while the loss of opportunities to plant significantly impacts their livelihoods.
- Current efforts to extinguish fires by giving appreciation and attention to communities affected by fire can lead to unintended consequences.
  - Rewards and attention can inadvertently reinforce and encourage fire-use behaviour.
  - Focus needs to be placed on increasing communities' capacity to manage land without fire.
- Instilling social norms around zero-burning behaviour will be important for the foreseeable future.
  - Change the message to reflect the fact that most burning has stopped and society expects and approves of zero-burning practices.
  - Work with farmers and community leaders to demonstrate best practice.
  - The presence of haze can lead to a greater tendency to use fire, with farmers saying, "If someone else is still burning, then why don't I?"
- Supporting and training farmers in zero-burning farming practices is crucial.
  - This includes increasing access to machinery – more than half of participants wanted access to heavy machinery use.
  - Small capacity machines are likely to be more effective than heavy machinery in helping farmers become skilled at clearing land, and in increasing their self-reliance.
  - Training and capacity building for zero-burning farming are needed.
- Supporting a change in livelihood systems to perennial-based options that do not require land clearing and repeated use of fire is a viable option.
  - Livelihood improvement options that enable farmers to make effective use of their land for decent incomes are also urgently needed.
- Poorer farmers need additional support to manage land without burning as they cannot access the resources they need, such as seeds, fertilizers, herbicides and machinery, on their own.

2.5 REFERENCES

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Lesson 3

Sustainable community business models for fire prevention and peatland restoration

Dyah Puspitaloka, Herry Purnomo, Ahmad Dermawan, Tuti Herawati, Nunung Parlinah and Qori Pebrial Ilham

3.1 BACKGROUND

Attention towards and pressures for sustainability began decades ago, well before the global agenda on sustainable development had yet to be established and agreed upon. Pressures to address sustainability issues were driven by regulatory enforcement, competition and consumer concerns (Sarkis 1998; Berns et al. 2009). Many companies responded by improving business models to meet requirements for sustainability standards (e.g., ISO 14000); improving supply chains; managing environmental quality; and carrying out lifecycle analyses (Sarkis 1998; Wu and Pagell 2011). Companies' commitments marked the importance of sustainability in developing and maintaining businesses (Cantele and Zardini 2018), with many companies adopting sustainability practices to gain competitive advantage and brand value (Resta et al. 2017). However, realizing companies' sustainability requirements necessitated expenditure and investment.

In recent decades, many large-scale businesses have adopted sustainability practices focusing on energy and material efficiency and the use of renewable energy (Ritala et al. 2018). Nevertheless, radical and systemic innovations are needed to support a widespread transformation. Business models are a means for identifying such innovations (Boons et al. 2013), and models that prioritize social and environmental aspects will lead to increased value and sales for companies (Esslinger 2011). These aspects are important foundations for sustainable business models built on the triple bottom line[2] concept of economic, social and environmental benefits (Evans et al. 2017). These aspects can be captured through the development of business models using a tool called the Triple Layered Business Model Canvas (TLBMC) (Joyce and Paquin 2016); an expansion on the Business Model Canvas (BMC) (Osterwalder and Pigneur 2010). Where BMC was developed to assist the processes of creating, capturing and delivering value with a focus on economic aspects, the TLBMC canvas comprises economic business models, environmental life cycles and social stakeholders. In our participatory action research (PAR), we tested the BMC developed by Osterwalder and Pigneur (2010), or the first layer of TLBMC, with the purpose of introducing this business formulation tool to local communities. In this chapter, we share our experiences in developing local-level business models, and recommend an updated alternative tool for community business model development.

Numerous strategies have been proposed for realizing the Government of Indonesia's commitment to reducing greenhouse gas emissions. One such strategy is forest and land fire prevention through the restoration of degraded peatlands. Restoration projects are influenced by social contexts, from determining the scope and goals of projects, to

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2 The 'triple bottom line' concept was coined by Elkington (1994) and is a 'win-win-win' strategy that simultaneously formulates benefits for the company, customers and the environment.

implementing restoration, including the revitalization – or establishment – of alternative community livelihoods (Puspitaloka 2018). Business model canvases are useful tools for helping facilitators to identify and formulate alternative sustainable livelihood models through participatory processes with local communities. Any resulting business models must be able to foster community participation and minimize environmental impacts by taking socioecological contexts into account. These are important because various anthropogenic pressures, in the form of human activities, have changed landscape conditions (Meijaard et al. 2013). The hydrological functions of peatlands have been disrupted by exploitative businesses, both legal and illegal, including mining (Dommain et al. 2016), logging (Dommain et al. 2016; Hergoualc'h et al. 2017) and many more. Given the current situation, attractive and profitable alternative livelihoods for local communities that can minimize negative externalities in their surrounding environment and lead to sustainability, become crucial. As such, our hope was to provide communities with sustainable business models that could be applied in, and contribute to, the fire prevention and peatland restoration agenda.

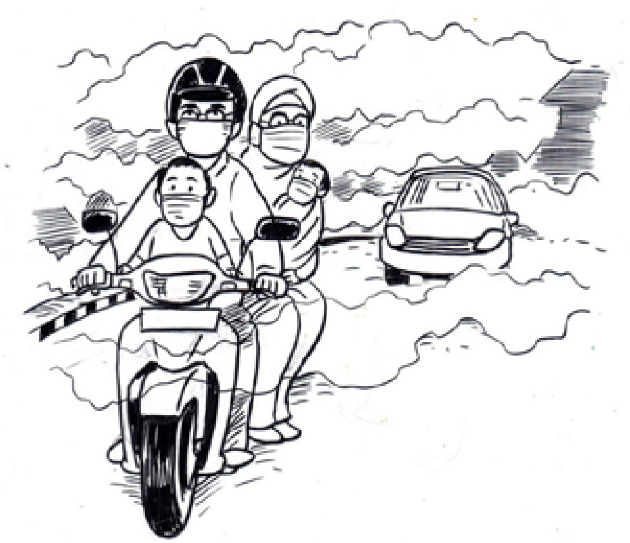


Figure 3.1. Sustainable livelihood alternatives are important for preventing peatland degradation, fires and haze

3.2 BUSINESS MODEL INTRODUCTION

3.2.1 Definitions

There are several definitions of business models from different scientists. Teece (2010), for example, defines a business model as, "the design or architecture of the mechanisms of creation, delivery and value capture… defines the way a company conveys value to customers, entices customers to pay for that value, and converts those payments into profits." Geissdoerfer et al. (2018) state that, "a business model is a representation of diverse elements of a value proposition, the creation and delivery of value, and the simplified value capture and interaction between diverse elements in an organization." A simpler definition is offered by Osterwalder and Pigneur (2010), who state that, "a business model describes the various reasons for which organizations create, deliver and capture value." These definitions all agree that business models must contain propositions, creation, delivery and value capture.

Key questions

What value propositions do consumers require?

How are these values created efficiently and effectively for profit?

How can business models support sustainability efforts?

3.2.2 Towards sustainable and circular business models

In this section we explain how conventional or traditional business models differ from sustainable and circular business models. Conventional business models only answer questions on the economic aspects of businesses, for example: who their intended customers are; what value(s) their customers desire; how they can give more value to their customers; what internal and external factors affect their businesses; and other relevant questions (Magretta 2002; Osterwalder and Pigneur 2010; Teece 2010). Sustainable business models are developed from conventional ones by adding three new characteristics and objectives: incorporation of sustainability concepts, principles and goals; proactive stakeholder management through value creation for a broad spectrum of parties; and the application of a long-term perspective. Sustainable business models can be upgraded further to solutions for circular business models (Geissdoerfer et al. 2018). According to Nikolova and Mesiano (2018), "A circular economy entails gradually decoupling economic activity from the consumption of finite resources and is based on three principles: design out waste and pollution, keep products and materials at their highest value and in use, and regenerate natural systems." A circular business model combines the principles of sustainable business models with intensifying, reducing, closing, slowing down and narrowing the flow of resources and energy, to reduce waste and emissions (Geissdoerfer et al. 2018).

3.2.3 Tools for formulating business models

Business Model Canvas (BMC)

Many tools can be used for formulating business models. The most widely used is the Business Model Canvas (BMC) developed by Osterwalder and Pigneur (2010). The BMC is a framework consisting of nine elements: customer segments, value proposition, channels, customer relationships, revenue streams, key resources, key activities, key partners and cost structure (Figure 3.2). **Customer segments** are the target groups or individuals to be addressed and served. Goods and services developed by producers must have a certain **value proposition** that corresponds to the intended customer segment. The process of delivering this value requires **channels,** which are the means for enabling businesses to reach customers in delivering their value proposition. The different types of relationships between businesses and each customer segment are represented by customer relationships. Meanwhile, **Revenue streams** describe the sources of money that businesses are likely to generate from their customers. Taking a step back from the process of generating proposed value, businesses need key resources, which represent lists of required assets. These key resources are then processed through **key activities**. To carry out these key activities, businesses must work with networks of partners reflected through **key partners.** Finally, all costs incurred are documented through the **cost structure**.

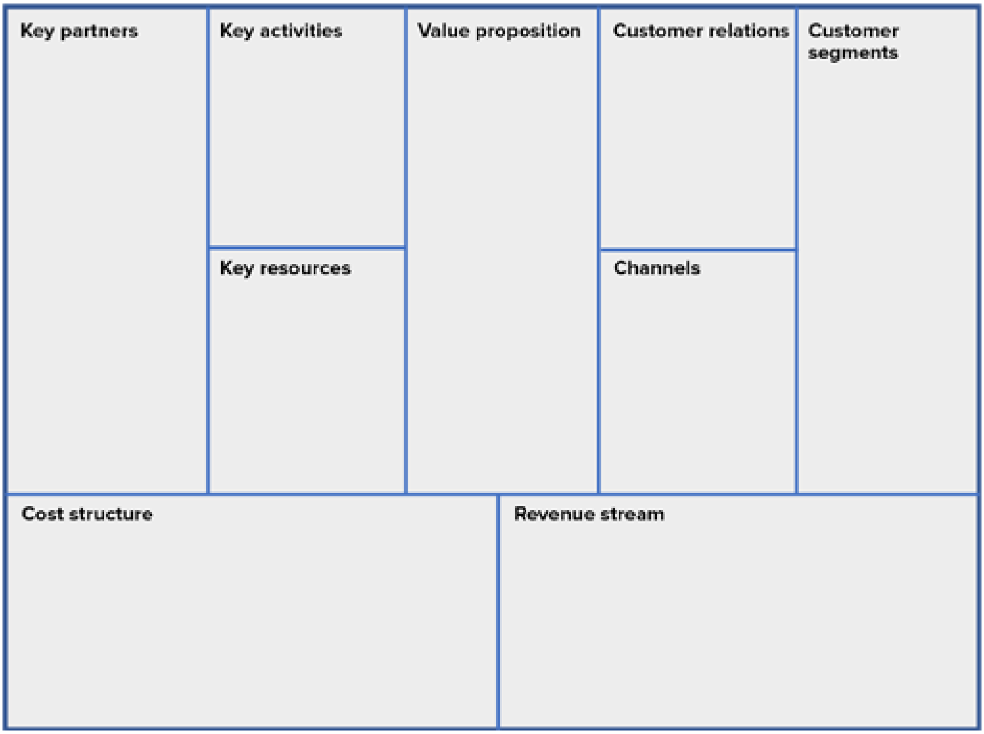
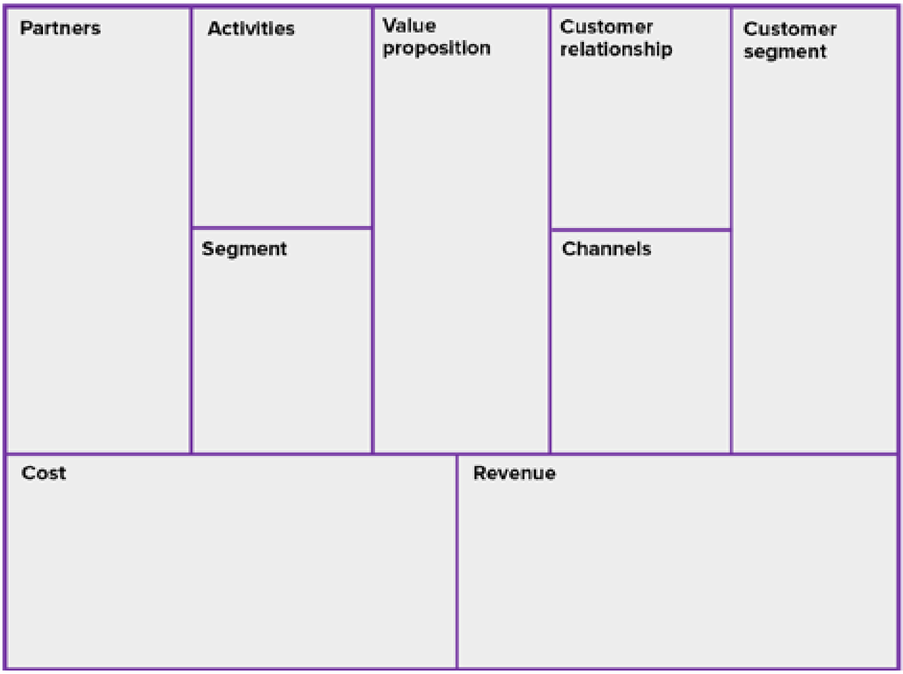


Figure 3.2. Business Model Canvas by Osterwalder and Pigneur (2010)

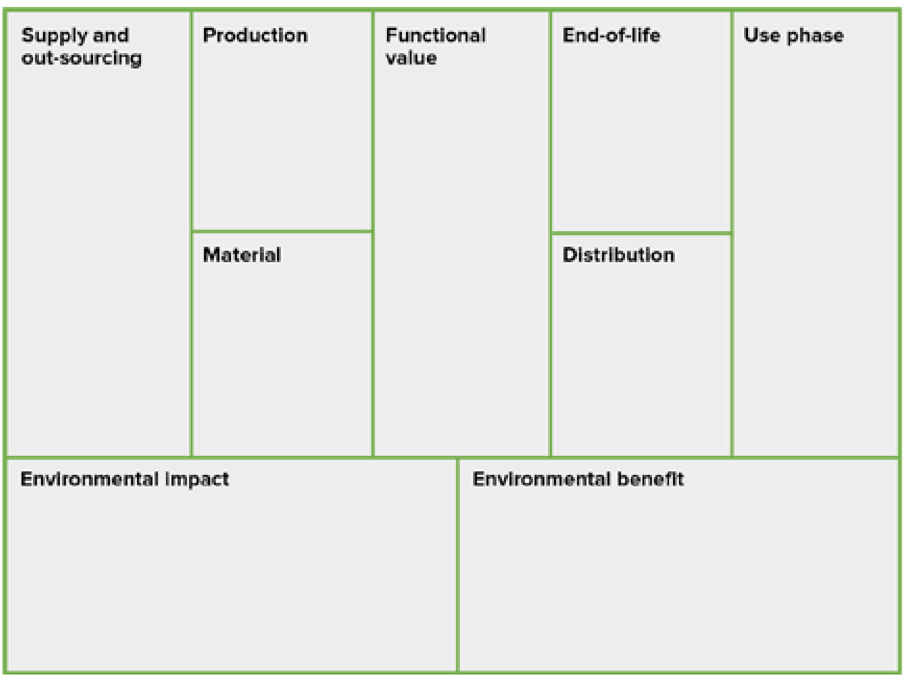
Triple Layered Business Model Canvas (TLBMC)

One tool suitable for sustainable business models that emphasize the triple bottom line of sustainability principles is the Triple Layered Business Model Canvas (TLBMC) developed by Joyce and Paquin (2016). The TLBMC is an expansion of Osterwalder and Pigneur's (2010) model comprising three layers (Figure 3.3). The first layer is an economic business model canvas similar to the BMC. The second layer adds an environmental life cycle canvas for considering the environmental impacts a business, while the third layer is a social stakeholder canvas for exploring a business' social impacts. The TLBMC allows horizontal and vertical coherence to occur. Horizontal coherence is defined as the role of a business model in facilitating a "broader system of thinking" and a "more holistic view". Vertical coherence is the alignment of different and interconnected values in its actions.

(a)


Partners
Activities
Segment
Value proposition
Customer relationship
Channels
Customer segment
Cost
Revenue

(b)


Supply and out-sourcing
Production
Material
Functional value
End-of-life
Distribution
Use phase
Environmental impact
Environmental benefit

(c)

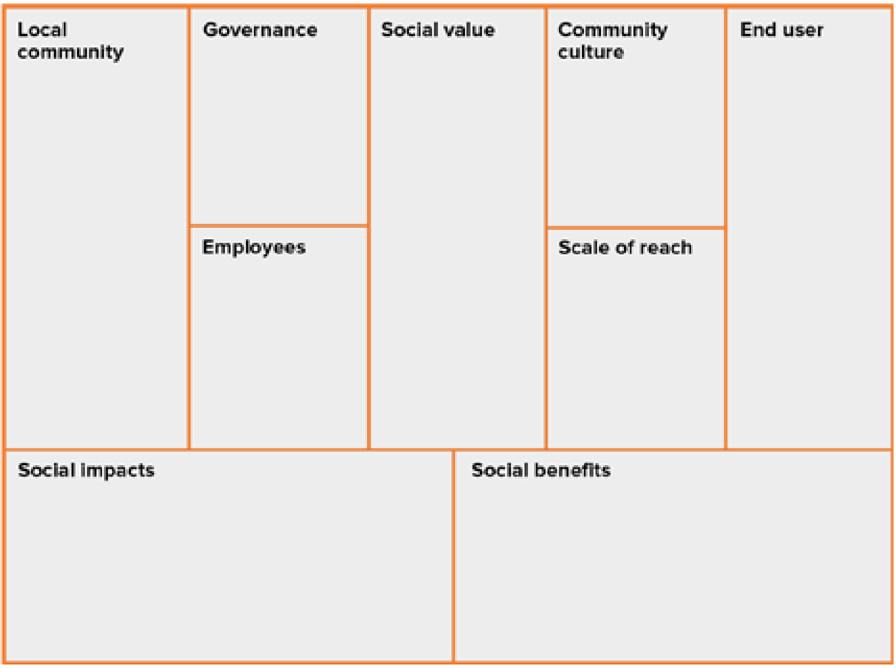


Figure 3.3. The Triple Layered Business Model Canvas (Joyce and Paquin 2016): (a) economic business model canvas, (b) environmental life cycle business model canvas, and (c) social stakeholder business model canvas

Circular Business Model Planning Tool (CBMPT)

Nußholz (2018) presented the Circular Business Model Planning Tool (CBMPT) by adapting Osterwalder and Pigneur's BMC to create a tool for formulating business models that "maintain and use the values present in products for as long as possible". The CBMPT tool, which integrates circular principles throughout the life cycles of products as its foundation, consists of five stages: collection and reintegration of materials for product manufacture (reduction of primary ingredients); first sale to extend product life; second collection and reintegration (organizing take back); additional sales of the product or its components; and material recovery (Figure 3.4).

Figure 3.4. Circular Business Model Planning Tool (Nußholz 2018)

Key question

What is an appropriate tool for narrating and describing the entire process from value proposition to value capture, especially for rural communities?

3.2.4 Criteria for a good business model

Conventional or traditional business models are characterized by their ability to answer a variety of key questions regarding target customers: the value they require or desire; and how that value can be delivered at a viable and economical cost (Osterwalder and Pigneur 2010; Teece 2010, 2018). A good business model provides additional values for customers (Magretta 2002), and is unique and difficult to replicate (Teece 2010, 2018). A good business model also understands and examines internal and external factors, such as customers, supply and business environment (Teece 2010). In addition, a good business model can detect or understand existing business models accompanied by strategic analysis (Teece 2018). However, these criteria do not necessarily answer sustainability issues. Bocken et al. (2014) said that sustainable business models are built on the basis of the following criteria: maximizing material and energy efficiency; creating value from waste; substituting with renewables and natural processes; delivering functionality rather than ownership; adopting a stewardship role; encouraging sufficiency; re-purposing businesses for society and the environment; and developing scale-up solutions.

3.3 CASE STUDY: DEVELOPING BUSINESS MODELS WITH LOCAL COMMUNITY GROUPS IN DOMPAS VILLAGE

CIFOR is working with the University of Riau's Centre for Disaster Studies (PSB UNRI) on a Participatory Action Research (PAR) project in Dompas Village in Riau's Bengkalis Regency. So far, the PAR has consisted of four phases: reflection, planning, action or implementation, and monitoring. During **the reflection phase**, community groups reflected on socioecological conditions in the village and learning best practices. In **the planning phase**, CIFOR and PSB UNRI facilitated community groups, helping them to develop business models and workable action plans. The groups comprise the village Fire Care Community or *Masyarakat Peduli Api* (MPA) group, which is managing an area of public land referred to as Action Arena 1); a women's Family Welfare Development or

Pemberdayaan Kesejahteraan Keluarga (PKK) group and a male farmer group, which are co-managing land referred to respectively as Action Arenas 2 and 3; family farmer groups, which are managing private land referred to as Action Arenas 4, 5 and 6); and households, which are managing their own private home gardens, referred to collectively as Action Arena 7. All of these action arenas are located on peatlands within the Dompas Village administrative region.

During the PAR we facilitated and guided these community groups through the following steps: choosing goods or services; formulating business models; formulating action plans; implementing business models and action plans; monitoring and evaluation, and disseminating lessons learned. In this section, we discuss the first and second of these steps.

3.3.1 Steps in facilitating business models with community groups

Step 1 – Choosing goods or services

Each community group had its own livelihood development interests. We facilitated their selection of commodities for development using a study by Ilham et al. (2019) on potential commodity value chains for peatlands. The study emphasized the importance of considering economies of scale in selecting potential commodities. We discussed the results of market surveys, topographic mapping and peat depth surveys conducted in Bengkalis Regency. We then asked each community group to identify and choose commodities or services they were interested in for subsequent development in their action arenas. Each group realized the importance of understanding and considering economic, social, engineering and environmental aspects. Discussions and decision making relating to their goods or services choices included stimulating questions on value proposition for in-depth exploration during the subsequent step.

The community groups agreed to plant combinations of timber and non-timber commodities, and provide services on their peatland action arenas. The Fire Care Community (MPA) group in Action Arena 1 chose to develop a combination of multipurpose tree species and fishing ecotourism. The women's group in Action Arena 2 and the farmer group in Action Arena 3 chose combinations of multipurpose tree species and pineapple cultivation. Farmer family groups in Action Arenas 4, 5 and 6 chose to enrich their monoculture rubber plantations with liberica coffee. Given the high demand for coconuts in the region, with the help of the Dompas Village Government, households chose to grow hybrid coconuts in their home gardens as Action Arena 7.

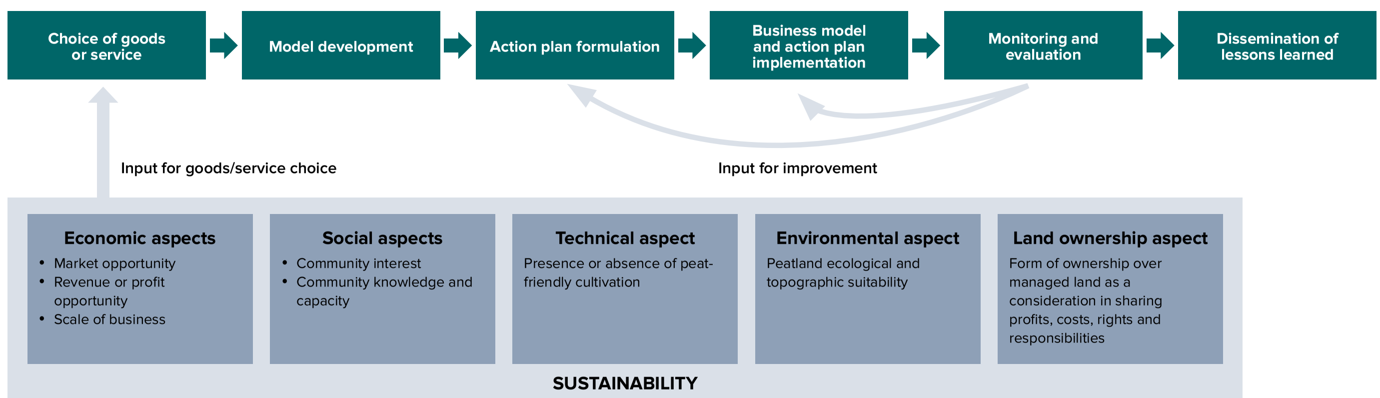


Figure 3.5. Site-level processes for facilitating community groups in developing business models

Figure 3.6. Facilitators play an important role in guiding discussions so participants can participate actively

We also facilitated group discussions on sharing rights and responsibilities, and the revenues from and costs involved in developing their chosen commodities. These discussions considered the ownership aspect of land managed by individuals or community groups. For example, as Action Arenas 2 and 3 are on land owned by individual villagers and co-managed by groups, joint planning and agreements were necessary. Agreements covered the rights and obligations of relevant actors, and cost and revenue sharing between management groups and landowners, with the MPA groups conducting fire prevention patrols.

Step 2 – Developing business models

Once agreements were reached on choices of goods and services, the facilitators began explaining business model concepts. Community groups considered the BMC from Osterwalder and Pigneur (2010), with each one identifying and populating the nine BMC canvas elements with guidance from facilitators. Laying their ideas out under the nine components made it easier for them to understand the bigger pictures for their models and formulate action plans.

3.3.2 Examples of business model canvases created in Dompas Village

Each of the community groups in Dompas formulated different business models to apply and learn from in their action arenas, three of which are discussed in this section. Despite these models being far from perfect, especially in terms of consistency between components, they do illustrate that given the right motivation and assistance from facilitators, people in rural areas can develop presentable business models.

Fishing ecotourism business model canvas

The MPA group in Dompas formulated a fishing ecotourism business model canvas for a 2.2-hectare area as Action Arena 1 (Figure 3.7). They planned to reach and serve the local community, fishing enthusiasts, fish brokers and end consumers (**customer segments**). In addition to providing recreational fishing services and renting fishing equipment, fishing ecotourism in Dompas would offer an area of natural beauty, and a culinary experience providing local fish and coffee to target consumers (**value proposition**). In addition to building relationships with sellers and suppliers (**channels**), the MPA group would use online platforms to deliver this value proposition. Relationships would be developed with customers by expanding networks in fishing communities and organizing fishing competitions (**customer relations**).

The group projected revenue from implementing this business model being secured through entrance tickets to ecotourism areas, annual membership fees for fishing hobbyists, restaurants, equipment rentals, and sales of children's toys (**revenue streams**). To realize these projected revenues, the MPA group would require financial and human capital, coffee machines, fish fingerlings, fishponds and other facilities (**key resources**). These resources would then be used to support and carry out activities in construction and maintenance (**key activities**). The costs involved in implementing this business model would include construction costs, workers' wages and salaries, and fish seedlings (**cost structure**). Taking limited networks and capital into account, the MPA group planned to build partnerships and networks with private companies through Corporate Social Responsibility (CSR) programmes, the Bengkalis Regency Tourism Office, village-owned enterprises (BUMDes) and fish fingerling partners in Siak Kecil Subdistrict (**key partners**).

Pineapple agroforestry business model canvas

The women's group in Dompas formulated a pineapple agroforestry business model covering an area of 3.3 hectares as Action Arena 2. The model involved cultivating pineapples together with multipurpose trees, including timber-yielding species. In this business model (Figure 3.9), the women's group explored a pineapple business model specifically targeting end consumers (**customer segments**) by delivering a variety of fresh and processed products, such as fresh pineapples, jam, *dodol, rujak*, pineapple ice

<table>
<tr>
<td rowspan="2">Key partners
• Companies
• Tourism office
• village-owned enterprises
• Fish fingerling partners in Siak Kecil Subdistrict</td>
<td>Key activities
• Building fish ponds
• Seeking fish fingerlings in Siak Kecil Subdistrict
• maintaining and feeding fish
• Building gates and roads</td>
<td rowspan="2">Value proposition
• Fish
• Fishing tourism
• Fish-based foods
• Ecotourism
• Selling/renting fishing gear
• Coffee kiosk
• Selling toys</td>
<td>Customer relations
• Fishing community
• Advertising fishing competitions on social media</td>
<td rowspan="2">Customer relations
• Local community
• Fishers
• Fish broker
• End consumers</td>
</tr>
<tr>
<td>Key resources
• Companies
• Tourist</td>
<td>Channels
• Selling fish online
• Fish broker/ traders in Pakning Village
• Selling fish directly</td>
</tr>
<tr>
<td colspan="2">Cost structure
• Heavy equipment
• Fingerlings
• Building materials
• Worker salaries and wages</td>
<td colspan="3">Revenue streams
• Fishing memberships
• Parking fees
• Entrance tickets
• Restaurants
• Fishing gear
• Selling toys</td>
</tr>
</table>

Figure 3.7. Fishing ecotourism business model canvas formulated by managers of Action Arena 1

and medicines. These products would be delivered to customers at competitive prices and formulated by exploring market opportunities (**value proposition**). The intended end consumers would be reached through a seller network (**channel**), by managing the network and good relations with sellers and consumers in the market (**customer relations**). The business model was expected to generate revenue, especially from the sale of fresh fruit (**revenue stream**). To realize expected revenues, they would have to invest in fertilizers, pineapple seeds, farming implements, workers' salaries and, most importantly, land (**key resources**). Available resources would be managed through a series of activities, including pineapple agroforestry land management, product maintenance and promotion (**key activities**). To carry out key activities using key resources, the women's group projected costs including those for purchasing seeds and fertilizers, and paying workers for clearing land and harvesting (**cost structure**). The women's group identified the MPA and village government as key partners in its business model.

Figure 3.8. Applying fertilizer to pineapple agroforestry land

Key partners
- Fire care community
- Village government

Key activities
- Pineapple maintenance
- Pineapple management
- Product promotion

Key resources
- Fertilizers
- Seedlings
- Equipment
- Labour costs/ wages
- Land

Value proposition
- Pineapples
- *Dodol*
- *Manisan*
- Jam
- Pineapple ice
- *Rujak*
- For medicine
- Cheap
- Opportunities available

Customer relations
- Through markets

Channels
- Through traders

Customer relations
- Consumers

Cost structure
- Fertilizers
- Seedlings
- Land clearing costs
- Harvest labour costs

Revenue streams
- Fresh pineapples

Figure 3.9. The women's group's pineapple agroforestry business model canvas for Action Arena 2

Coffee agroforestry business model canvas

Groups of farming families in Dompas managing Action Arenas 4, 5 and 6 formulated a liberica coffee business model (Figure 3.11) targeting coffee companies, customers and specialist coffee grinders (**customer segments**). They would offer green coffee beans as well as roasted or ground coffee in attractive packaging (**value proposition**). To reach intended consumers, they hoped to be able to market their products through several cafes, and directly to coffee factories (**channels**). Communication with customers would be maintained through proper and continuous communication, and through offering incentives such as discounted prices (**customer relations**). Most revenues were projected to come from sales of certificated coffee beans and coffee sales (**revenue streams**). Using resources such as certified coffee seeds, fertilizers, human resources and financial capital (**key resources**), the family groups would carry out key activities such as training, shade tree planting, fertilization, maintenance and comparative studies. Costs such as planting, maintenance, packaging and processing were identified as being important to the business model (**cost structure**). They hoped to partner with other family groups and local communities, private companies and the MPA group (**key partners**).

Figure 3.10. Harvesting coffee

Key partners	Key activities	Value proposition	Customer relations	Customer relations
• Families • Nearby local community members • Companies • Fire care community group	• Training • Fertilizer application • Planting shade trees • Maintenance • Comparative studies	• Properly packaged products • Green coffee beans • Roasted coffee beans • Ground coffee	• Communication • Providing discounts	• Coffee grinding specialist (Akiong) • Coffee factories • Customers
	Key resources		**Channels**	
	• Certificated seed • Regular fertilizer • Fruit fertilizer • Human resources • Capital (operational costs)		• Cafes • Factories	
Cost structure			**Revenue streams**	
• Planting • Maintenance • Fertilizer application • Packaging • Processing			• Coffee beans • Coffee	

Figure 3.11. Liberica coffee business model canvas created by farming families for Action Arenas 4, 5 and 6

3.3.3 Overview of the subsequent steps

There is no one panacea for a successful business, so communities should test business models formulated in the field using real business scales guided by action plans. Taking into account the context, objectives and timeframe of the PAR, we facilitated follow-up discussions together with stakeholders, local government officials, landowners and communities. Discussion topics included the roles of each participating actor as well as identifying potential and emerging challenges. Using a participatory approach, communities began to reflect and convey their ideas on who they considered important actors and partners, as well as their respective roles and responsibilities. They also identified potential challenges or obstacles that might arise in realizing their businesses together, along with solutions for dealing with them. They then determined action plans and schedules. The most important thing was for these discussions to result in commitments between village governments, landowners and communities, with CIFOR and PSB UNRI as facilitators.

The essence of good business models and action plans lies in how they can be implemented, monitored and evaluated on an ongoing basis, for further reflection and refinement. Funding from the Temasek Foundation enabled communities to go through these processes during the 2018 to 2019 period. The community groups are now managing a total area of 11.1 hectares in Action Arenas 1–6 (excluding Action Arena 7 on villagers' home gardens), with business model guidelines and action plans. Regular monitoring is carried out to identify challenges and opportunities that arise so they can provide lessons for dissemination to other communities. Regular monitoring is also important for improving the business models into the future. Detailed explanations on participatory action research processes and information technology-based participatory monitoring are presented in other chapters of this book.

3.4 SUSTAINABLE COMMUNITY BUSINESS MODELS FOR FIRE PREVENTION AND PEATLAND RESTORATION

Business models developed through the PAR process in Dompas Village have been piloted on a total area of 11.1 hectares, and are currently undergoing monitoring and evaluation. In the second PAR loop, the results of this monitoring and evaluation will be used in improving the piloted business models. Using the PAR process in Dompas Village as a case study, we drew the following conclusions:

1. Peatland-based commodity business models must consider pre-production activities, specifically zero-burning land preparation. It is important to emphasize to communities that the adoption of zero-burning management can prevent peat subsidence and disruption to the hydrological functions of peatlands. In addition, separating key activities into pre-, mid- and post-production activities allows for more detailed identification of processes and resources required.
2. Many programmes and interventions target community groups to reach the wider community while building collective action at the community level. Programmes and interventions on peatland restoration, and other topics such as family well being, business development and others, emphasize groups rather than individuals as beneficiaries. Programme designers and implementers need to think about how benefits and costs are shared among participants to ensure equitable distribution.
3. A wide variety of goods and services, both real and intangible, such as ecotourism and carbon sequestration and/or storage can be provided when restoring degraded peatlands. The introduction and recognition of these types of goods and services is important in educating communities and increasing their awareness of the important values of and benefits from protected ecosystems.
4. The sustainability aspect must be recognized as an important value proposition when formulating business models. In practice, the inclusion of sustainability

principles is essential for gaining a positive brand image and reaching new markets with environmentally conscious consumers.

5. Introducing communities to and educating them about business model formulation is a good exercise for encouraging them to exchange ideas. Follow-up questions are vital for exploring specific topics in more detail and optimizing discussion time to build engagement and collaboration within discussion groups.
6. Community participation and brainstorming must be valued. It is important for communities to exchange ideas through brainstorming, then decide and formulate their ideas as business models for testing in the field and intensive monitoring and evaluation.

Considering our conclusions, we developed a tool we called the Sustainable Business Models for Communities (SBMC). The tool adopts Osterwalder and Pigneur's Business Model Canvas (BMC), considers Joyce and Paquin's Triple Layered Business Model Canvas (TLBMC) and Nußholz's Circular Business Model Planning Tool (CBMPT), and combines these with the most important element, i.e., learning from implementation with community groups at the local level. Figure 3.12 shows the Sustainable Business Models for Communities (SBMC) tool designed specifically for fire prevention and restoration on peatlands.

This SBMC tool relies heavily on participatory approaches with a focus on intervention at the community level. It emphasizes cost-benefit sharing mechanism transparency within groups, and redefines cost structures and revenue streams by recognizing the existence of direct and indirect costs and tangible and intangible goods and services. It defines key activities in greater detail by dividing them into pre-, mid- and post-production activities. In summary, the three important pillars underpinning the idea to develop the SBMC were: participation, sustainability and transparency for local community groups.

3.4.1 Guiding questions for applying the SBMC tool

Table 3.1 shows the objectives of and guiding questions to help groups list details under each of the SBMC components. Each component is interconnected. For example, key activities are related to key resources, and to a business's benefit and cost calculations. It is important to understand how each component works and is connected to others when facilitating and guiding brainstorming and discussion processes.

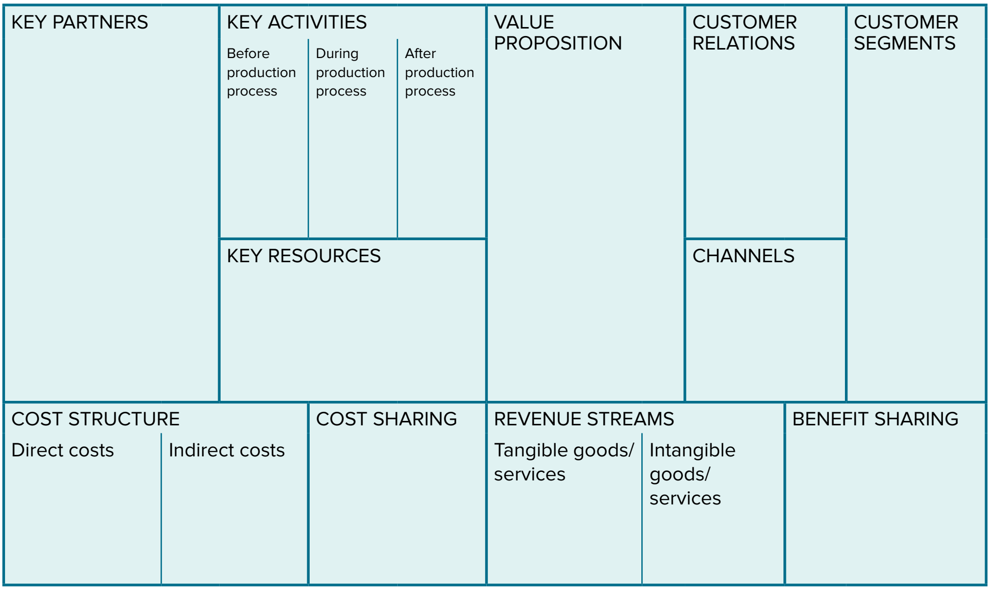


Figure 3.12. The Sustainable Business Models for Communities (SBMC) tool for fire prevention and restoration on peatlands

Table 3.1. Components, objectives and guiding questions for each component in the SBMC tool

Component	Objective	Guiding questions
Key partners	Identify key partners and their roles	1. Who are potential key partners in growing the business? 2. What is the role of each key partner?
Key activities (before, during and after production)	Identify pre-, mid- and post-production activities. Introduce and raise awareness about zero-burning land preparation for developing land-based commodities on peatlands. Introduce and identify options to minimize or utilize waste	1. What activities are needed before, during and after production? 2. Does each of these activities require tillage using fire or draining peatlands, or heavy machinery? 3. What is the impact on peatlands if their activities require the use of fire, heavy machinery or draining processes? 4. What alternatives have the most potential for maintaining peatlands? 5. Are there any key activities that have the potential to minimize or utilize waste from the production process?

Continued to the next page

Tabel 3.1 continued

Component	Objective	Guiding questions
Key resources	Identify the key resources required to operate the business model. Brainstorm the actions needed to ensure key resources are used effectively and efficiently	1. What are the main resources needed to realize the main activities? 2. Are there any threats that can hamper the sustainability of raw material supply? 3. What actions or plans are needed to ensure efficient and effective use of key resources?
Value proposition	Identify the value proposition offered to customer segments	1. What values do customers need and want to pay? 2. How does each value differ from that offered by competitors? 3. Do the proposed values acknowledge sustainability principles and practices? 4. How do sustainability principles and practices distinguish these proposed values from those of competitors? 5. What follow-up plans and strategies are required?
Customer relations	Identify strategies and approaches for maintaining relationships with customer segments	What actions and strategies are needed to maintain relationships with customers?
Channels	Identify channels for use as means for reaching customer segments	What channels might be used to reach customers?
Customer segments	Identify target customers or markets, according to the value proposition to be delivered	1. Who are intended customers willing to pay for the value offered by the producer? 2. Which potential customers or markets might be willing to pay a higher price (premium price) for sustainable products? 3. What are customer preferences like? Is the proposed value proposition appropriate for the customer segment you want to target?

Continued to the next page

Tabel 3.1 continued

Component	Objective	Guiding questions
Direct cost structure	Identify direct costs required to produce the goods/service	What direct costs are required to support the business?
Indirect cost structure	Identify indirect costs required to produce the goods/service; that contribute substantially to creating an enabling production/business environment. In the context of peat restoration, indirect costs include fire prevention, firefighting patrols and canal blocking to keep peat moist	1. What indirect costs are necessary and important to support business continuity? 2. Are there any disaster mitigation activities (e.g., for recurrent fires and haze) the business needs to cover?
Cost sharing in groups	Identify group cost-sharing mechanisms	1. How will direct and indirect costs be divided with the group? 2. How will key partners help with payments for fees or access to funding?
Revenue streams from tangible goods/ services	Identify and project potential revenues from tangible goods/ services	1. What are tangible goods and services with the potential to generate profits? 2. Will revenues generated from identified tangible goods and services be greater than costs incurred? 3. What strategy might be used to ensure maximum profits?
Revenue streams from intangible goods/ services	Identify and project potential revenues from intangible goods/ services	1. What are the potential intangible goods/ services? (e.g., ecotourism and carbon) 2. What strategy might be used to start selling intangible goods/services?
Benefit sharing in groups	Identify group benefit sharing mechanisms	1. What are the financial and non-financial benefits of the business model? 2. How will these benefits be shared and how can you ensure they are shared fairly?

3.5 CONCLUSION

In developing Sustainable Business Models for Communities (SBMC) canvases, adopting existing principles and combining them with a systematic understanding of socioecological context, are essential to support scaling-up and replication in other locations. Doing so will also enable community groups to practice systematic thinking in clearly defined steps. This exercise will allow them to capture the big picture and formulate necessary strategies. For supporting fire prevention and peatland restoration, business models should be designed in such a way that allows communities to have sustainable livelihood options while restoring degraded peatlands. It is also important to formulate business models that communities can work on and test. Successful application of community-based business models is expected to generate triple bottom line benefits that can help communities develop and move forward independently, while also contributing to sustainable development.

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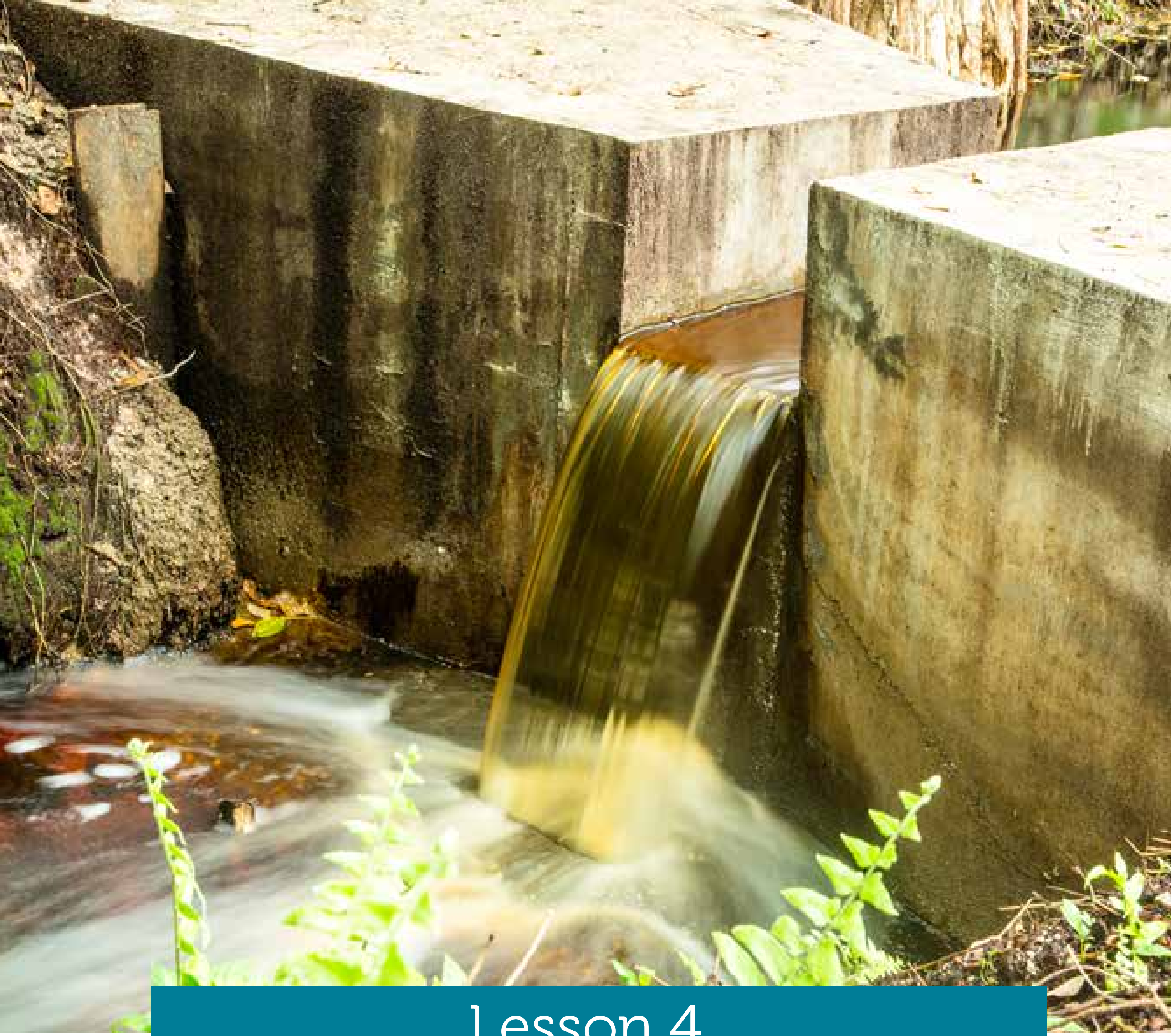

Lesson 4

Canal blocking and groundwater level monitoring systems

Imam Basuki, Beni Okarda, Sigit Sutikno and Adhy Prayitno

4.1 INTRODUCTION

Devastating forest and land fires spread through peatland ecosystems in Sumatra and Kalimantan during the dry seasons of 1997 and 2015 causing fatalities and losses amounting to trillions of rupiah. A major cause of these fires was groundwater levels in the regions' degraded peat soils being markedly lower than in natural intact tropical peat forest ecosystems like those in Papua. Large swathes of Sumatra and Kalimantan's peatlands have been drained, leading to increased fire and flood risk, and accelerating carbon emissions to levels that jeopardize the world's climate.

With international funding support, the Government of Indonesia and development partners are striving to prevent fires in peatland ecosystems and establish rapid response systems to tackle any such occurrences. Fire prevention efforts include the development of peat rewetting infrastructure and replanting endemic peatland species in degraded areas targeted for restoration.

This chapter, which provides a series of guidelines on constructing canal blocks on peatlands and monitoring their rewetting impacts, was prepared based on the results of trials conducted in the Dompas Village region in Bukit Batu Subdistrict, Bengkalis Regency in Sumatra's Riau Province. Stakeholders in peatland fire prevention – the Peatland Restoration Agency or *Badan Restorasi Gambut* (BRG), Bengkalis Regency Government, concession companies and local communities – chose and agreed upon Dompas as it had been devastated by fires in 2015 when the subdistrict had one of the highest numbers of hotspots in Indonesia. Hopefully this chapter can become a valuable resource for constructing high quality and durable canal blocks to benefit all stakeholders.

The chapter begins by explaining the 'what', 'why' and 'how' of the canal blocking and groundwater level monitoring processes involved in Participatory Action Research (PAR) in Dompas.

- **What?**
  The purpose of canal blocking was to increase groundwater levels in areas surrounding canal blocks. This was part of a larger research agenda within a framework of PAR for fire prevention on peatlands. Our PAR study activities involved a cycle of reflection, planning, action and monitoring phases. All activities were aimed at reducing peatland fire risk and greenhouse gas emissions at the village level.

- **Why?**
  There have been many cases of rewetting infrastructure failing, due either to poorly planned construction or a lack of adequate awareness raising and discussion about its planning and development. This has resulted in an absence of synergy, trust and understanding between stakeholders in canal blocking and parties in project areas. In some cases, people whose daily activities have been affected have deliberately damaged canal blocks. This demonstrates that canal blocking should not be implemented using a top-down approach, but instead should prioritize participatory processes by involving local stakeholders, particularly those impacted by peatland fires and the rewetting of degraded peatland ecosystems. PAR was an alternative option for doing so, and could be used to produce high-quality canal blocks for optimum utilization in meeting local stakeholders' wishes (Figure 4.1).

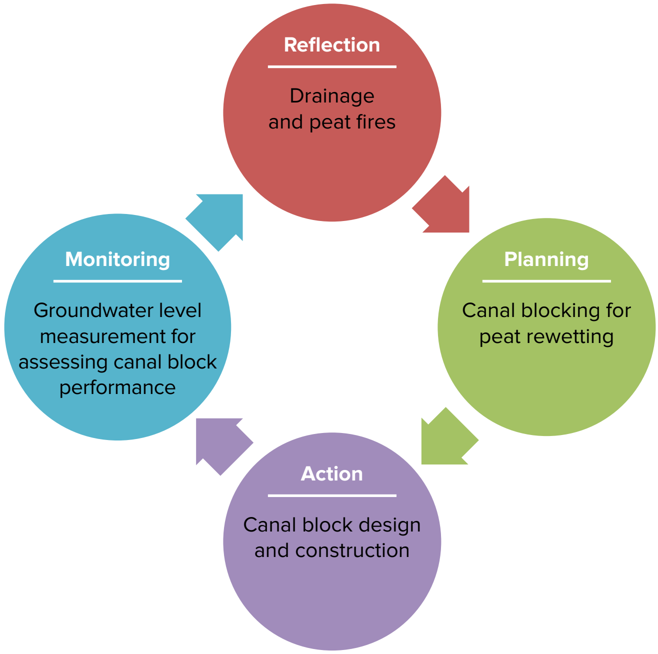

Figure 4.1. Phases in PAR on constructing canal blocks to tackle peatland drainage and fire problems

- **How?**
  Participatory action research would be put into practice to better solve problems in peatlands. During its reflection phase, for example, problems posed by peat drainage systems were discussed with local communities and village authorities. Discussion processes resulted in participatory selection and agreements on ways to solve identified problems, including canal blocking or backfilling. During the subsequent planning phase, the same participants prepared implementation plans for the activities they chose during discussion forums. The plans were then implemented during the action phase, with canal blocking carried out using methods approved during the discussion forums. Then, canal blocks' performance in increasing groundwater levels were measured and monitored to generate data during the monitoring phase. Data collected during this phase would be analysed to evaluate how successful the chosen methods had been in solving identified problems. These evaluations would constitute the reflection stage in the subsequent PAR cycle for determining whether or not any improvements were necessary. If problem solving goes according to plan, then up-scaling will be planned for expansion in other areas.

4.2 CANAL BLOCKING

4.2.1 Reflection phase

Prior to any work taking place, a series of pre-survey activities and interviews with village leaders were conducted to raise awareness of PAR and secure approval from the village community. The CIFOR research team and the Temasek Foundation (research funder) then held a meeting in the Dompas Village office to formally introduce project activities to village authorities and community members (Figure 4.2). The team also visited Rozi, chair of the Dompas Village Fire Care Community or *Masyarakat Peduli Api* (MPA) at his home, which has a nursery with seedlings for tree planting in peatland restoration. These activities involved a process of reflection to understand the condition of peatlands degraded by drainage and land fires, as well as processes needed to rectify problems, one of which would be planting peat swamp forest trees.

4.2.1.1. Preliminary observations of land cover conditions and canal networks

The CIFOR research team, Singapore Cooperation Enterprise (SCE) and community members conducted field observations by visiting rubber and oil palm plantations, which dominate land cover in Dompas. We observed a 10 hectare (ha) oil palm plantation belonging to Atik, a successful figure in farming oil palm and rubber on peatlands, and discussed a two-metre-wide canal he had blocked himself by filling it with peat. This land was considered as a site for peat rewetting with the construction of a canal block and additional planting of forest trees.

Figure 4.2. Discussion in the Dompas Village office (top) and peat swamp forest tree nursery visit (bottom)

We also observed a canal block serving as a bridge from plantation land to a nearby cement road that connects local rubber farmers to the provincial ring road around 300 m to the east (Figure 4.3). On village land approximately 200 m from the canal there is a 'SESAME' automatic groundwater level monitoring station built in 2018 and belonging to the Peatland Restoration Agency (BRG). Observations continued to a canal block around 500 m west of village land that CIFOR had built previously. It is sited at a higher elevation than the village land. We then continued to observe a wider deeper canal (with a mineral soil bed) dug by oil palm plantation concession holders on peatland directly adjacent to land belonging to villagers. The canal drains water from the peatland area into a river to the north, which then empties into the sea. In doing so, it has resulted in water that originally flowed from peatlands to village land and community rubber plantations being diverted to the river. In addition, we visited an area of the village on tide-affected muddy mineral soil near the provincial road.

In the reflection phase, baseline conditions for peatlands in the study area were established through a literature review, mapping peat depth and topography, and collecting peat soil samples. The literature review involved collecting maps of the research area from various sources, including a 1:250,000 scale map of peatlands in Indonesia from Ritung et al. (2011); a Peatland Hydrological Unit (PHU) map with the same scale from the Ministry of Environment and Forestry; and administrative and topographic maps from the Geospatial Information Agency or *Badan Informasi Geospasial* (BIG). These maps provided information on boundaries, rivers, roads and elevations. Satellite imagery was also collected for processing to generate land cover and elevation models.

Figure 4.3. Preliminary observations of land cover, canal networks and canal blocks in Dompas

4.2.1.2. Peat boundary and depth, topographical and environmental characteristic surveys

To secure additional information on the local environment, we conducted field activities with villagers and members of the village Fire Care Community group. Training was given to participants selected and approved beforehand by the village authorities to accompany the research team. This training, which took place both before and during field activities, was intended to increase participants' capacity to collect data on peat depth and topography, and to ensure data quality.

Figure 4.4. Screenshot from a mobile phone using the ArcGIS Collector application showing action arena locations

The android-based mobile phone application ArcGis Collector (Figure 4.4) was used for field surveys and geolocation in measurement sites. The application, which is part of the ESRI Geospatial Cloud platform, can be modified to suit user needs, and allows data collectors to use maps on their mobile phones to collect and edit spatial data during field surveys. The application is available as a free download from the Google Play store. It allows map layers can be uploaded into the application for field use, and can work well offline where no internet connection is available. It is similar to the popular mapping application, Avenza Maps.

Transects for topographic measurements/ elevation differences were established along the boundaries of the project's action arenas, which were agreed upon by stakeholders involved in PAR activities. Elevation measurements were taken at 25 metre intervals along these transects using direct levelling.[3]

Differences in elevation were measured using a 30-metre-long clear plastic hose

3 http://www.fao.org/tempref/FI/CDrom/FAO_Training/FAO_Training/General/x6707e/x6707e05.htm#80

filled with water, recording distances from the water at each end of the hose to the ground, and then calculating the difference between those distances. This method involved two surveyors; one at each end of the pipe.

In taking such measurements, the two surveyors stood 25 metres apart, with one holding the hose so the water at their end was at an agreed height above the ground – 50 cm, for instance. The surveyor at the other end then measured the distance between the water level at their end of the hose to the ground. If the height recorded was greater, for instance 75 cm, then the elevation at their end would be 25 cm lower than at the other surveyor's end (75 cm – 50 cm = 25 cm). Conversely, if the height recorded was smaller, for instance 25 cm, then the elevation at their end would be 25 cm higher than at the other surveyor's end. The difference between measurements recorded at each end of the hose indicated the differenced in elevation between location points along the transects (Figure 4.5).

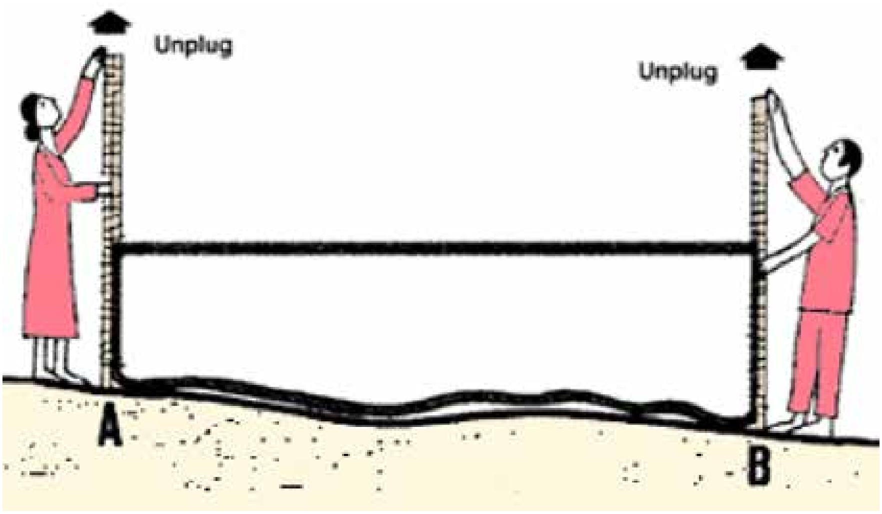

Figure 4.5. Two surveyors measuring difference in elevation between two points located 25 m apart

Source: Adapted from www.fao.org

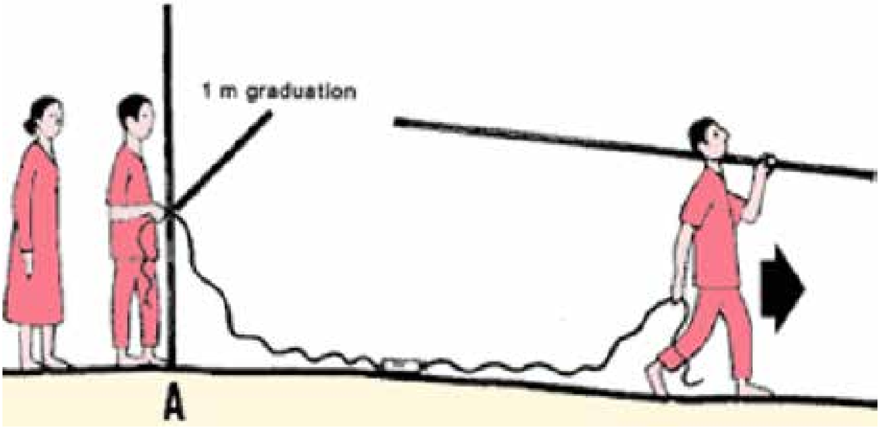

Figure 4.6. Surveyor one at surveyor two's measurement point while surveyor moves to the next point

Source: Adapted from www.fao.org

For taking elevation measurements at subsequent points along the transects, surveyor one would move to surveyor two's location, while surveyor two moved on to the next measurement point 25 m away. Surveyor two then recorded the height of the water level from the ground at their end of the pipe when the water level at surveyor one's end had been set at the height recorded previously by surveyor two (Figure 4.6).

The time required for measuring differences in elevation largely depended on land cover conditions and the skills of the surveyors involved. Taking measurements on land covered with dense undergrowth was more time consuming as it involved clearing transects, and required a third person with a machete. In these activities, taking 40 elevation measurements would take an average of around four working hours (Figure 4.7).

Figure 4.7. Dompas Fire Care Community members taking elevation measurements

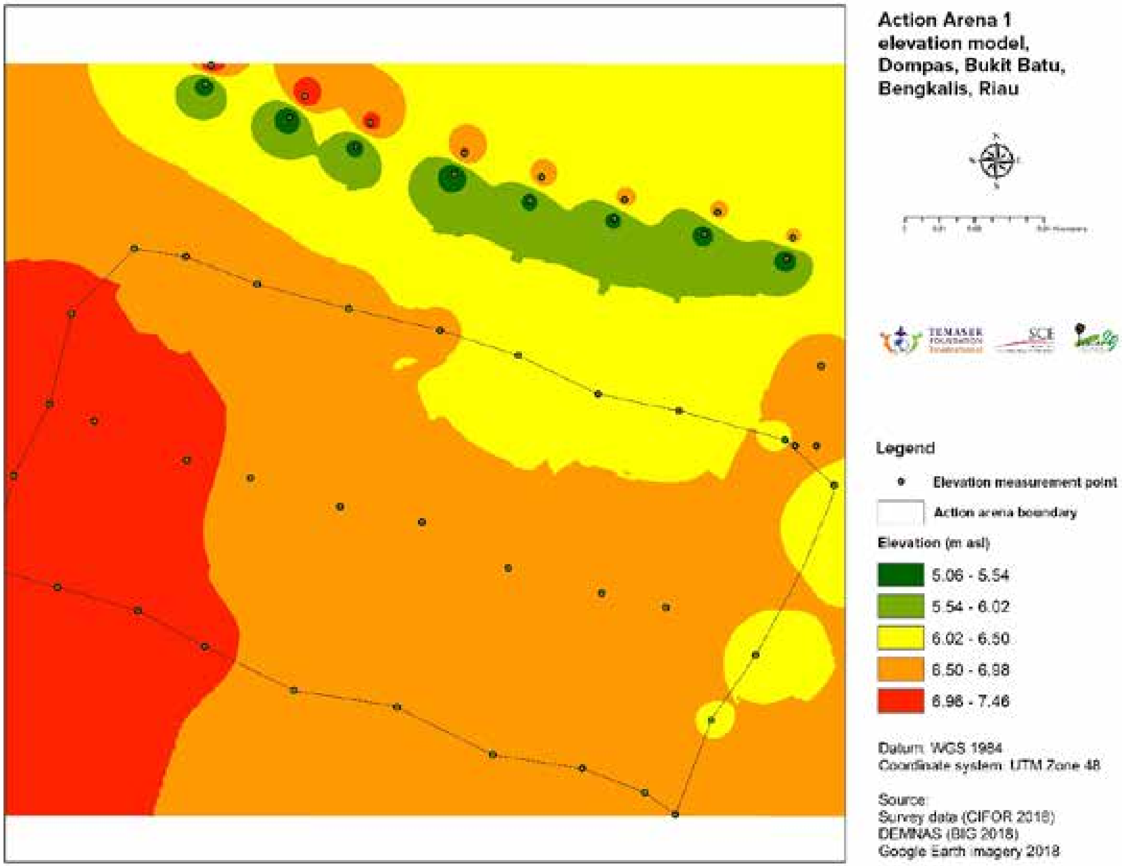

Figure 4.8. Digital elevation model based on field measurements taken in Action Arena 1

In addition, simple peat quality measurements were taken using the qualitative approach outlined by Agus et al. (2011), where peat decomposition levels were determined by taking half handfuls of wet peat from the soil surface and kneading them. By observing the amount of peat remaining after kneading, it was possible to estimate its level of decomposition. More than 75% of the original amount remaining indicated young or fibric peat; 15–75% remaining indicated moderately decomposed or hemic peat; and less than 15% remaining indicated highly decomposed or sapric peat (Figure 4.9). A sapric quality was an indication that peat material had decomposed through a process of oxidation, while a fibric quality indicated peat still containing fresh organic matter and root fibre.

Figure 4.9. Qualitative measurement of peat decomposition levels: hemic or moderately decomposed peat (left) and sapric or highly decomposed peat (right)

Community members were also selected for training on measuring peat depth and taking peat samples using *eijkelkamp* augers (Figure 4.10). Peat sampling transects were set at 150 m long, consisting of 6 sampling sites located 30 m apart following Kauffman et al. (2016). Three peat samples were collected from each drilling site, taken carefully from depths of 40–45 cm, 70–75 cm and 195–200 cm from the surface following Chimner et al. (2014). Each peat sample was stored in plastic with a unique coded label, and immediately sent to the soil laboratory for carbon analysis. In addition, approximately 1 kg of peat was collected from the soil surface at each drilling site, and stored in plastic with a unique coded label, for subsequent chemical characteristics analysis in the soil laboratory. These activities were conducted in each of CIFOR's PAR action arenas in Dompas Village.

Figure 4.10. Measuring peat depth and taking peat samples

Peat depth mapping was also carried out on the entire village area to obtain more detailed and accurate peat maps for use in research activities in the village. This mapping involved a semi-systematic approach utilizing existing maps as starting points. Working maps were created by extracting information on peatland boundaries, peat depth, village boundaries, rivers and roads, and adding peat depth measurement location points. These location points were established to represent depth variations as depicted in the peat map in Ritung et al. (2011), and to determine boundaries between peat and non-peat areas (Figure 4.11).

Closer observations were necessary in peat and non-peat boundary areas to identify the exact locations of peat boundaries. In these areas, observation points were set at distances of 250 m or closer depending on the outcomes of observations on the ground. In areas with peat depths of 1–6 m, observation points were set at distances of 500 m. Measurements were taken from random points in areas with peat depths exceeding 6 m.

Peat depth measurements were taken at each observation point using drills that could be extended up to 20 m. Boundaries between peat and mineral soils had to be examined by taking soil samples from peat boundaries and photographing them.

Data on peat depths and geographic coordinates, and photos from all measurement locations were stored in the ArcGis Collector application, and subsequently downloaded and saved to computers using ArcGis 10.4.1 software. Peat depth models for most parts of Dompas were built based on observational data stored in computers using the *Kriging*[4] method (Oliver 1990). These results provided useful information for reflection on peat conditions in the study area and their implications for land management activities.

Measurement results showed all action arenas being in areas with deep peat more than 4 m thick (Figure 4.11). This meant all PAR activities would need to focus on and reflect activities striving for peatland ecosystem rehabilitation and restoration. It was noteworthy that our peat depth model map contrasted significantly with information obtained from the peat map in Ritung et al. (2011), which showed all action arenas being on shallow peat (<1 m). This was likely due to the relatively small scale of the peat map they used. With this in mind, it seems necessary to check peat depth using a semi-detailed scale of 1:50,000 or higher for land use on peatlands at the village level.

4 https://desktop.arcgis.com/en/arcmap/10.3/tools/3d-analyst-toolbox/how-kriging-works.htm#ESRI_SECTION1_F2C5B52BEBED 4A 01BB90828985284ACB

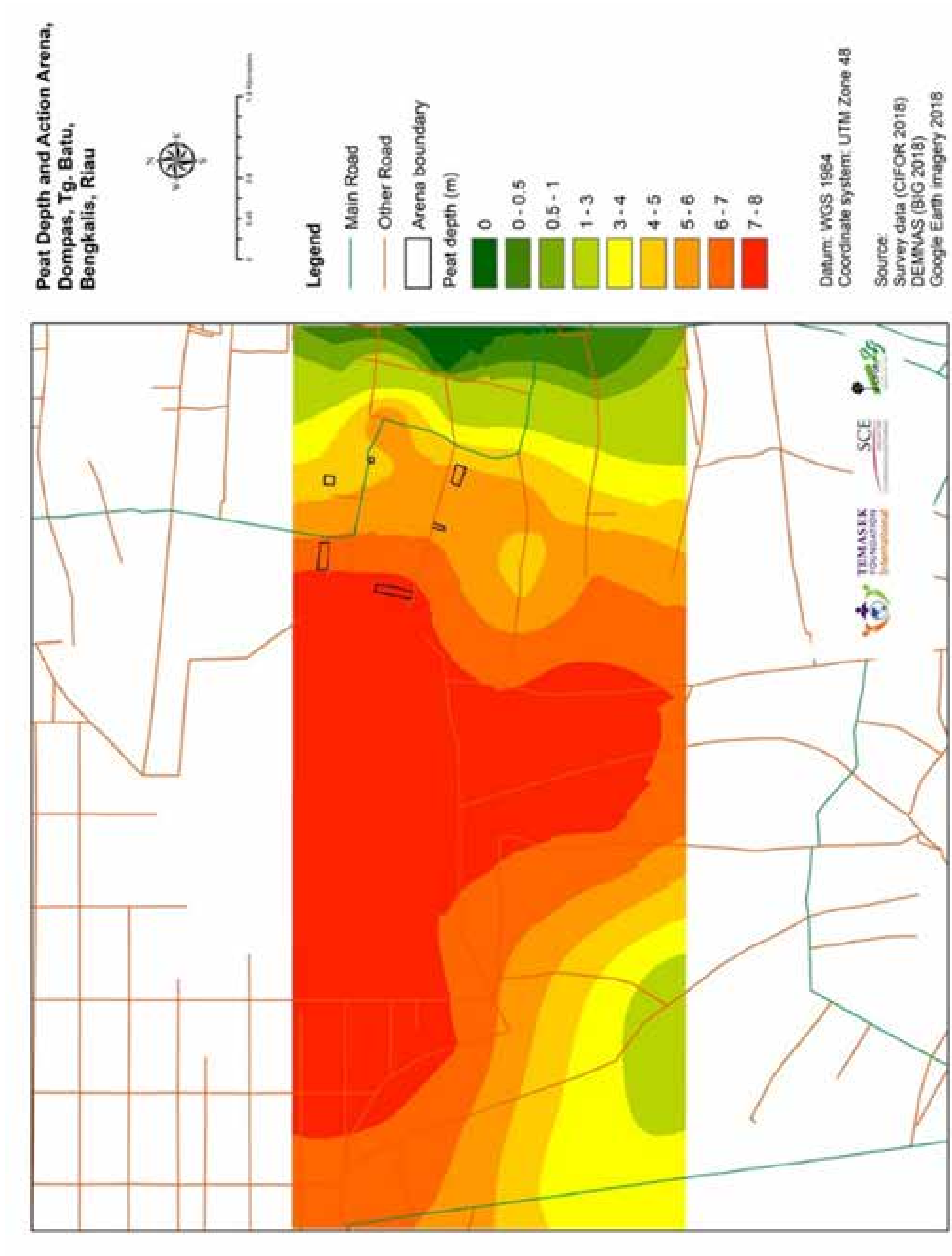

Figure 4.11. Peat depth model and action arenas in Dompas

The results of activities during the reflection phase, including determining peat depth and drainage canal conditions in the area, strengthened the argument for the need to restore degraded peatlands in Dompas. They also demonstrated the importance of field observations and securing accurate information on an area's biophysical conditions (distribution of canals, rivers, roads and land cover) in the reflection phase for ensuring proper planning and implementation in the subsequent planning and action phases.

4.2.2 Planning phase

By the planning phase, participating parties had a good understanding of conditions in all action arenas as plans needed to be based on evidence gleaned during the reflection phase. Good planning and appropriate solutions were necessary for constructing effective canal blocks as the agreed means for tackling the identified problems of drained peat and high fire risk. Canal blocks would have to be able to rewet dry peat by increasing groundwater levels to reduce fire risk.

All information relevant to peat characteristics had to be studied as the fibric, hemic or sapric quality of peat affects its hydraulic conductivity and available nutrients for vegetation.

Topographic information for each action arena provided indications of likely water movement in those locations, with water flowing from higher areas and concentrating in lower lying ones. Elevation references were obtained from National Digital Elevation Model (*Demnas*) images from the Geospatial Information Agency or *Badan Informasi Geospasial (*BIG).

Aerial photographs taken using cameras mounted on Unmanned Aerial Vehicles (UAVs) provided further information on the canal network, land cover and vegetation conditions (Figure 4.12). Information on the canal network was essential for planning the positioning of canal blocks as part of the overall hydrology in the study area. Meanwhile, information on land cover and vegetation conditions provided important baseline data for assessing the impacts of peat restoration.

Figure 4.12. Aerial photograph showing action arenas to the west of Dompas and the coastline

To further understand hydrological conditions of the study area, it was necessary to conduct a hydrological study to analyse the area's water balance. This analysis provided useful information on the history of water excess and deficits in the study area. As fluctuations in Groundwater Level (GWL) could be predicted from data on groundwater level and rainfall over the previous six months (Figure 4.13), such information was essential for determining a water management policy for the study area.

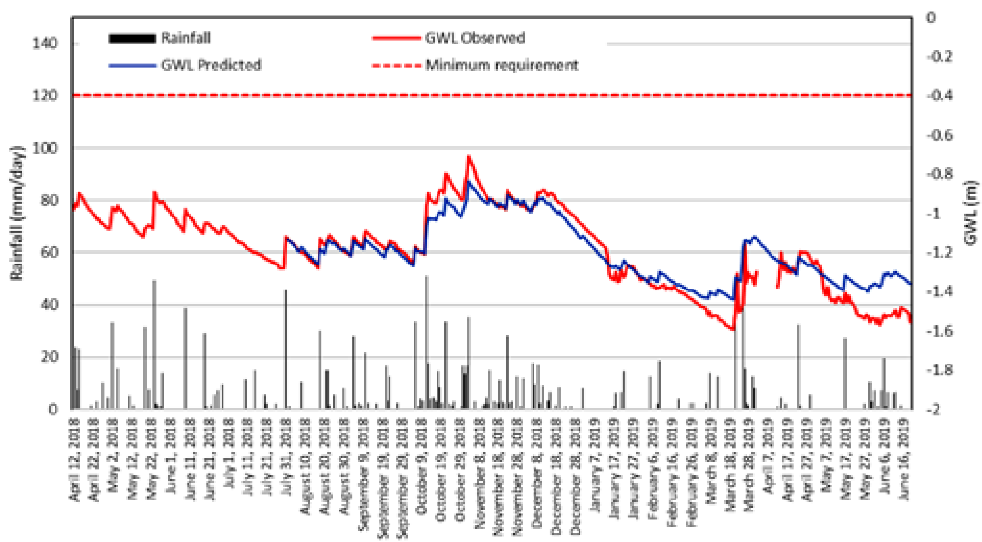

Figure 4.13. Predicted and measured groundwater levels and rainfall data from the BRG monitoring station at the study site

4.2.3 Action phase

It was necessary to discuss canal block designs properly and thoroughly with those selected to participate in their construction. It was essential to find community members who understood the processes involved in and had the necessary capacity for constructing high quality canal blocks. Village facilitators played a vital role in this process. In addition to ensuring a participatory framework, it was also important to ensure the peat wetting infrastructure would meet the requisite quality and function as desired. Canal blocks would have to be durable and prove effective at raising groundwater levels. To ensure canal blocks were built to standards required by applicable legislation, their design was compared to those outlined by the Peatland Restoration Agency (BRG) as shown in Figure 4.14; by the Ministry of Environment and Forestry;[5] and by Ritzema et al. (2014) as shown in Figure 4.15. BRG guidelines on canal blocking in peat environments are laid out in Dohong et al. (2017). This process was aimed at ensuring necessary steps could be taken and adapted to social and biophysical conditions in the village.

5 https://gambut.oirto.com/model-pembangunan-sekat-kanal/

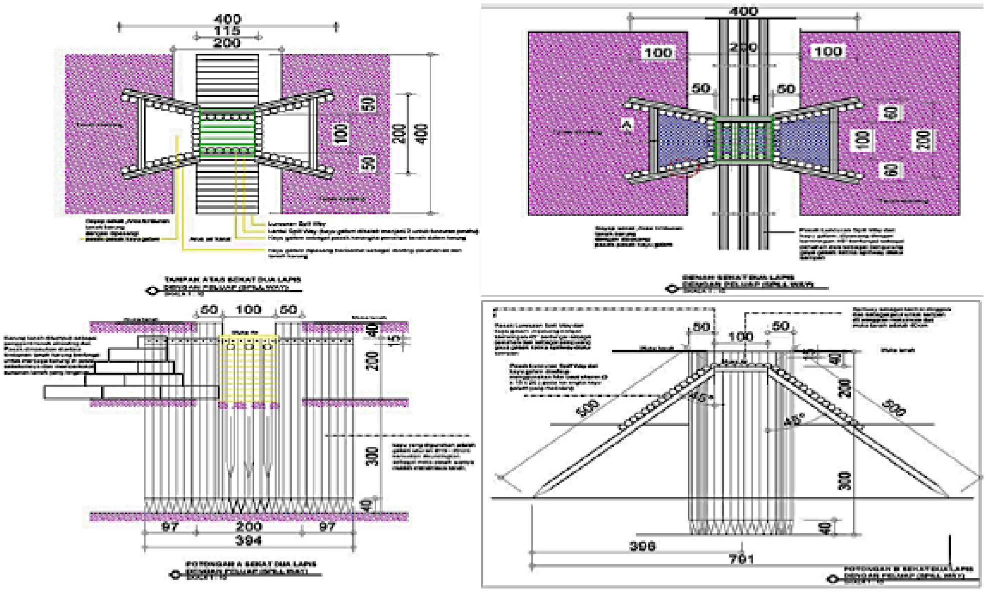

Figure 4.14. Permanent canal block design suggested by Dohong et al. (2017)

Discussions on work schedules, design specifications, materials required, methods and work targets were held before any construction commenced. A working group of nine people including members of the Dompas Fire Care Community group agreed terms of reference for canal block construction works. It was important for everyone involved to understand and ensure expected work schedules and quality standards were met. Daily tasks and work schedules were discussed and agreed with all group members.

Surrounding topographic conditions had to be considered when determining locations for canal blocks. They were positioned at the lowest points in each action arena to ensure optimum rewetting. Canal blocks would be constructed using available materials by considering local labour capacity. They would need to suit the width of the canals and be able to withstand the potential volumes of water that would collect during transitions between dry and rainy seasons. The wider the canal, the stronger the construction would have to be.

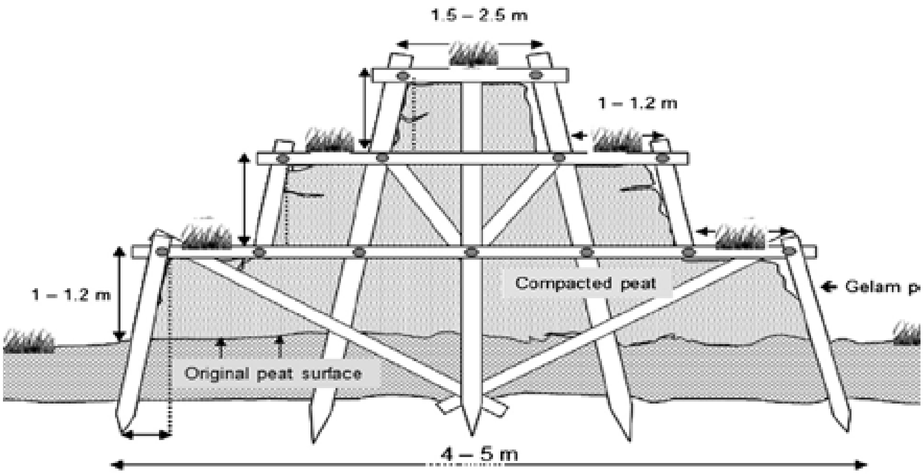

Figure 4.15. Canal block design from Ritzema et al. (2014) using materials available in villages

To ensure canal block quality, their construction was supervised by a hydrologist or researcher. Standard procedures for canal blocking had to be met and implemented consistently and carefully.

These standard procedures are as follows:

- Canal blocks should be constructed during the dry season when water levels in canals are low enough to do so. Attempting to construct robust canal blocks is risky during the rainy season, when damming and diverting water flows are particularly difficult.
- Materials for canal block construction should be selected and purchased according to local availability. Avoid using materials that are difficult to obtain, as this can hinder work. All materials should be purchased and delivered to work sites in line with work schedules and stages of construction. Such materials include PVC drainpipes, 12 mm steel reinforcement rods, cement, sand, gravel, mineral soil, sheets of plywood, wooden poles (*gelam/Melaleuca* sp.), 6 mm diameter wire mesh, thick waterproof tarpaulin, burlap sacks and nails.

- Prepare eight 6-m-long piles by filling the tapered ends of 10 cm diameter PVC pipes with concrete. Position them to become primary piles in the canal block. Drive the piles down into the mineral layer, then fill them to their brims with wet concrete (Figure 4.16).
- For a 6-m-wide canal, canal block 'wings' should be constructed by digging 30-cm-wide channels in four directions to at least 1 m from the canal. These channels should be the same depth as the canal. For narrower canals with widths of 1.5 m, it is only necessary to dig 'wing' channels in two directions – one on each side of the canal – for a single layer partition wall canal block construction (Figure 4.17).
- Prepare wooden poles of around 10 cm in diameter to form the backbones of the canal block walls. Taper the ends of the poles using a chainsaw. The poles should be around 7 m long so they can be driven down to penetrate the mineral soil layer. Once driven down, the poles should be fastened together by nailing long, 5-cm-wide planks to their upright ends. Around 90 poles will be needed for a 6-m-wide canal, and around 30 for a narrower 2-m-wide canal.
- Prepare a water outlet/sluice gate in the middle of the canal block. It should be around 1 m wide with a depth of 40 cm from the canal block surface.
- Canal block walls comprising wooden poles, wire mesh and concrete should be made using plywood forms reinforced with wooden frames. Pour concrete into the plywood forms, then remove them once the concrete is completely dry.

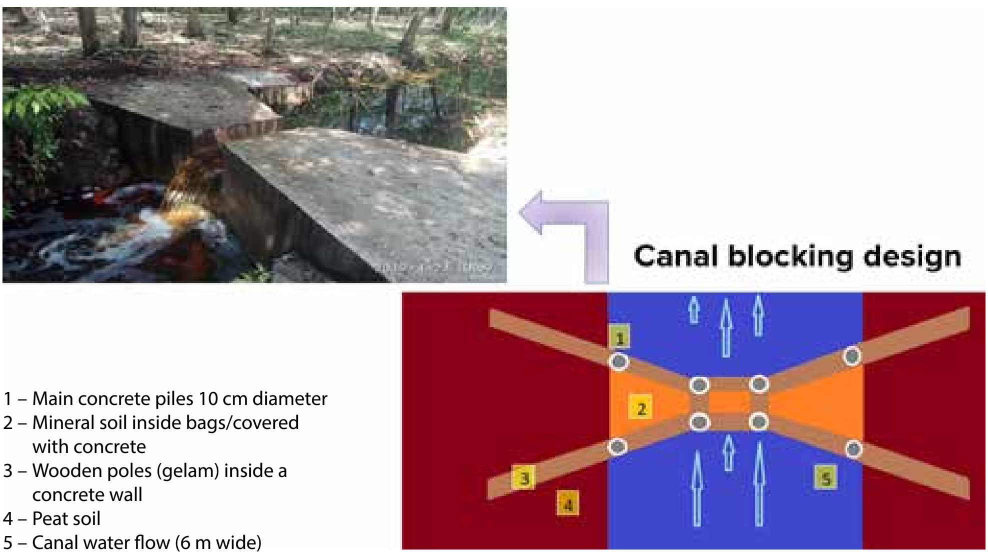

Figure 4.16. High-quality (permanent) canal block design agreed upon with community members

Figure 4.17. Permanent single layer partition wall canal block design agreed with community members

- Infill the spaces between the two walls on either side of a 6-m-wide canal using sacks filled with mineral soil and covered with thick waterproof tarpaulin. First compact the bottom of these spaces by trampling, then pile up the mineral soil-filled sacks. After that, level the upper parts above the sacks by adding sand and compacting it. Finally, add wire mesh to the upper surface of the canal block and concrete it.

An alternative canal block design was aimed at reducing the force of falling water, which can erode canal beds. This design used a 'morning glory' spillway with 4-inch-diameter PVC pipes (Figure 4.18).

The morning glory spillway design would allow water levels in canals to be set as needed. The construction process for a canal block with a spillway is similar the one described for a 6-m-wide canal. The only difference is that PVC pipes for spillways should be installed immediately after installing the concrete piles. Morning glory spillway canal blocks were constructed in Action Arenas 2, 3 and 5, after other canal blocks had already been built in Action Arenas 1, 4 and 6.

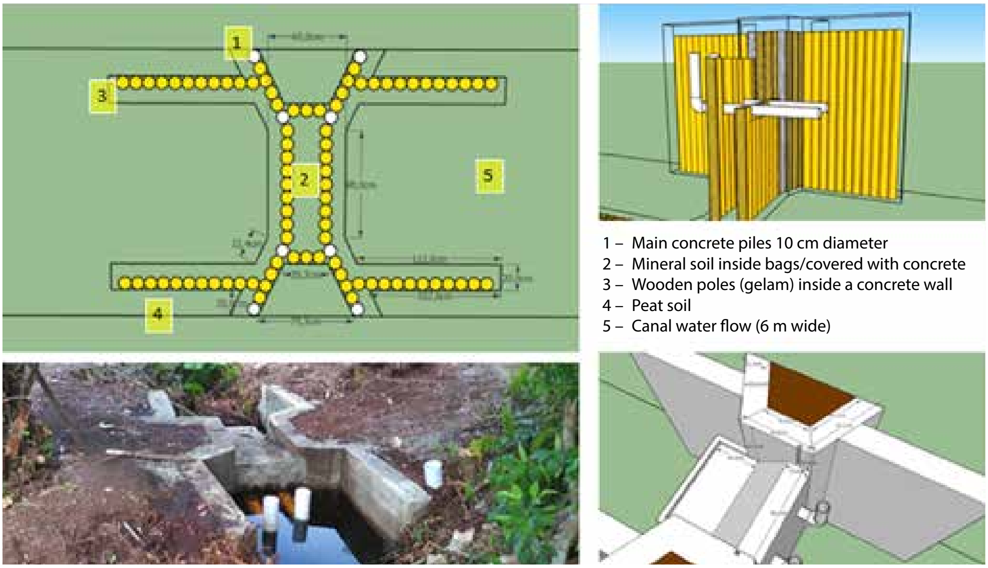

Figure 4.18. Alternative canal block design with a 'morning glory' spillway

Construction costs for a high-quality, double-layer canal block for a 6-m-wide canal were approximately IDR 25.5 million, while costs for a single partition wall block for a 1.5-m-wide canal were around IDR 3 million. These costs, which included purchasing materials, equipment rental and workers' wages, provided information supplementing the cost requirements laid out in the national Peatland Restoration Agency Strategic Plan (BRG 2016).

4.2.4 Monitoring phase

The monitoring phase was essential for determining whether canal blocks were successful in achieving the desired impact of rewetting peat and making it less fire prone during the dry season. It was necessary to identify variables that represented rewetted peat conditions, and measure them periodically. Important variables for comparing action arenas with and control areas without canal blocks included groundwater level depths, peat soil moisture levels, and peat subsidence rates. Control sites were chosen in locations adjacent to and with similar conditions to the action arenas, which allowed researchers to examine the impacts of canal blocking in each arena.

Important steps in establishing a design for monitoring canal block impacts included:

- Identifying control sites for comparisons with arenas where canal blocks had been installed;

- Determining locations for measuring groundwater level, soil moisture and peat subsidence rate variables to establish canal block impacts most effectively. Though Ritzema et al. (2014) reported canals affecting peatland water levels at distances of up to 1,000 m perpendicular to them, the reflection stage showed some action arenas being less than 400 m away from canals (Figure 4.19). With this in mind, we decided to take impact measurements around 100 m from canals in locations certain to be affected by canal blocking, and not by canals in adjacent areas. This took into account that areas equidistant to two canals would be affected by each one.

Figure 4.19. Locations of six action arenas to the west of Dompas and the coastline. The white line is a road flanked by canals on either side that accelerate the draining of water from peatlands

4.2.4.1. Groundwater Level (GWL) monitoring

To measure the impacts of canal blocking, eight peat groundwater level monitoring dipwells were installed in and around each action arena (Figure 4.20). Four dipwells were positioned inside each action arena in sites affected by canal blocks; one around 5 m upstream of the canal block, and the other three to form corners of a square spaced 100 m apart, while the other four were installed in control areas not affected by canal blocks, and directly adjacent to or near the action arenas (Figure 4.21). Soil moisture and solar radiation variables were also measured close to each monitoring dipwell site.

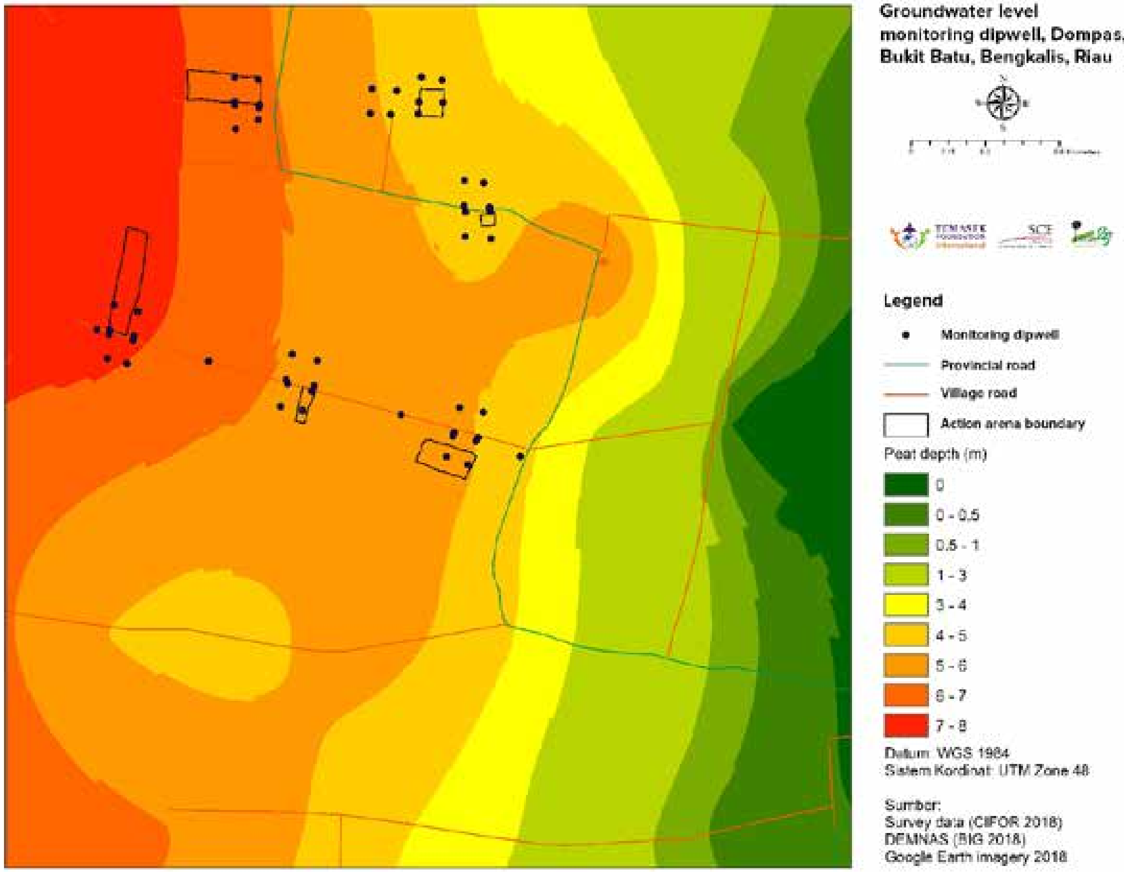

Figure 4.20. Locations of 48 peat groundwater level (GWL) monitoring dipwells in action arenas and control sites in Dompas

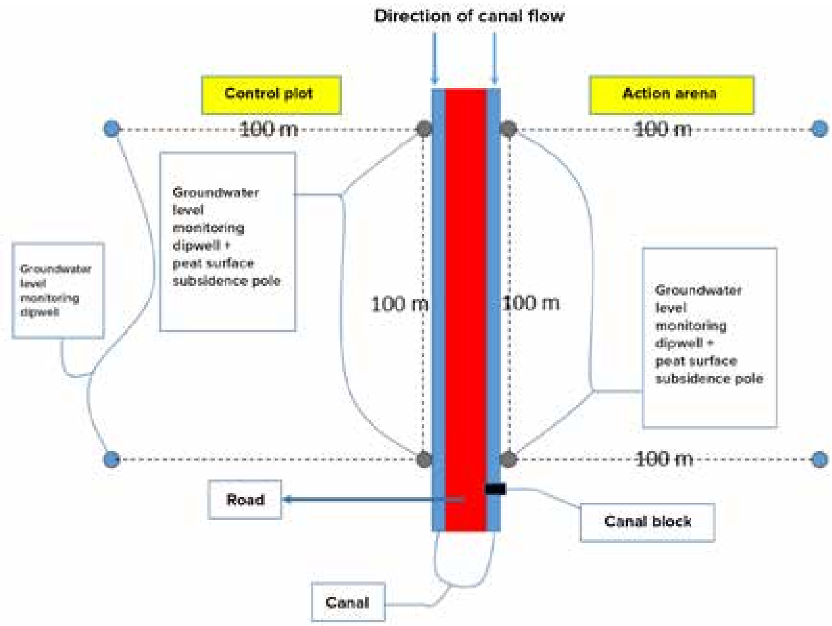

Figure 4.21. Design used for monitoring canal blocking impacts on groundwater levels, soil moisture and peatland subsidence

- **Tools and materials**

No.	Tools and Materials	Use
1	GPS	To determine geographic coordinates of monitoring dipwells
2	Power drill	To make holes in dipwell pipes
3	Saw	To sharpen ends of dipwell pipes
4	PVC pipe	Monitoring dipwell pipes
5	*Eijkelkamp* auger	To bore holes in peat for monitoring dipwell pipes
6	Tape measure (50 m)	To measure distance
7	Permanent board marker	To mark out measuring stick measurement gauges
8	Measuring stick	To measure groundwater levels inside pipes
9	Marker ribbon	To mark monitoring dipwell locations
10	Metal wire	To mark monitoring dipwell location poles
11	Portable soil testing equipment	Soil moisture meter
12	Steel reinforcement rod	Peat surface subsidence measuring poles

- **Installing monitoring dipwells**
  Two-inch diameter PVC pipes were cut to lengths of around 3 m and sharpened at one end. Using a hand drill, small holes around 1 cm in diameter were made along the lengths of the pipes at distances of 25 cm between each hole. The bottoms of pipes were sealed with pipe caps, each with a hole drilled in them. At the measurement sites, the pipes were inserted into holes bored into the peat until around 20 cm remained above the surface, and given easy-to-open caps (Figure 4.22). The pipes were then marked with action arena codes and dipwell numbers.

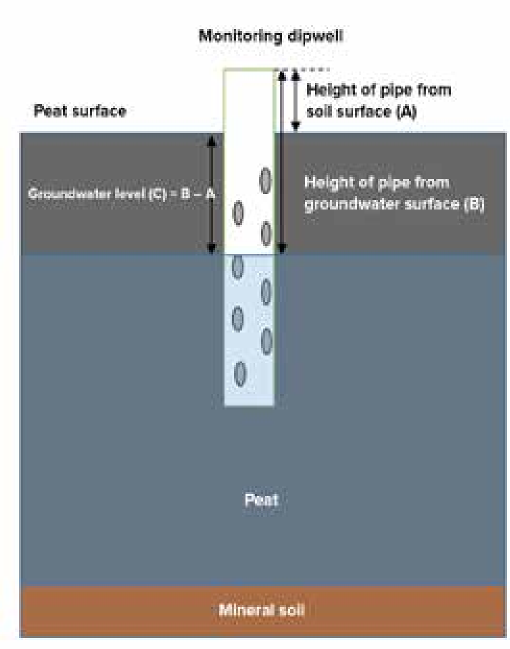

Figure 4.22. Cross section of monitoring dipwells installed in peatland action arenas in Dompas

- **Taking field measurements**
  Groundwater levels were measured relative to peat surfaces using a tape measure and measuring stick. First, the distances between water surfaces inside dipwell pipes to the tops of the pipes were measured (B). Then the heights of pipes remaining above the surface of the ground were measured (A). Groundwater levels (C) were the differences between each B and A (Figure 4.22).

  Examples of monitoring results in Figure 4.23 below show groundwater levels being higher throughout the year in action arenas where canal blocks had been constructed than in control sites.

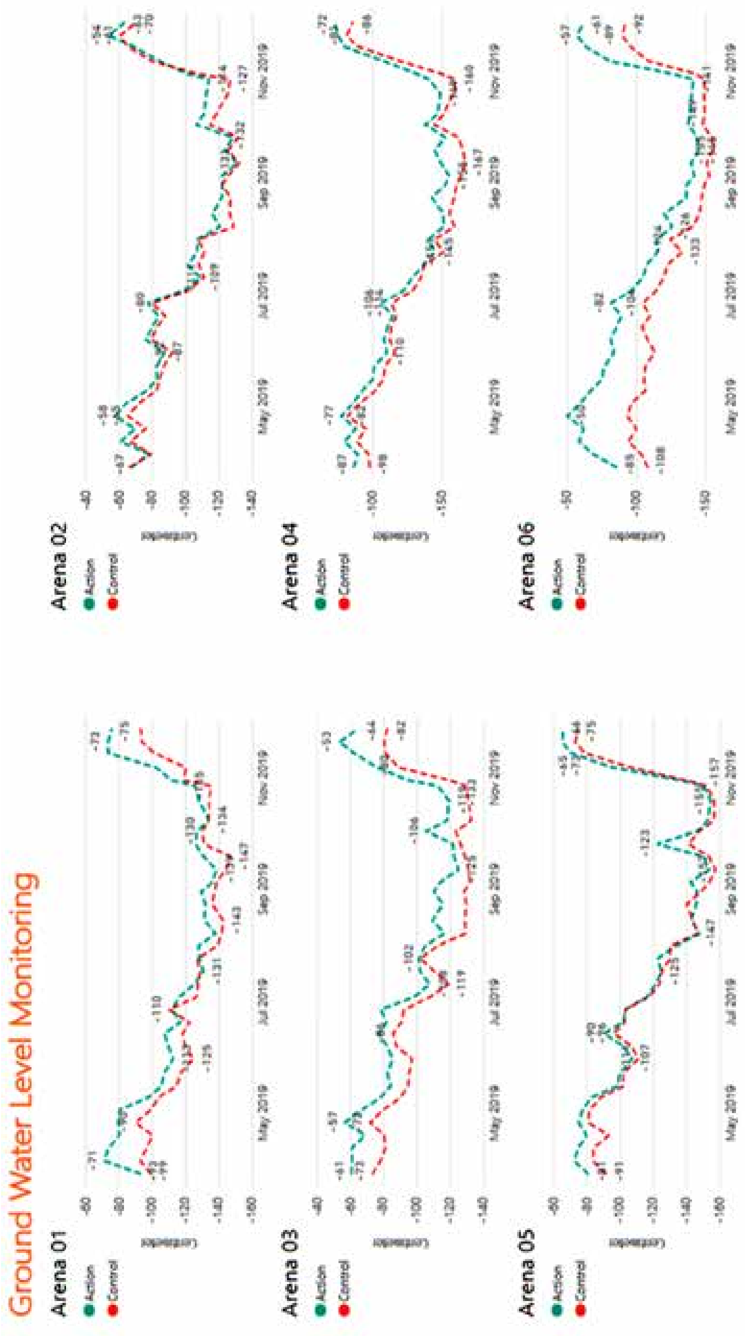

Figure 4.23. Results of groundwater level monitoring over an eight-month period in 2019

4.2.4.2. Peat subsidence monitoring

Four peat subsidence measuring poles were installed around each canal blocking site. The poles were made from steel reinforcement rods cut to lengths of 1 m more than peat depths so they could penetrate the mineral soil layer below and still leave 50 cm protruding above the surface of the ground to provide the baseline for monitoring peat subsidence (Figure 4.24). Measurements would then be taken at the end of activities so the differences in measuring pole heights between the first and second measurements would indicate the extent of peat subsidence over the period between measurements being taken. Monitoring locations were ringfenced to ensure the measuring poles were not disturbed by villagers' daily activities or by animals.

Measuring poles were installed at distances of 5 m upstream of each canal block, approximately 1 m from the closest canal walls. A second measuring pole was installed in each action arena at a distance of 100 m upstream of the first pole. Third and fourth poles were installed in nearby control areas at distances of 1 m from the nearest canal walls.

- **Tools and Materials**

No.	Tools and materials	Use
1	GPS	To determine the geographic coordinates of monitoring locations
2	Handsaw	For cutting steel reinforcement rods
3	Steel reinforcement rod	Measuring pole material
4	Tape measure (50 m)	To measure distance
5	Marker ribbon	To mark monitoring locations
6	Metal wire	To mark monitoring locations
7	Measuring gauge	To measure pole height
8	Steel reinforcement rod	Peat surface subsidence measuring pole

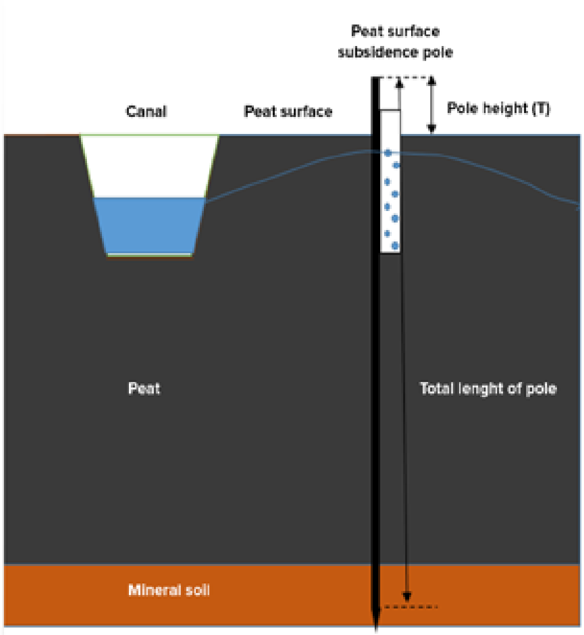

Figure 4.24. Peat subsidence measuring poles were installed 1 m from canal walls

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Lesson 5

Zero-burning land preparation for forest and land fire prevention

Nurul Qomar, Ahmad Muhammad, Qori Pebrial Ilham,
Hari Priyadi Rusantoyo and Lailan Syaufina

Haze disasters over the last two decades have caused widespread local, national and international unrest. The source of this haze has been forest and land fires on peatlands, often as a result of land clearing for agriculture and estate crops. Some community members still view the use of fire as a practical, effective and economical means of land preparation. With the recent strict ban on burning, people have become more wary and are choosing alternative land preparation methods to avoid violating the law. However, some zero-burning land clearing methods or *Pembukaan Lahan Tanpa Bakar* (PLTB) have proved difficult for communities due to their limited knowledge and technological capacity, and the higher costs involved.

Land preparation involves clearing land and controlling soil fertility to create optimum space and conditions for cultivating specific crops. It is an important stage in ensuring successful commodity enterprises because proper land preparation will create conditions conducive for plant growth (Nugroho 2012).

Farming communities, estate crop companies and plantation forest companies have often used fire in land preparation as it is easy, cheap and fast (Hendromono et al. 2007). Anshari et al. (2010) also noted smallholder farmers generally using fire in preparing peatlands for cultivation as doing so helps eliminate pests and diseases, reduces soil acidity and can make soil more fertile. Some smallholders still use fire in preparing land for planting.

Burning for land clearing does have certain advantages: it is easy and simple to do; does not require any heavy machinery; can be applied on all gradients of land; quickly releases nutrients, especially P, K, Ca and Mg; eradicates pests and plant diseases; suppresses the growth of broadleaf weeds; is cheaper in the short term, and the ash it produces can function as fertilizer (Hendromono et al. 2007). However, the losses it causes far outweigh these advantages. Many studies have recorded forest and land fires, especially on peatlands, causing environmental degradation, emitting huge volumes of greenhouse gases, disrupting human health, and having enormous social and economic impacts (Hermawan 2006; Subiksa et al. 2011; Yuliani et al. 2019). Land preparation by burning is less profitable in the long run because fewer nutrients are available once vegetation has been burned, and those remaining are quickly lost through leaching. Further, burned waste can no longer be used to produce valuable products like charcoal or compost.

To tackle the problem of forest and land fires, the Government of Indonesia has passed legislation prohibiting burning in clearing and preparing land. Article 56 of Law No. 39/2014 on Plantations prohibits all plantation business actors from clearing and/or cultivating land by burning. Accordingly, efforts are needed to increase societal understanding of the dangers of using fire in preparing land; change attitudes towards and behaviour in land processing for the common good; and ensure fire risk is a serious consideration when calculating land preparation costs.

Box 5.1. Legislation prohibiting the burning of land and forests

1. **Law No. 41/1999 on Forestry**

   Article 50 Paragraph (3) letter d – All persons are prohibited from burning forest

   Article 50 Paragraph (3) letter l – All persons are prohibited from discarding objects that can cause fires and damage, and endanger the existence or continuity of forest functions inside the forest estate.

   Article 78 Paragraph (3) – Any person intentionally violating the provision referred to in Article 50 paragraph (3) point d shall be subject to imprisonment for a maximum of 15 (fifteen) years and a maximum fine of IDR 5,000,000,000 (five billion rupiah).

   Article 78 Paragraph (4) – Any person who due to negligence violates the provision referred to in Article 50 paragraph (3) point d, shall be subject to imprisonment for a maximum of 5 (five) years and a maximum fine of IDR 1,500,000,000 (one billion five hundred million rupiah).

2. **Law No. 32/2009 on Environmental Protection and Management**

   Article 69 paragraph (1) letter h – All persons are prohibited from clearing land by burning.

   Article 108 – Any person burning land in contravention of Article 69 paragraph (1) letter h shall be subject to imprisonment for a minimum of 3 (three) years to a maximum of 10 (ten) years, and a minimum fine of IDR 3,000,000,000 (three billion rupiah) to a maximum fine of IDR 10,000,000,000 (ten billion rupiah).

3. **Law No. 39/2014 on Plantations**

   Article 56 Paragraph (1) – All Plantation Business Actors are prohibited from clearing and/or cultivating land by burning.

   Article 108 – Any Plantation Business Actor clearing and/or cultivating land by burning as referred to in Article 56 paragraph (1) shall be subject to imprisonment for a maximum of 10 (ten) years and a maximum fine of IDR 10,000,000,000 (ten billion rupiah).

Box 5.2. Fires on peatlands

Forest and land fires often occur on peatlands drained for crop cultivation. Drained peatlands have lower groundwater levels and extremely low soil moisture, making them highly fire prone during dry seasons. As peat is an accumulation of biomass, once it catches fire it is extremely difficult to extinguish given the abundance of fuel, and fires can smoulder below the surface of the ground. As peatland regions have become more accessible, communities, capital owners (*cukong*) and companies have cleared many such areas for new plantations, especially oil palm. Although classified as marginal land, peatlands are cultivated mostly because of a limited availability of mineral land, and land prices becoming increasingly expensive. The

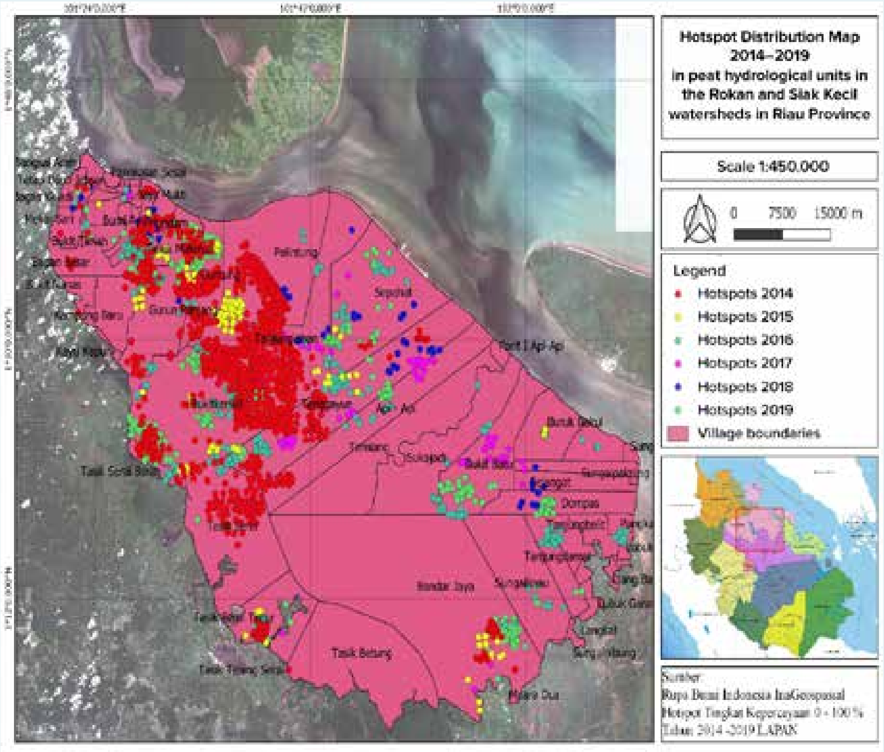

Figure 5.1. Hotspots in the Rokan–Siak Kecil rivers peat hydrological unit, 2014–2019

Source: Modis Sensor Data at 0–100% level of confidence processed by LAPAN[6]

6 http://modis-catalog.lapan.go.id/monitoring/hotspot/index (accessed 29 December 2019)

Continued to the next page

Box 5.2 continued

habit of communities and plantation companies to prepare land by burning is still widespread as it is cheaper than mechanical methods that use heavy machinery.

Riau Province has the largest expanse of peatlands in Sumatra at approximately 4 million hectares. One area subject to repeated fires is the Rokan–Siak Kecil rivers peat hydrological unit (KHG) in Bukit Batu District, Bengkalis Regency where Dompas Village is located. Forest and land fires occurred there every year during the 2014–2019 period, most notably in 2014, when 1,336 hotspots were recorded at confidence levels of 0–100%. Numbers of hotspots in 2018 and 2019, were eight and 17, respectively.

The most fire-prone months over the five years from 2024–2019 were during the first dry season in February and March and the second dry season from July to September, which constitute the months with the lowest rainfall in Riau.

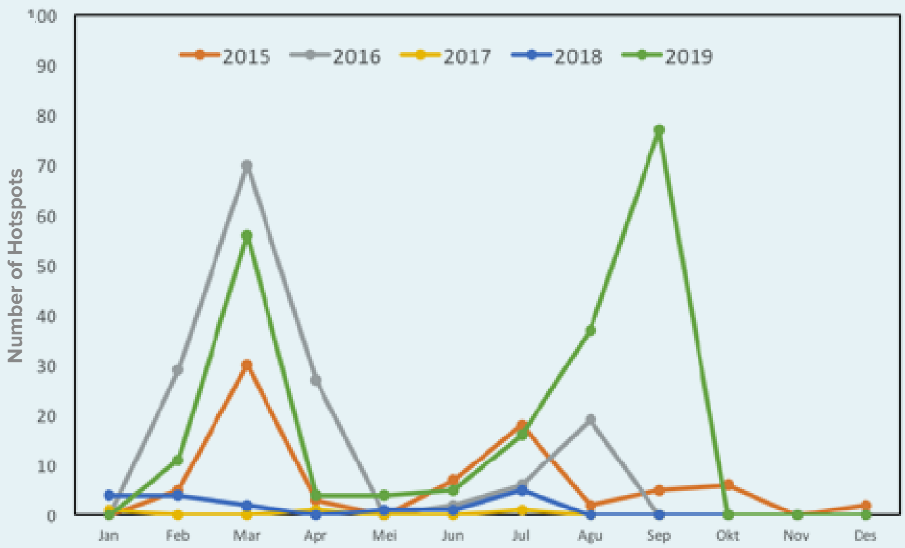

Figure 5.2. Hotspots in the Rokan–Siak Kecil rivers peat hydrological unit by month from 2014–2019

Source: Sensor Modis data at a more than 70% level of confidence processed by LAPAN[7]

7 http://modis-catalog.lapan.go.id/monitoring/hotspot/index (diakses 29 Desember 2019)

Zero-burning land preparation (PLTB) is part of the drive towards sustainable land management. As a technique for clearing land without using fire, PLTB can be practiced continuously for agriculture on peatlands without the need for a fallow period (Sunanto 2008). Practicing PLTB techniques will reduce subsidence and loss of carbon stock, and ultimately lead to peat conservation (Yulianti and Adji 2018).

Generally, PLTB activities can be grouped into preparation, slashing and felling, land clearing, waste utilization, tillage, land conservation and fire prevention stages. Tjahjono (1999) stated that PLTB involves slashing and felling, sorting and collecting, then utilizing logs to create products with economic value. Plant debris can be utilized for briquettes and activated charcoal. PLTB also necessitates using herbicides to eradicate weeds that grow after vegetation is cleared (Noor 2010).

5.1 ZERO-BURNING LAND PREPARATION (PLTB) METHODS

Switching from burning to zero-burning land preparation necessitates alternative methods acceptable to local communities. Broadly speaking, there are two PLTB methods: manual and mechanical, but the two can also be combined. According to Hendromono et al. (2007), land preparation methods are determined primarily by the original land cover type and growing requirements of the planned crop. Land cover type determines the technology, labour, time and costs required for land preparation. Land cover is classified according to the dominant vegetation type as dense forest, woody scrub or woodless scrub (ferns, grasses, reeds and broadleaf shrubs). Meanwhile, crop type determines conditions required for cultivation, such as the need for shade or direct sunlight, drainage or soil moisture levels, above and belowground space requirements, and the need for tillage or substrate treatment.

In addition, in choosing the appropriate PLTB method, it is necessary to consider the type of land and topographic conditions, available equipment and manpower, costs, and potential impacts on land and community conditions. The use of peatlands for crop cultivation requires regulating drainage in land preparation, considering that uncontrolled drainage will increase the threat of forest and land fires.

Slope gradient is another determining factor in choosing the appropriate PLTB method. Land clearing in areas with slope gradients below 15% can use tractors or bulldozers. Where slope gradients are between 16% and 20%, it is necessary to make paths by stacking debris along contour lines. Where slope gradients exceed 20% and erosion risk is significant, spraying with herbicides is more appropriate (Hendromono et al. 2007).

As a peatland restoration approach, land preparation needs to be peat friendly. In preparing land, it is important to consider the following principles: no burning; no peat draining; no heavy equipment; minimizing tree felling; minimizing fertilizer use; minimizing herbicide use; optimizing mulch utilization; optimizing plant spacing; optimizing tree cover; increasing land productivity; increasing farmers' earnings; and improving sustainability.

With the above principles in mind, three PLTB options are available (Table 5.1): manual (*tebas imas*); light mechanical; and heavy mechanical. Manual PLTB involves the use of machetes, axes and/or chainsaws for underbrushing, which can be done either thoroughly or partially depending on the following considerations: the characteristics of the crop to be cultivated; the planting system; equipment, labour and time considerations; and the size and condition of the land. Manual PLTB is highly labour intensive so can provide local employment.

Meanwhile, light mechanical PLTB requires hand tractors to clear vegetation. This method is only possible when the predominant land cover is grasses and ferns, there are few woody plants, and farmers have access to hand tractors. Heavy mechanical PLTB, which involves using excavators or bulldozers, is appropriate when the land to be cleared has many trees and stumps, and farmers have access to and the costs necessary for renting heavy machinery. Each method has advantages and disadvantages (Table 5.2), so choice will depend on the local situation and conditions.

Table 5.1. PLTB methods

No.	Method choice	Explanation
1	Manual	Cutting and slashing vegetation with machetes and axes (*tebas imas*) in combination with chainsaw use when land cover is woody vegetation comprising trees and shrubs, and farmers have no access to heavy machinery
2	Light mechanical	Clearing vegetation with hand tractors or mini tractors in combination with strimmers when land cover vegetation is predominantly grasses and ferns with no woody vegetation, and farmers have access to hand tractors
3	Heavy mechanical	Cleaning with heavy equipment (excavators and/or bulldozers) when the land has many trees, stumps and/or trunks, and farmers have access to and the costs required for heavy machinery rental

Table 5.2. Advantages and disadvantages of different PLTB methods

No.		Manual	Light mechanical	Heavy mechanical
1	Advantages	• Provides more employment • Creates a platform for communality • Maintains existing ecological systems	• Saves time and labour costs • Maintains existing ecological systems	• Saves time (and costs when on a large scale) • Clears and levels land more effectively
2	Disadvantages	• Requires more manpower • Is more time consuming • Poses problems with moving heavy materials	• Requires equipment that may not be available to local communities • Poses problems with moving heavy materials	• Requires equipment that is probably unaffordable for local communities • Requires suitable access roads for machinery • Has the potential to damage peat

5.2 MANUAL PLTB/*TEBAS IMAS*

To help communities with small-scale land preparation, this section describes the stages involved in underbrushing or *tebas imas*, which comprises felling trees, clearing scrub, stacking biomass, utilizing plant debris, controlling weeds, and making small reservoirs (*perigi*).

a. Felling trees

On land overgrown with trees, essential activities are felling and timber utilization. Trees can be felled selectively by species, size or position, or clear cut depending on the type of crop being cultivated. If integration with efforts to accelerate peat restoration is desired, then native species land cover can be maintained.

Figure 5.3. Land condition after selective tree felling, seen from above and at ground level

Trees can be felled using saws or chainsaws by trying to keep stumps as short as possible. The lower parts of trunks up to the first layer of branches can be used for sawn timber, while sections of trunks above the first layer of branches can be used as raw material for wood chips, pulp or particle board. Small branches and leaves can be chopped up and broken down to form compost. Roots and lower parts of trunks unsuitable for sawn timber can be used for firewood or making charcoal.

b. Clearing scrub

Woody scrub and undergrowth can be cleared by using machetes and strimmers. Clearing with a machete can avoid cutting the native species necessary for accelerating land rehabilitation or restoration.

Figure 5.4. Clearing scrub and herbaceous plants

Box 5.3. Woody vegetation on burned peatlands

Native coastal peatland tree species that have burned in Dompas include *leban* (*Vitex pubescens*), *chelate* (*Syzygium sp*.), figs (*Ficus sp.)*, *geronggang* (*Cratoxylon arborescens*) and *mensira* (*Ilex sp*.). The dominant woody shrubs are *tenggek burung* (*Euodia redleyi*) and *gelam* (*Melaleuca leucadendron*). To accelerate peatland restoration, these tree and woody shrub species should be left when clearing and preparing land.

c. **Stacking biomass**

Plant debris biomass from felling and clearing can be stacked up in pre-excavated trenches or '*jalur kotor*' to prepare clear flat pathways to facilitate planting and maintenance. When growing pineapple (Mores cultivars), for example, it is necessary to prepare trenches 25 m wide. Heavier debris is often stacked up with the help of heavy machinery, but this can cause peat subsidence, potentially leaving land vulnerable to flooding.

Plant litter biomass that cannot be utilized, such as small branches, twigs, leaves and bark, can be left *in situ*, chopped manually, then spread evenly across the planting site. This waste serves as mulch for the soil to supplement the remaining fern root networks referred to locally as '*akar ghambut*'. The mulch and *akar ghambut* will decompose and return nutrients to the soil. They also help to inhibit weed growth, and maintain soil moisture, soil temperature and microorganisms in creating conditions conducive to plant growth. On mineral soils, mulch can also reduce rainwater impact on the soil surface, thereby reducing erosion and increasing water absorption. Mulch and *akar ghambut* are lost when peatlands are cleared using heavy machinery, as they will be excavated and stacked in *jalur kotor* or removed from the area.

Figure 5.5. Biomass stacking in '*jalur kotor*'

Box 5.4. The importance of *akar ghambut* in protecting *tanah ghedang*

When growing Mores pineapples on peatland in Sungai Pakning Village in Bukit Batu Subdistrict, Javanese inmigrant farmers in Kampung Jawa Hamlet found that removing the 10 cm-thick layer of fern roots using heavy machinery resulted in peat moisture falling significantly. They now leave this residual root layer, which local people refer to as '*akar ghambut',* to maintain soil moisture and protect the '*tanah ghedang*' or peat layer beneath.

Mores pineapples are known to be quite adaptable and can grow well on acidic and nutrient-poor peatlands. According to the farmers in Sungai Pakning and others in Tanjung Layang Village in Siak Regency's Sungai Apit Subdistrict, Mores pineapples do not require fertilizer or dolomite application to improve growth on peat, though providing additional nitrogen (N) three and six months after planting can be beneficial when necessary.

d. Controlling weeds

Weed growth can be controlled by spraying herbicides prior to planting. A uniform covering of ferns, grasses, and broadleaf shrubs will normally emerge around 15–21 days after clearing, with growth rates depending on precipitation intensity. To make spraying more effective, herbicides can applied once an even covering of herbaceous plants has emerged. Weed eradication can be repeated to increase the weed mortality percentage. However, it is important to consider the environmental impacts of chemical use, as herbicides can trigger methane (CH_4) emissions from anaerobic decomposition of organic matter.

Box 5.5. Herbal growth during the first dry season

Riau Province has two dry seasons each year. The first, from February to March, is characterized by low rainfall and can result in large numbers of forest and land fires, especially on peatlands. In Dompas, this had the effect of slowing herbaceous growth and delaying the spraying schedules for the first and second applications of herbicides. The first was carried out in the second week of February 2019, 1.5 months after clearing, while the second took place in the third week of March. Herbaceous regrowth in Dompas predominantly comprised bracken (*Pteridium aquilinum*), giant swordfern (*Nephrolepis bisserata*), *paku miding (Stenochlaena palustris)*, swamp water fern (*Blechnum indicum*) and liana (*Uncaria acida*).

Figure 5.6. First herbicide application (1.5 months after clearing) and post-application conditions

Photos by the Dompas Fire Care Community (MPA) group

e. Stump removal

Stump decomposition can be accelerated by applying fungi such as *Trametes* sp. to hardwood species and *Pleurotus* sp. to softwood species. Stumps can also be removed using crowbars and chainsaws. Stump removal is intended to prevent the emergence of new roots, which can disrupt crop growth, and to facilitate routine crop maintenance. Removing stumps also provides space for cultivated crops to extend their roots, thereby resulting in healthy seedling growth in seasonal crops. It is not necessary to remove stumps when land is being prepared for perennial crops that do not require intensive maintenance.

Figure 5.7. Stump removal with a chainsaw, and land ready for planting

Figure 5.8. Using a *perigi* for monitoring groundwater levels and excavating a *perigi* using a mattock

f. Creating *perigi*

Ethnic Malay communities in Riau have a form of traditional local wisdom that can be utilized for anticipating fires on recently cleared land. They are accustomed to making small reservoirs, known locally as *perigi*, on the boundaries of their land. *Perigi* are shallow rectangular wells around two metres deep, and measuring approximately one metre by two metres. The size of a *perigi* can be modified to suit land conditions, groundwater level or any other requirements. Besides serving as land boundary markers, *perigi* are also beneficial in facilitating access to water on peatlands, which can be used for various purposes, including firefighting, and as effective groundwater monitoring sites.

5.3 LAND PREPARATION COST COMPARISON

PLTB activities can be costly (Table 5.3). Manual land preparation for pineapple cultivation in Dompas Village required expenditure of IDR 6,300,000 ha^{-1}. Costs should be lower when cultivating rubber, oil palm or similar plantation crops that require less intensive land preparation. Despite being more expensive, in the long run PLTB will provide many benefits including higher soil nutrient availability, wood waste and other waste that can be utilized to provide added value. In addition, PLTB is more environmentally friendly, does not cause haze, and does not have adverse social and economic impacts on health and transportation.

Table 5.3. Cost comparison for different land preparation methods

Cost (IDR)	Land preparation method		
	Burning	Heavy machinery	Manual clearing for pineapple plantations
Tools*	-	-	250,000
Fuel**	-	-	100,000
Chemicals***	-	-	700,000
Labour	-	-	4,750,000
Supervision	-	-	500,000
Total cost (IDR ha^{-1})	1,000,000	7,000,000	6,300,000
Total time (work days ha^{-1})	2–5	1–3	30–40

*) Machetes, sprayers and crowbars
**) Fuel for chainsaws used in stump excavation
***) Herbicides for weed control

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Lesson 6

Planting on peatlands

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6.1 PEATLAND RESTORATION

Revegetation is one of a number of approaches to peatland restoration. Through Minister of Environment and Forestry Regulation No. P.16/MENLHK/SETJEN/KUM.1/2/2017, the Government of Indonesia has provided technical guidelines for restoring the functions of peatland ecosystems. The regulation mentions numerous species by location and use, including woody plants, such as *meranti* (*Shorea pauciflora, Shorea tesmanniana*, *Shorea uliginosa), ramin* (*Gonystylus bancanus*) and agarwood (*Aquilaria* sp.), as well as food-producing plants including Kasturi mango (*Mangifera casturi*) and sago (*Metroxylon* spp.).

Participatory Action Research (PAR) on fire prevention and peat restoration was implemented through field trials focussing on Dompas Village in Bukit Batu Subdistrict, Bengkalis Regency, Riau Province. The outcomes of these trials were later disseminated to surrounding villages. Most of the Dompas Village administrative area constitutes a peatland ecosystem. The Ministry of Environment and Forestry (2017) defined such ecosystems as complete composites of accumulated peat elements that are mutually influential in forming balance, stability and productivity. To implement the 3Rs (Revegetation, Rewetting and Revitalization) approach to peatland restoration, the Center for International Forestry Research (CIFOR) and the University of Riau's Centre for Disaster Studies (PSB UNRI) facilitated trials in seven action arenas in Dompas on previously drained and fire prone peatlands. The 3Rs approach to peatland ecosystem restoration focusses on returning such areas as much as possible to their original state.

6.1.1 Phases of replanting

The phases involved in replanting the action arenas are shown in Figure 6.1 below. The reflection phase comprised a literature review and collection of baseline biophysical data. The subsequent planning phase involved a series of focus group discussions (FGDs) aimed at selecting tree species for planting. These discussions resulted in the community choosing *meranti*, agarwood, durian, coffee and mangosteen. Some of these species accord with those listed in Minister of Environment and Forestry Regulation No. P.16/MENLHK/SETJEN/KUM.1/2/2017 as being suited to biophysical conditions like those in Dompas. In addition to focussing on species selection, the FGDs also looked at developing business models for each chosen commodity. These business models are discussed in a separate chapter.

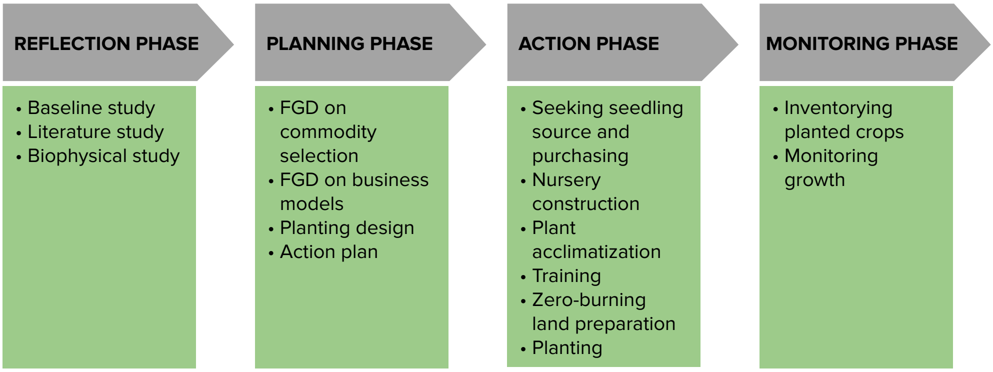

Figure 6.1. Phases of PAR in the context of replanting

6.1.2 Participatory construction of the Dompas nursery, and acclimatization processes

Nurseries are an essential element of peatland revegetation, and many rehabilitation programmes have failed due to an absence of any seedling acclimatization processes. To avoid the same mistake being repeated, the PAR process involved the construction of a nursery with a seedling house to accommodate and allow seedlings to acclimatize before any planting was undertaken. According to the Ministry of Agriculture's Horticultural Research and Development Centre, acclimatization is an important process in ensuring seedlings are conditioned and adjust gradually and optimally to local environmental conditions and microclimates to avoid plant stress.

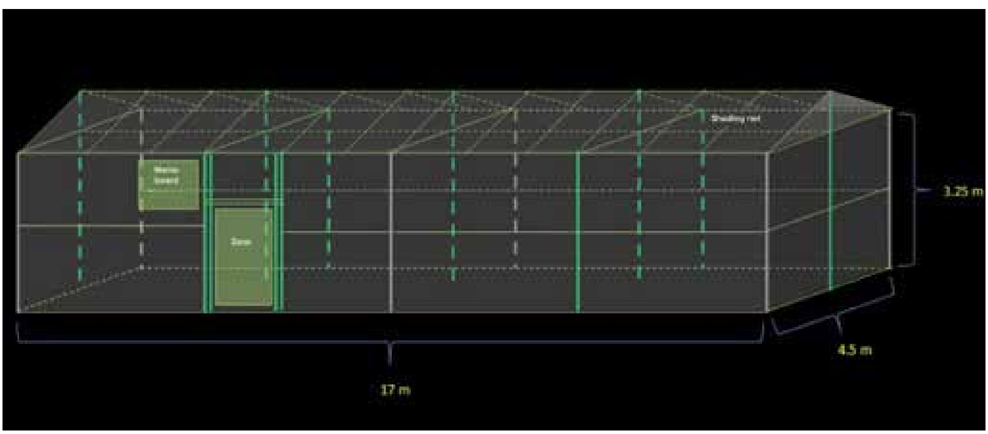

Figure 6.2. Seedling house design

The dimensions of the seedling house are 17 x 4.5 x 4 m (Figure 6.2). In addition to accommodating seedlings for replanting, the women's farmer group also uses the Dompas nursery for propagating horticultural crops, including chilies and watermelons for planting in home gardens.

It took five people nine days to construct the nursery seedling house. The construction process, which was carried out in a participatory manner, involved determining the design, dividing tasks, and collecting and preparing the necessary building materials (Box 6.1).

The nursery seedling house has played roles in:

1. Strengthening human and social capital by providing a space for Fire Care Community (MPA) and farmer group members as well as other villagers to propagate crops and exchange information, knowledge, experience and lessons learned;
2. Strengthening financial/economic capital by allowing the development of nursery enterprises as additional, long-term sources of income.

Box 6.1. Materials and design

The nursery seedling house made use of materials available in Dompas and surrounding villages. Uprights were made using a combination of lengths of *nibung (Oncosperma tigillarium)* wood and cement-filled 5-inch diameter PVC pipes. Villagers chose nibung for its strength and weather resistance, and because it is a tried and tested material for piles in raised houses on riverbanks and in peat swamps. The frame was made of 3-inch diameter lengths of bamboo, which was chosen for its flexibility, its capacity to withstand force, and its weight, to prevent unnecessary load on the building. It was also the more environmentally- and ecologically-friendly option as it is much more fast growing than wood-bearing trees, which take time to produce again after harvesting. Bamboo is also in abundant supply around Dompas, and is much cheaper than wood. Quantities of materials used in constructing the Dompas nursery seedling house are listed in Table 6.1.

continued to the next page

Box 6.1 continued

Table 6.1. Materials required for seedling house construction

No.	Material	Size	Diameter (inches)	Number
1	*Nibung*	5 m	5	12 lengths
2	Bamboo	3–4 m	3	24 lengths
3	Shade nets	1.2 x 50 m	-	2 rolls
4	PVC pipes	-	5	3 pipes
5	Cement	-	-	5 sacks
6	Sand	-	-	1 m^3
7	Gravel	-	-	1 m^3
8	Nail	-	-	5 kg
9	Water taps	-	-	2 pcs
10	Hose	10 m	-	1 pc

To reduce direct sunlight and prevent undue stress to plants, 25%–40% weave density shade nets (Paranet 60%–75%) were installed on the seedling house roof and walls. These nets, which are made of polyethylene and commonly used in nurseries for woody plants and some horticultural crops, keep out 60%–75% of direct sunlight so seedlings receive around only 25%–40%.[8] Two rolls of 120 cm by 50 m shade netting were required. Other materials used were three 1/2 inch PVC pipes, five sacks of cement, one cubic metre of sand, one cubic metre of gravel, five kilogrammes of nails, two water taps and a ten-metre hosepipe.

8 https://bibitbunga.com/mengenal-paranet-dan-fungsinya-untuk-tanaman/

6.1.3 Revegetation activities in Dompas action arenas

Revegetation in peatland ecosystems involves efforts to restore land cover, either by planting native species in peatlands earmarked for protection, or other species with economic value that are suited to wetlands in peatlands designated as having a cultivation function. According to the Peatland Restoration Agency (BRG), revegetation can be carried out by planting endemic species, species adaptable to peatland conditions, and through enrichment planting. In addition, seed dispersal techniques can be enhanced and applied.

Revegetation in Dompas was carried out in a participatory manner, with community groups managing the village's action arenas. Tree species having success and favourable survival rates in planting trials included *meranti*, agarwood, *geronggang*, mangosteen, durian, *chempedak*, *matoa* and coffee. Notes from the community groups' participatory planting activities in Dompas included:

1. Ensuring selected tree species have already grown in the village and can be used by the community;
2. Making sure seedlings are at least 70 cm tall, in good health (with no wilting leaves) and acclimatized to the local climate before planting;
3. Planting during the rainy season, but if it has to be done in the dry season then seedlings should be planted in shady areas and watered regularly. Alternatively, ferns or shrubs can be left for shade by clearing 50–100-cm-diameter circles around planting holes rather than being completely removed;
4. Ensuring soil is in a naturally moist state before digging planting holes if carried out during the dry season;
5. Observing planted seedlings intensively, watering them and clearing away any unwanted undergrowth to ensure optimum development.

6.1.3.1. Planting and maintenance stages based on lessons from Dompas

Planting on burned peatlands involved the following stages:

1. Digging 50-cm deep planting holes measuring 25 x 25 cm in predetermined locations with plant spacings of 3 x 5 m, 5 x 5 m and 5 x 10 m;
2. Applying compost or manure with added NPK, urea and potash into the planting holes;
3. Replacing dead, unhealthy or damaged seedlings 1–4 months after planting;
4. Applying fertilizer, ideally every two months for one year, comprising 80% compost or manure and 20% chemical fertilizers (NPK, urea and potash). In the second and third years, apply the same combination of fertilizers once every four months and six months, respectively.

6.1.3.2. Monitoring in the Dompas action arenas

To ensure successful revegetation, it was necessary to monitor each individual tree. In facilitating this, CIFOR developed a real-time digital information system for monitoring tree growth, determining numbers of trees planted and survival rates. Data on tree species and height were collected on a regular basis. The stages involved in tree monitoring and data collection included:

1. Marking (tagging) planted trees using pre-prepared labels with barcodes;
2. Scanning label barcodes on planted trees using Android-based devices;
3. Ensuring data had been recorded accurately, and immediately uploading data to the central server.

Advances in user-friendly technologies have greatly helped accelerate efforts to restore damaged peatland ecosystems. A more detailed explanation of monitoring processes is presented elsewhere in this book.

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6.2 GROWING LIBERICA COFFEE ON PEATLANDS

6.2.1 Liberica coffee's ability to adapt to peatlands

Liberica coffee (*Coffea liberica*) is known for its capacity to adapt to peat soils where arabica and robusta coffee cannot grow (Hulupi 2014). According to Gusfarina (2014), liberica coffee is also more tolerant to pests and diseases, and resistant to hot climates and high humidities. Further, liberica coffee crops do not require intensive horticultural practices in their maintenance.

6.2.2 Characteristics of liberica coffee

Liberica trees have thicker leaves, wider canopies, and larger fruits with thicker skins compared to both arabica and robusta coffee (Hulupi 2014). According to Nyoto,[9] due to this thickness of skin, liberica coffee cannot be processed manually, but can be stored for long periods of time. When ripe, its fruits can be red, orange, yellow or yellowish green.

Figure 6.3. Liberica coffee training and field practice on Atek's farmland in Action Arena 4

Photo: Pandam Nugroho Prasetyo/CIFOR

9 Personal communication, 7 May 2019

6.2.3 History of liberica coffee

According to Hulupi (2004), liberica coffee was originally introduced to Indonesia by the Dutch in the nineteenth century to replace arabica coffee crops that had been affected by the leaf rust (*Hemileia vastatrix)* fungus. It was planted on wetlands and peat swamps along the east coast of Sumatra from Jambi to Riau, and particularly on the islands of the Meranti.[10]

In its original planting sites, liberica coffee was commonly intercropped with other non-oil palm crops. Liberica coffee requires shade trees to reduce the intensity of sunlight on its leaf canopy, and does not grow well in open areas. It is not a water intensive species, so will not have an adverse effect on peat hydrological management.[11]

6.2.4 Liberica coffee in the action arenas

Action Arenas 4, 5 and 6 are peatlands where agroforestry or rubber agroforestry practices are being applied with combinations of tree and agricultural commodities (de Foresta et al. 2000). Most agroforestry, which can provide solutions in helping to overcome the problems of global warming and poverty, is practiced on dry land. However, it is sometimes practiced in wetlands, on both peatlands and tidal lands (Waluyo and Nurlia 2017).

Figure 6.4. Liberica coffee training and field practice site on Atek's farmland in Action Arena 4

Photo: Pandam Nugroho Prasetyo/CIFOR

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10 Media Indonesia. 2018. *Panen Kopi Liberika di Lahan Gambut*. Retrieved on 7 May 2019 https://mediaindonesia.com/read/detail/139631-panen-kopi-liberika-di-lahan-gambut

11 Yitno Suprapto. 2016. *Kopi Aroma Unik Ini Bersahabat dengan Lahan Gambut*. Retrieved on 7 May 2019 https://www.mongabay.co.id/2016/11/24/kopi-aroma-unik-ini-bersahabat-dengan-lahan-gambut/

One growing model that can provide social, economic and ecological benefits is coffee-based agroforestry. Filler trees in coffee-based agroforestry have economic impacts, and ecological impacts on coffee plants. Coffee grown under regulated numbers of shade trees can provide higher yields (Lisnawati et al. 2017).

6.2.5 Potential of liberica coffee

Liberica coffee is a flagship commodity in Meranti Islands Regency, where it is planted between coconut, areca nut and rubber trees. Liberica coffee has significant economic potential as consumers are acquiring a taste for it (Ardiyani 2014). It is not as bitter as robusta, and has a sour jackfruit aroma similar to arabica and chocolate.

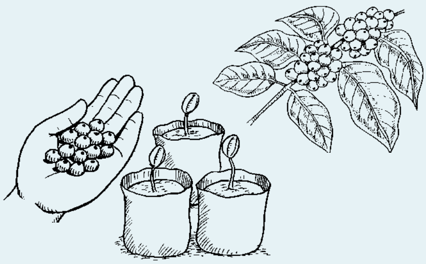
According to Nyoto,[12] one liberica coffee tree in the Meranti Islands can produce approximately 15–20 kg of fruits, which under ideal conditions can be harvested once every 20 days. Wet coffee fruit (cherry) prices in the region range from IDR 2,500–4,000 per kg. Hulled liberica coffee beans can fetch prices around IDR 30,000–40,000 higher than those for robusta coffee. In Malaysia, liberica coffee can fetch prices of IDR 48,800–51,200 (Martono et al. 2013). High quality dried green liberica coffee beans can be sold at prices of IDR 90,000–120,000 per kg. Prices can rise to IDR 200,000 per kg for roasted coffee beans, and higher still to IDR 250,000–270,000 per kg for ground coffee. Liberica luwak coffee can command fantastic prices of IDR 600,000 per kg for roasted beans, and IDR 1,100,000–1,300,000 per kg for ground coffee. These price increases are due in part to heavy shrinkage, with 50%–60% of weight lost from coffee fruit (cherry) to green beans, and a further 10%–15% lost in roasting.

In addition to favourable prices, liberica trees also higher yielding than their robusta counterparts because they can bear fruit throughout the year and be harvested monthly (Gusfarina 2014).

12 Personal communication, 7 May 2019

Overview of the stages involved in liberica coffee cultivation

Seedling selection

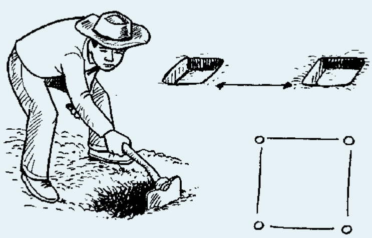


- For planting on peatlands, liberica coffee seedlings should be at least 70 cm tall before planting so they do not sink too far below the surface when planted.
- Ensure liberica coffee seeds come from certified or high quality parent stock.

Acclimatization

- Acclimatize liberica coffee seedlings in nurseries for around four weeks after they arrive on site.

Land preparation



- Mark out planting holes at distances of 2.5 x 2.5 m or 3 x 3 m apart depending on the position of plants/shade trees that have already been planted.
- Dig planting holes measuring around 40 x 40 cm.

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Planting

- Plant liberica coffee seeds that have already undergone the acclimatization process.
- Ensure there is adequate shade around the planted coffee seedlings.

Maintenance

- Apply liquid fertilizers around 3–4 times a year. The fertilizer composition should consist of 30 kg (1 sack) of cow manure mixed with 1 kg of potash (KCl) and 1 kg of urea, with EM4 dissolved in palm sugar added to activate bacteria and microorganisms in the EM4. Add the mix to a large 200-litre barrel filled 3/4 full of water. Then close and store for 2–3 weeks.
- Add around 15 ml of the fertilizer mix per litre of water, and apply regularly to each stem for the first four months after planting. Next, add around 30 ml per litre of water and apply regularly to each stem for the subsequent four months. Finally, add a maximum of 350 ml per litre of water and apply regularly for the third four months and beyond until trees are large.
- Conduct circle weeding as necessary to remove ferns, weeds or grasses from around the planted coffee trees.
- Liberica coffee requires clean sanitation, so ensure circles around the planted coffee trees are always kept free of unwanted undergrowth.

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Maintenance

- Prune trees when they reach heights of around 1.5–2 metres (at approximately one year old). Prune them to resemble the shape of an open umbrella.
- Water liberica coffee trees to suit weather conditions: once or twice a week when rainfall is low; once every one or two weeks when rainfall is moderate; and once a month when rainfall is high.

Harvesting

- At two years liberica coffee trees begin to bear their initial, poorly formed fruits. These initial fruits should be discarded.
- At two and a half years, trees begin to produce coffee cherries or mature fruits.
- Liberica coffee trees should be ready to harvest at around 2.5–3 years after planting.
- Bumper harvests occur every 4–5 months with a picking interval of once every two weeks.
- After harvesting, prune coffee trees, remove old branches and return them to heights of 1.5–2 metres.

6.2.6 Farm management

As there is no liberica coffee seed source in Dompas, seeds were brought in from the Meranti Islands, Meranti Regency and Parit I/II Village in Sungai Apit Subdistrict, Siak Regency, Riau Province. These seeds came from certified parent trees patented by the Ministry of Agriculture and the Ministry of Law and Human Rights under the name Kopi Meranti Liberika.

6.2.7 Farmer-to-farmer coffee training

Coffee training was held at local farmer Atek's home garden in Dompas on 27–29 January 2019, with the managers of Action Arenas 4, 5 and 6 in attendance. The training also involved a study visit to Misdi's liberica coffee plantation in Parit I/II Village in Siak Regency. The trainer, Rudi Hidayat, Secretary of the SAR'T (Sustainable, Accountability, Resources That Trust) Foundation, took a focus group approach to the training, with discussions, questions and answers, as well as practical implementation in the field and a comparative study. Materials included literature on liberica coffee cultivation, plantation management, planting, plant spacing, treatment, maintenance and harvesting.

6.2.8 References

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Lisnawati A, Lahjie AM, Simarangkir BDAS, Yusuf S, Ruslim Y. 2017. Agroforestry System Biodiversity of Arabica Coffee Cultivation in North Toraja District, South Sulawesi, Indonesia. *Biodiversitas* 18(2):741–751.

Waluyo EA and Nurlia A. 2017. *Potensi pengembangan kopi liberika (Coffea liberica): Pola agroforestry dan prospek pemasarannya untuk mendukung restorasi lahan gambut di Sumatera Selatan (belajar dari Kabupaten Tanjung Jabung Barat, Provinsi Jambi).* Proceedings from a national seminar on 19–20 October 2017 on development of agricultural science and technology with local farmers for the optimization of sub-optimum land. pp. 255–264. Palembang, Indonesia: Sriwijaya University Center of Excellence for Research and Development of Suboptimum Land (PUR-PLSO).

6.3 PINEAPPLE CULTIVATION ON PEATLANDS

6.3.1 Peatland restoration through pineapple cultivation

Restoration of damaged peatlands through pineapple cultivation has been practiced in several regions in Sumatra. The Peatland Restoration Agency (BRG) is encouraging pineapple cultivation on peatlands in Pagaruyung Village, Kampar Regency,[13] while CIFOR has been working with PSB UNRI to facilitate pineapple agroforestry on a total area of seven hectares in Action Arenas 2 and 3 in Dompas Village, Bengkalis Regency in the context of the Participatory Action Research (PAR) on Community-based Fire Prevention and Peatland Restoration project. During the PAR planning phase, the action arena managers created pineapple agroforestry business models. Pineapple cultivation training was then held on 10 March 2019 as part of the subsequent PAR action phase. This training commenced with the provision of materials and a focus group discussion in the Dompas Village office, and continued with pineapple planting and further discussions in the field. The resource person during this training was Syamsul Hadi, a pineapple farmer and BRG facilitator from Sungai Apit Subdistrict in Siak Regency. The training was followed up with pineapple and tree planting in Action Arenas 2 and 3.

CIFOR research (Ilham et al. 2019) shows pineapple being one of a number of productive, profitable and peat-friendly commodities together with areca nut, fish and wild honey. The research recommends carrying out pineapple cultivation on peatlands though agroforestry systems by applying best practices in land preparation, propagation and planting to strengthen social, human and financial capital.

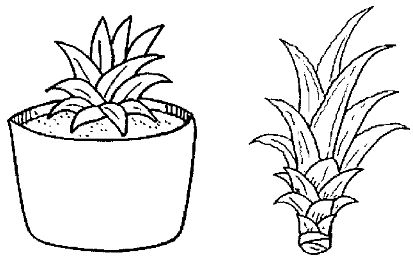
13 https://www.cendananews.com/2019/04/budidaya-nanas-di-lahan-gambut-riau-membuahkan-hasil.html

6.3.2 Pineapple cultivation

A. Seedling selection

Pineapple seedlings should be carefully selected before planting, and unhealthy seedlings disposed of. Seedlings should also be selected by size and origin (Hadiati and Indriyani 2008). According to the Ministry of Agriculture Cyber Extension, seedlings can take the form of crowns, stem buds or root buds. Features of good seedlings include:

- Being derived from normal, healthy parent plants;
- Being uniform or coming from one type of source. For example, do not mix seedlings from root buds with seedlings from crowns.

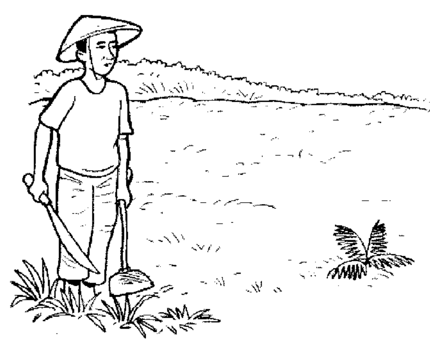


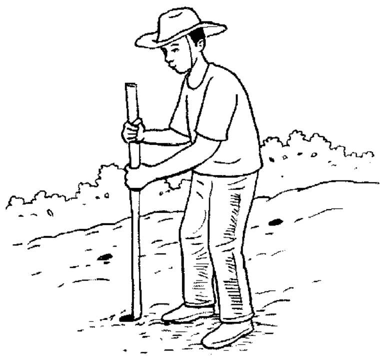
Seedling selection

B. Land preparation and planting

Peatland should be prepared by avoiding the use of fire and heavy equipment, because both can damage peat. In the PAR, land for pineapple cultivation was prepared manually by clearing shrubs and tree stumps, which have the potential to interfere with plant growth, through a process known locally as *tebas imas.* Fields were then sprayed with herbicides to eradicate weeds, after which planting paths were made following one-row or two-row planting designs. According to Hadiati and Indriyani (2008), distances between such paths can be set at around 80–100 cm, with distances between pineapples being 35–50 cm (Figure 6.5). In agroforestry systems, as plant spacings need to be adjusted to tree planting plans, plant spacing for pineapples in the PAR in Dompas was set at 70 cm, with paths set 100 cm apart.

Zero-burning land clearing by *tebas imas*





Making planting holes

Planting pineapples

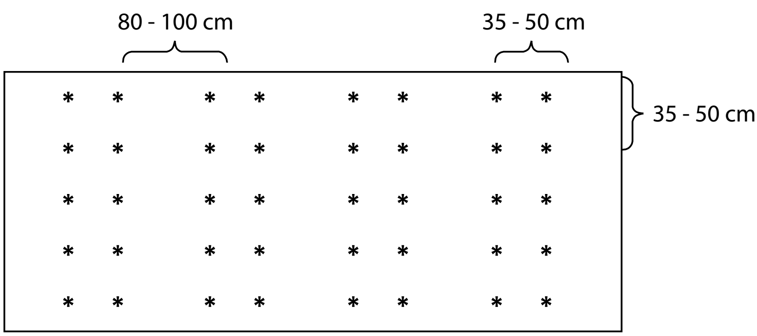


Figure 6.5. A two-row pineapple planting design based on Hadiati and Indriyani (2008). For the PAR in Dompas, plant spacing was set at 70 cm with one-metre-wide paths running between planting rows

According to Hadiati and Indriyani (2008) and the Ministry of Agriculture Cyber Extension (2010), pineapple seedlings should be planted at depths of 5–10 cm depending on the size of the class, or the length of the seedling. To prevent seedlings falling over, the soil around stem bases should be compacted. Then, the crop should be watered until the soil is wet.

C. Maintenance (fertilizer application, weeding, thinning and watering)

1. Fertilizer application

In general, there are two types of fertilizer applications for pineapple crops: base fertilizer and follow-up fertilizer applications. Doses will depend on plant needs and land conditions (Hadiati and Indriyani 2008). Table 6.2 provides a summary of base and follow-up fertilizer applications for pineapple cultivation.

2. Thinning

Large healthy pineapple fruits can be produced by thinning pineapple suckers, leaving a maximum of two suckers in each clump (Hadiati and Indriyani 2008).

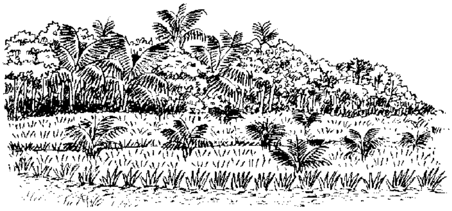
3. Weeding

For maximum yields, pineapple plots should be weeded to become completely weed free. Weeding can be carried out periodically (2–4 times at the time of planting), and to coincide with thinning.[14]

4. Watering

Hadiati and Indriyani (2008) stress the importance of watering pineapple crops until plants are 1–2 months old. If soil conditions are too dry, growth will be slow and fruit yields small. Watering should be carried out at least once a week, especially during the dry season. Once plants are fully grown, watering once every two weeks is sufficient.[15]

Fertilizer application



Thinning

Weeding

Watering

14 http://cybex.pertanian.go.id/artikel/17469/budidaya-nanas/

15 https://www.infoagribisnis.com/2015/06/budidaya-nanas/

Table 6.2. Fertilizer applications on pineapple crops*

Types of fertilizers	Fertilizer dosage per hectare	Fertilizer application time
Base fertilizer of manure	10 tons	After planting
First follow-up fertilizer: • Urea • Copper sulphate ($CuSO_4$)	 300 kg 5–10 kg	 2–3 months after planting
Second follow-up fertilizer: • Urea • Copper sulphate ($CuSO_4$) • TSP • Potash (KCl)	 300 kg 5–10 kg Adjust to requirements Adjust to requirements	 5–6 months after planting
Third follow-up fertilizer (for larger stems): • Etrel/ZPT (plant growth regulator) • Urea	 150 ml 100 kg	 9–10 months after planting
Fourth follow-up fertilizer (for larger fruits): • Urea • Copper sulphate ($CuSO_4$) • Potash (KCl)	 250 kg 5 kg 250 kg	 11–12 months after planting, indicated by the emergence of pistils/pineapple fruits

*Fertilizer doses obtained from literature and pineapple training resource persons

Table 6.3. Estimated pineapple harvest times

Types of seedlings	Harvest Time
Seedlings from stem buds	18 months after planting
Seedlings from suckers	15–18 months after planting
Seedlings from crowns	24 months after planting

5. Harvesting

According to Hadiati and Indriyani (2008), pineapple harvest times vary depending on the variety and seeds used. Table 6.3 provides estimated harvest times by seedling type. Characteristics of pineapples that are ready for harvest, according to Hadiati and Indriyani (2008) are as follows:

- Crowns are more open
- Fruit stalks are wrinkled
- Pineapple eyes are flatter and rounder in shape,
- The skin at the base of the fruit begins to turn yellow
- A pineapple aroma begins to be apparent.

Harvesting

Once the above characteristics appear, choose pineapple fruits that are ready for harvesting, make diagonal cuts at the bases of their stalks, and place cut pineapples in the shade so they do not wither.

6.5.1 References

Ministry of Agriculture *Cyber Extension*. 2010. *Budidaya nanas*. Retrieved 5 May 2019. http://cybex.pertanian.go.id/artikel/17469/budidaya-nenas/

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6.6 HYBRID COCONUT CULTIVATION ON PEATLANDS[16]

The Participatory Action Research on Community-based Fire Prevention and Peatland Restoration project in Dompas Village involved many activities focussing not only on action arenas, but also on revitalizing the community economy by planting hybrid coconuts in all villagers' home gardens.

Community members opted for planting hybrid coconut in interviews and integrated discussions on what crops they wanted to plant. Of the 351 people interviewed from the eight neighbourhoods in Murni and Lestari hamlets in Dompas, 311 were interested in planting hybrid coconut. Interested villagers joined a special training session on hybrid coconut cultivation given by Joko Paryanto from the *Usaha Pembibitan Hijau Tani* nursery in Siak and Tarsono from *Yayasan Bina Cinta Alam Siak* in the Dompas Village Office on 18 December 2018. As part of the session, 38 community members participated in practical field training on best practices for hybrid coconut cultivation.

16 By: Pandam Nugroho Prasetyo, Joko Paryanto, Tarsono, dan Herry Purnomo.

Hybrid coconut seedlings were distributed to the first batch of villagers three weeks after training once they had prepared 40 x 40 cm planting holes and added manure or organic fertilizer mixed with SP36 in line with training guidelines. Seedlings were distributed in stages to different neighbourhoods once the previous ones had finished planting, and the subsequent ones had prepared planting holes. This process was intended to encourage the community to be disciplined in running the programme in a sustainable manner.

Hybrid coconut

6.6.1 Hybrid coconut at a glance

Hybrid coconut (*Cocos nucifera*) is a cross between a *genjah* female parent and *kelapa dalam* male parent that results in an improved variety with superior traits from both parents that can bear more fruit and enhance community earnings.

6.6.2 Advantages of hybrid coconut

Hybrid coconuts generally have shorter stems than most varieties. Advantages over other varieties include their ability to adapt well to peatlands. They are also fast growing and highly productive, starting to bear fruit three years after planting with around 5–7 coconuts per bunch. By 4–5 years after planting they can produce 10–20 coconuts per bunch. Hybrid coconut fruits are quite large – similar to *kelapa dalam* – with thick, relatively hard flesh and high oil content.[17]

17 https://benuamesin.com/keunggulan-bibit-kelapa-hibrida/

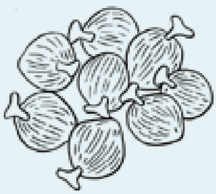
6.6.3 Growing hybrid coconut

Hybrid coconut seedlings were brought in from Medan in North Sumatra and Indragiri Hilir Regency in Riau Province with the help of the *Usaha Pembibitan Hijau Tani* nursery enterprise in Benteng Hilir Village, Siak Regency.

Steps involved in growing hybrid coconut on a household scale based on the experiences of farmers in Siak Regency are outlined below.

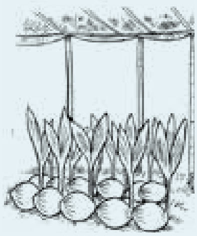
Seedling selection and acclimatization

- **Seedling selection**



Deformed or damaged seedlings

- **Acclimatization**



Parent trees

- Ensure parent trees are around 20–40 years old.
- Good quality trees bear fruit continuously throughout the year, are pest and disease free, and have even open umbrella shaped crowns.

Characteristics of good fruits for use as seedlings

- Round or nearly round and whole (not deformed)
- Of medium size and length (22–25 cm long and 17–20 cm across)
- Ripe with a smooth outer skin (not deformed, diseased or pest ridden)

Acclimatization

Hybrid coconut seedlings should be acclimatized to the local environment in nurseries for approximately 3–4 weeks after arriving on site.

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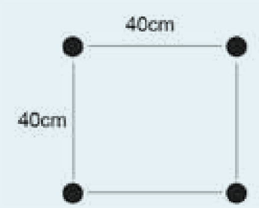
Box continued

Land preparation



Pre-fertilized planting hole

Land preparation

- Prepare planting holes measuring 40 x 40 cm, then fill the holes with manure or organic fertilizer and leave to ferment for 3–4 weeks.
- Adjust planting hole depths to seedling size (usually around 20–30 cm deep).
- Ensure circles around the planting holes are free of weeds and wild grasses.

Planting

Planting

- Plant hybrid coconut seedlings in upright positions and ensure they are exposed to sufficient sunlight.
- Ensure seedlings are not buried too deeply as growing stems should be above the surface to facilitate optimum growth. Ideally, around 1/3 of the hybrid coconut fruit should be visible.

Continued to the next page

Box continued

Maintenance

- **Watering**

- **Weeding**

- **Pest and disease eradication**

Watering

- Water as necessary, and daily during the dry season. Water volumes depend on seedling age, as the older they get, the more water they require. Average water requirement for the first six months after planting is 1/2–3 litres day^{-1} seedling^{-1}.

Weeding

- Clear grass and weeds from circles around the bases of planted seedlings and loosen soil if it is too hard (for clay soils).

Pest and disease eradication

- Spray with insecticides and fungicides if plants are affected by pests or disease.

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Box continued

Maintenance

- **Fertilizer application**

Fertilizer application

- Apply fertilizer around one month after planting by adding urea at a dose of 100 g per tree. A subsequent application of a straight fertilizer such as SP36 should only be given a year after planting, and followed up three months later with a 250 g dose of potash (KCl). These subsequent applications should be to circles around stem bases rather than directly to plants.

- **Harvesting**

Harvesting and pruning

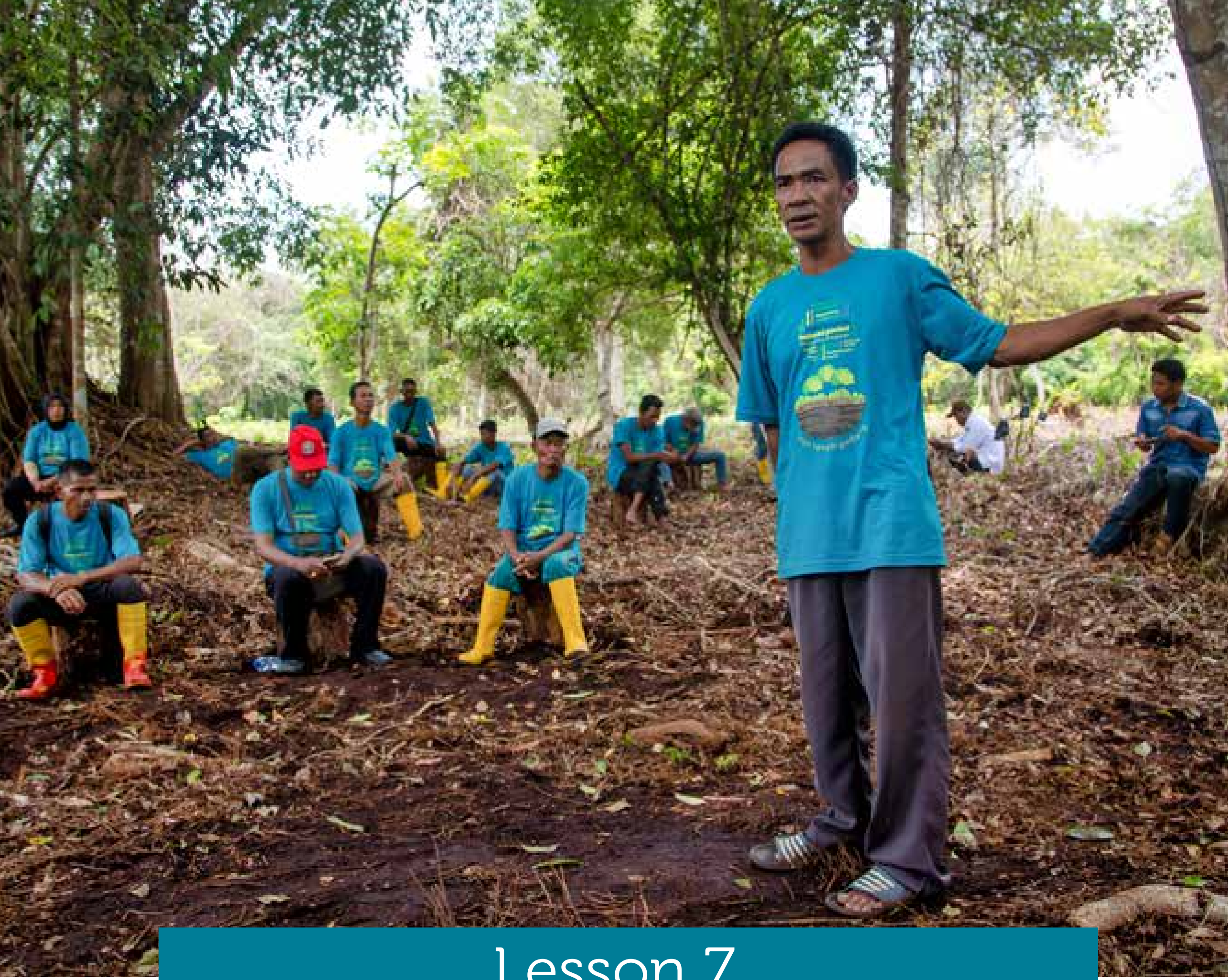
- Hybrid coconut palms begin to bear fruit after three years, and can be harvested from four to five years after planting.
- Pruning involves removing old coconut fronds.

6.6.4 Reference

South Sulawesi Provincial Plantations Office. 2019. Budidaya Kelapa Hibrida. Accessed 5 May 2019. http://www.ternakku.net/2016/10/Budidaya-Kelapa-Hibrida.html

Disclaimer:

These guidelines on cultivating liberica coffee, pineapple and hybrid coconut were prepared for the Participatory Action Research on Community-based Fire Prevention and Peat Restoration project conducted in Dompas Village, Bukit Batu District, Bengkalis Regency, Riau Province from 2018 to 2019. The information provided was sourced from literature and resource persons involved in cultivation training in Dompas, and is suited to peatland conditions in the village. Cultivation in other regions may require different techniques depending on land suitability and other prerequisite conditions.



Lesson 7

Strengthening fire care community groups

Lessons from Participatory Action Research

Agus Andrianto, Heru Komarudin, Dyah Puspitaloka, Rozi, Deden Djaenudin and Aenunaim

7.1 BACKGROUND

The forest and land fire prevention and management paradigm in Indonesia has undergone significant changes to become more comprehensive and strategic in direction. These changes began after devastating fires in 2015 led to a realization among stakeholders that forest and land fires could not be solved by reactive suppression, and that more attention to prevention was essential.[20] Fires cannot be contained by agencies alone, so the involvement of a wider range of stakeholders, including local communities, is a determining factor in effective fire prevention and response.[21] The important strategic role of communities was reflected in a 2015 Presidential Instruction[22] mandating the establishment and empowerment of village Fire Care Community or *Masyarakat Peduli Api* (MPA) groups. Currently, there are 704 such groups with 10,569 members across 28 provinces.

The aim of the MPA initiative, which came from the Ministry of Environment and Forestry and regional governments in fire affected areas, was to build community-based institutions to help prevent, mitigate and tackle forest and land fires. However, MPAs still face numerous obstacles to achieving these goals, including weak capacity to organize and build collective action; lack of understanding among task force volunteers; limited facilities, infrastructure and financial support; and lack of cooperation between different stakeholders. Various studies in Riau have shown MPAs' roles in preventing and suppressing forest and land fires still being hampered by relationships between MPAs and local governments (Meiwanda 2016); fire management methods (Evayanti and Zulkarnaini 2014); and lack of effective communications and early warning systems (Badri et al. 2018).

Despite commitments to strengthening MPAs, approaches being taken are not conducive to achieving targets, and not enough attention is being paid to actual conditions and needs, including dynamics within communities. Therefore, a guide developed from lessons learned and direct experiences of community groups was required. This chapter provides a useful step-by-step guide for MPAs in meeting technical, procedural and administrative requirements, which, in turn, will empower them address problems appropriately to suit local characteristics and conditions.

20 http://cifor.org/fire-and-peatland-restoration/

21 National coordination meetings on controlling forest and land fires

22 Presidential Instruction No. 11/2015 on Improvement of Forest and Land Fire Control

7.2 STRENGTHENING FIRE CARE COMMUNITIES: LESSONS FROM ACTION RESEARCH

Community institutional empowerment involves efforts to give power or strength to communities. It is defined as the ability of individuals to bond with communities to empower them with the aim of finding new alternatives in community development (Mardikanto 2014). Strengthening MPAs is a vital step in better preparing communities to play a more active role in tackling forest and land fires. Doing so is important because the fire problem cannot be solved by government agency or company resources alone. The highly dispersed locations of forest and land fires in conservation areas, plantation concessions and community-managed land complicates effective suppression. This is exacerbated by climate conditions, piled up dry biomass, and hydrological conditions making land more fire prone. Consequently, cross-sectoral collaboration and participation of stakeholders, including communities, are essential for handling forest and land fires.

This lesson was compiled based on participatory action research (PAR) conducted with six MPAs in Bukit Batu and Siak Kecil Subdistrict, Bengkalis Regency, Riau Province. Analyses of focus group discussion and interview outcomes showed MPAs performing quite differently, and numerous obstacles preventing these community groups from achieving their goals. The results of discussions with national and regional stakeholders, including the Directorate General of Climate Change Control, Directorate of Forest and Land Fire Control, Siak Operational Area Fire Command (*Manggala Agni Daops Siak*), Bengkalis Regency Peatland Restoration Agency (KPH), Siak Regency Environment Agency and Bengkalis Regency Fire Brigade, show that various improvements need to be made to strengthen MPAs to enable them to achieve the objectives they are mandated with and answer current and very real demands.

MPAs are required to work actively, voluntarily and responsibly. Marnelly (2018) listed three categories of problems MPAs often face: work environment constraints, relating to work safety; community environmental constraints, relating to the lack of community participation in suppressing land fires; and natural environmental constraints, relating to the difficulty of extinguishing fires on peatlands.

Figure 7.1. Illustration of burning peatlands

7.2.1 Objectives

Given the above, this chapter was prepared with the aim of helping to identify and solve the technical, procedural and administrative problems constraining MPAs that result in them being less effective in performing their mandated roles. With issues identified and options available to address them, relevant stakeholders can better address problems and strengthen MPAs appropriately. Specifically, this chapter discusses:

1. Definitions and roles of MPAs in accordance with expected objectives
2. Detailed descriptions of MPA functions and structures, and the roles of partner institutions
3. Guidelines on work, activity reporting and financial accountability
4. Guidelines on monitoring and patrolling
5. Strengthening MPAs

7.2.2 An overview of MPAs in Bukit Batu and Siak Kecil subdistricts in Bengkalis Regency

MPAs in Dompas, Sejangat, Sukajadi, Tanjung Belit, Buruk Bakul villages and Sungai Pakning Ward each have seven to 15 members, with memberships established through village government decrees. In performing their duties, these MPAs are supported to varying degrees by equipment, facilities and operational funds. Groups' equipment, facilities and operational funds can come from external sources and/or through self-reliance. Operational funds, for example, come from village budgets, with amounts ranging from IDR 10,000,000 to 16,000,000 per year depending on the level of fire vulnerability. Some villages directly bordering company concessions receive additional incentives of IDR 80,000 per day for members who conduct patrols and submit fire prevention reports. In addition to being used for carrying out routine patrols, these operational funds are also used for tackling fire occurrences.

Figure 7.2. A fire-prone area in Dompas
Photo: D. Puspitaloka/CIFOR

MPAs in the five villages and one ward have categorized lands with a history of recurrent fires and vacant land overgrown with scrub (Figure 7.2) as fire-prone areas (Figures 7.3 to 7.8). These areas are prioritized for forest and land fire prevention patrols. During long dry seasons, the MPAs increase preparedness through more frequent fire prevention patrols. Once peatland fires have started, however, the time it takes for MPAs to extinguish them will depend on how thick and degraded the peat is. With longer and more frequent fires, operational funds are often insufficient, and can be exhausted when large numbers of firefighters are needed. Consequently, MPAs need to be strengthened and directed towards independence through support programmes that can empower them to create and implement different business models, as discussed in a separate chapter. One state-owned enterprise has implemented empowerment programmes in Sejangat Village and Sungai Pakning Ward, but using a top-down approach and non-intensive mentoring. In Sukajadi Village, meanwhile, the MPA has carried out empowerment activities on its own initiative, but unfortunately it has had no intensive facilitation. To date, the MPA in Dompas has been the only direct beneficiary of field trials conducted through participatory action research with a bottom-up approach and intensive mentoring.

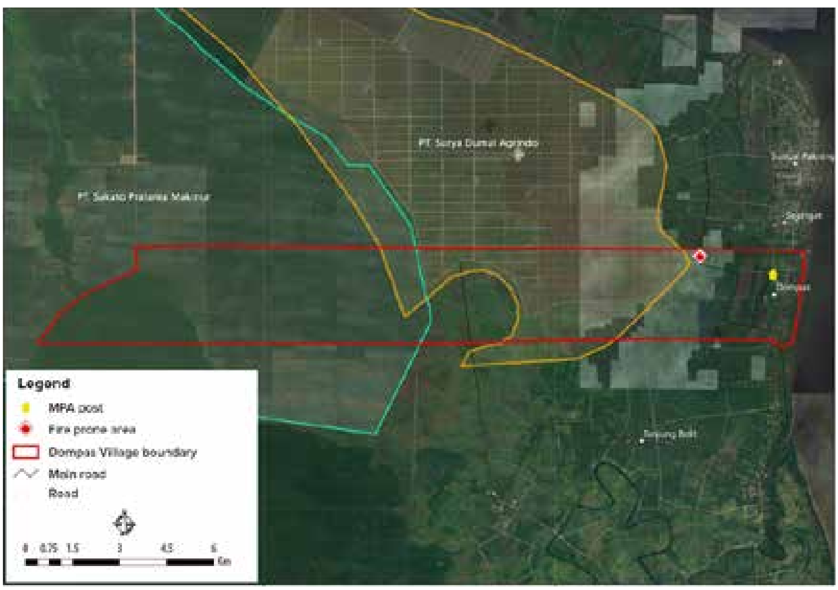


Figure 7.3. Map showing fire-prone areas in Dompas Village

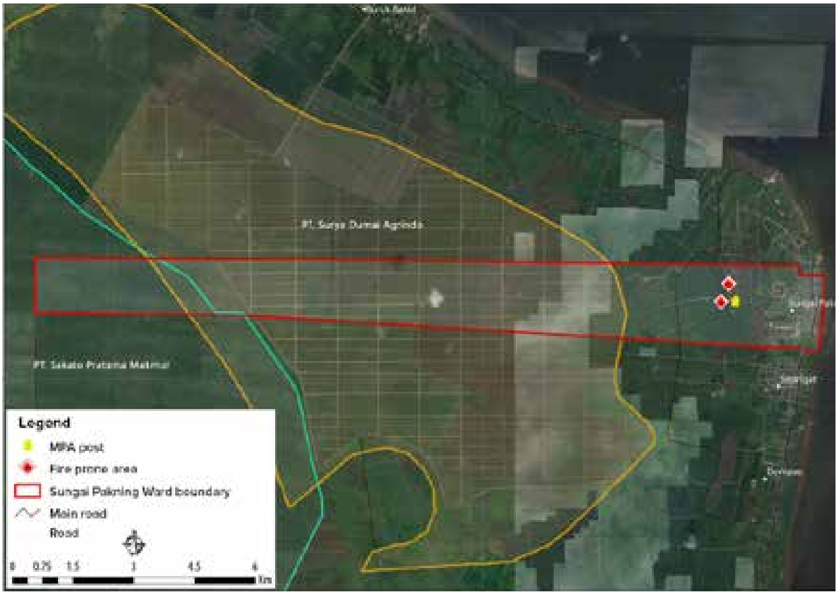


Figure 7.4. Map showing fire-prone areas in Sungai Pakning Ward

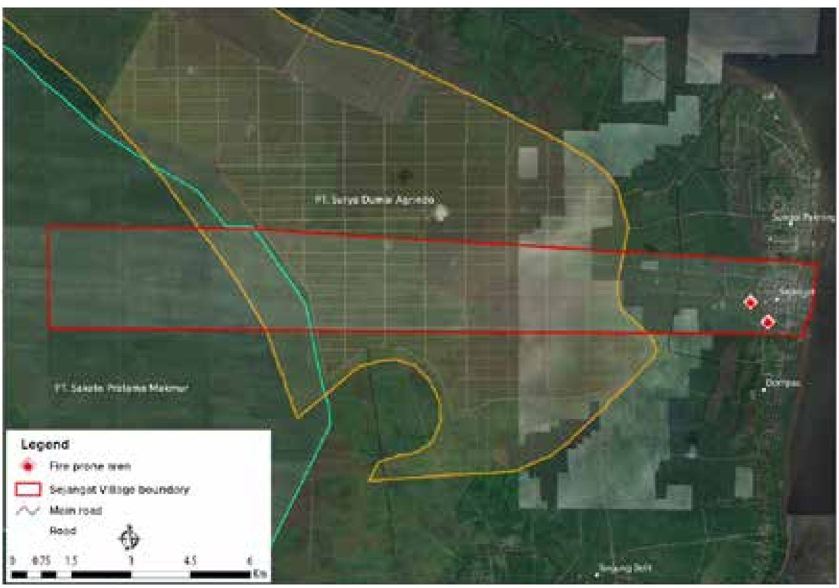


Figure 7.5. Map showing fire-prone areas in Sejangat Village

Figure 7.6. Map showing fire-prone areas in Sukajadi Village

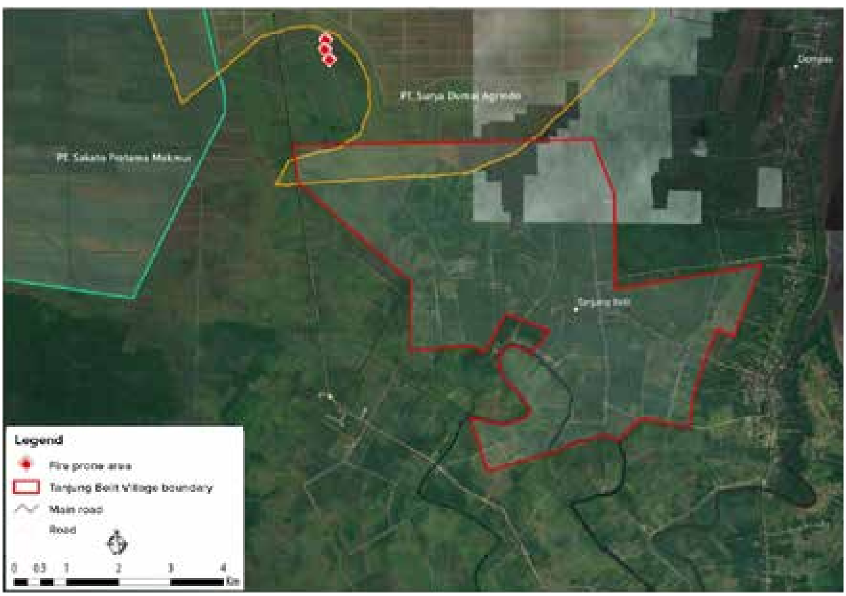


Figure 7.7. Map showing fire-prone areas in Tanjung Belit Village

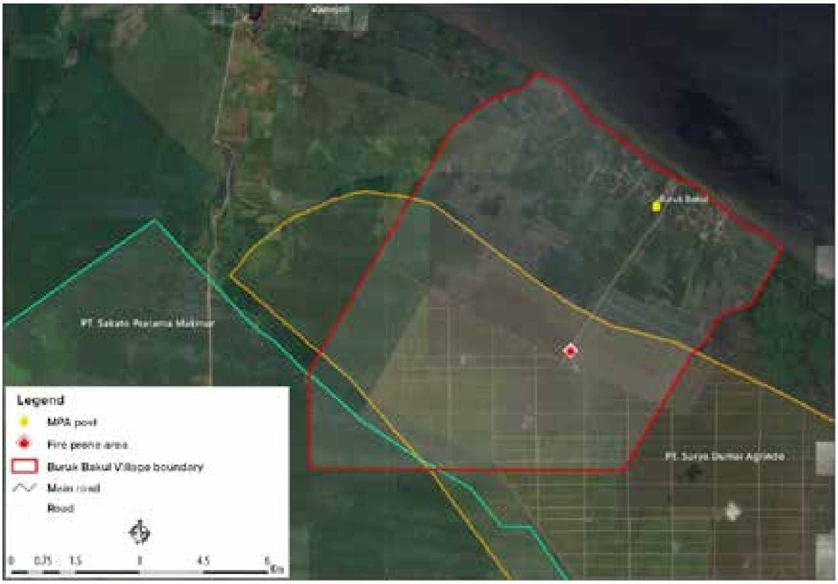


Figure 7.8. Map showing fire-prone areas in Buruk Bakul Village

7.2.3 Definition, requirements for establishment, organizational structure and roles of MPAs

Director General of Forest Protection and Nature Conservation Regulation No. P.2/IV-SET/2014 defines fire care communities or *Masyarakat Peduli Api* (MPA) as community volunteer groups concerned about forest and land fires that are trained/briefed and can be empowered to assist in forest and land fire control.

Establishing an MPA begins with the head of the local Forest Management Unit or *Kesatuan Pengelolaan Hutan* (KPH) determining a target village that borders a fire-prone area of forest estate. The MPA is then set up through stages of planning, ensuring necessary requirements are met, training/equipping and establishment. The planning stage starts with awareness raising and promotion in the target community to determine prospective MPA members. To be eligible to join an MPA, candidates must meet certain requirements, register as volunteers and participate in fire control briefings. The director general regulation recommends MPAs consisting of at least two teams, each with 15 members. Once requirements have been met, a facilitator from the Directorate of Forest and Land Fire Control Technical Implementation Unit or *Unit Pelaksana Teknis* (UPT), or a related institution will brief MPA members, provide them with membership cards and training certificates, and issue a Joint UPT Head, KPH Head and Subdistrict Head Decree formalizing MPA establishment. The MPA is then based in the village and receives funding from the APBDes village budget.

Each MPA has an organizational structure with the following positions and associated tasks and responsibilities:

- MPA Chair : Carries out planning, organizing, operational tasks, supervision and assessment of village land and forest fire control efforts
- Secretary : Manages administrative and secretarial matters
- Treasurer : Manages financial administration
- Team Leaders : Perform operational tasks in forest and land fire control

The tasks of village-based MPAs were originally stipulated by Minister of Forestry Regulation No. P.12/Menhut-II/2009 on Forest Fire Control. These were then regulated in more detail by Director General of Forest Protection and Nature Conservation Regulation No. P.2/IV-SET/2014, which stipulated MPAs as volunteer groups that receive continuous and full support from various parties to perform land and forest fire control operational activities under the planning and authority of the Manggala Agni Fire Command, KPH or subdistrict government.

However, after five years of implementation, it had become clear that the regulation's original assumptions were not working, and that to perform their functions effectively, MPAs would need to be empowered, and their capacity enhanced.

As forest and land fire problems and coordinating their management have become increasing complex, MPAs are now expected to have the capacity to:

1. Conduct prevention and early suppression efforts by:
   - Identifying fire-prone areas
   - Monitoring and maintaining canal blocks
   - Planning and building artesian wells for rewetting and water supply
   - Monitoring and maintaining water levels in canals
   - Planning and creating fire breaks
   - Conducting routine patrols.
2. Carry out efforts to mitigate the impacts of fires in their village areas by:
   - Extinguishing any fires that occur
   - Coordinating with relevant parties to extinguish fires.

3. Conduct rescue operations in fire emergencies and help other MPAs as necessary by:
   - Planning actions to prevent fires from spreading
   - Helping MPAs in other villages with firefighting
   - Supporting the Manggala Agni Fire Command in extinguishing forest fires.
4. Cooperate and coordinate with other agencies and institutions, such as MPAs from other villages, fire brigades, the regional environment office, KPH, and disaster management agency, and the Manggala Agni Fire Command.
5. Help with conducting research and developing science and technologies relating to fire
6. Help develop mapping information using GPS and the internet by:
   - Collecting hydrological data
   - Collecting plant data
   - Collecting fire data.
7. Organize community education and training programmes by:
   - Raising awareness about fire prevention through zero-burning land clearing
   - Recruiting volunteers at the village level
   - Refreshing fellow MPA members.
8. Facilitate the establishment of relevant village regulations and promote them to the community.
9. Manage and raise funds for MPA operational costs by:
   - Managing and reporting on funds sourced from the APBDes village budget
   - Seeking operational fund assistance from sponsors
   - Raising MPA funds through independent enterprises.

7.2.4 Towards empowered MPAs

Participants in a focus group discussion (FGD) involving MPAs from five villages and one ward in Bukit Batu and Siak Kecil subdistricts and representatives from the Siak Operational Area Manggala Agni Fire Command, defined ‘empowered’ as meaning each element of the MPA structure having the capacity to perform its functions to the optimum degree. To achieve this, MPAs’ roles and duties were described together in detail, and standard operating procedures (SOPs) were developed for guiding forest and land fire prevention and suppression, and organizing administration and reporting.

a. Roles and duties

1. MPA Chair
   - Leading and being responsible for the organization's operations
   - Drawing up annual work plans for fire control activities
   - Cooperating with other parties in forest and land fire control activities
   - Making assessment reports on forest and land fire control
   - Communicating the outcomes of MPA activities with relevant stakeholders.
2. Treasurer
   - Working with the MPA Chair to seek funding support
   - Arranging and managing organizational finances
   - Financial bookkeeping.
3. Secretary
   - Representing the MPA Chair when unavailable
   - Conducting administrative duties
   - Taking notes during meetings and documenting organizational activities.
4. Logistics section
   - Coordinating consumption and accommodation for each activity
   - Coordinating the provision of equipment, means and facilities for firefighting operations
   - Maintaining firefighting equipment and facilities.
5. Team leaders
   - Implementing programmes under the direction of the MPA Chair
   - Undertaking operational tasks for forest and land fire control
   - Coordinating prevention, suppression and post-fire handling activities
   - Organizing preparations and fire suppression strategies.
6. Advisors/Mentors
   - NGOs: facilitation and providing direction, guidance and training for forest and land fire control
   - Related agencies and offices: providing direction, guidance and training, as well as financial support, equipment and facilities for activities in forest and land fire control.

Figure 7.9. MPAs play important roles in rapid response and early fire suppression

b. Standard operating procedures for MPAs in forest and land fire control

Standard operating procedures (SOPs) contain step-by-step instructions for MPA volunteers on controlling forest and land fires routinely and synergizing to achieve set objectives (Figure 7.10). These SOPs are aimed at improving MPA efficiency, optimizing performance, and preventing miscommunication from resulting in the failure of forest and land fire control operations.

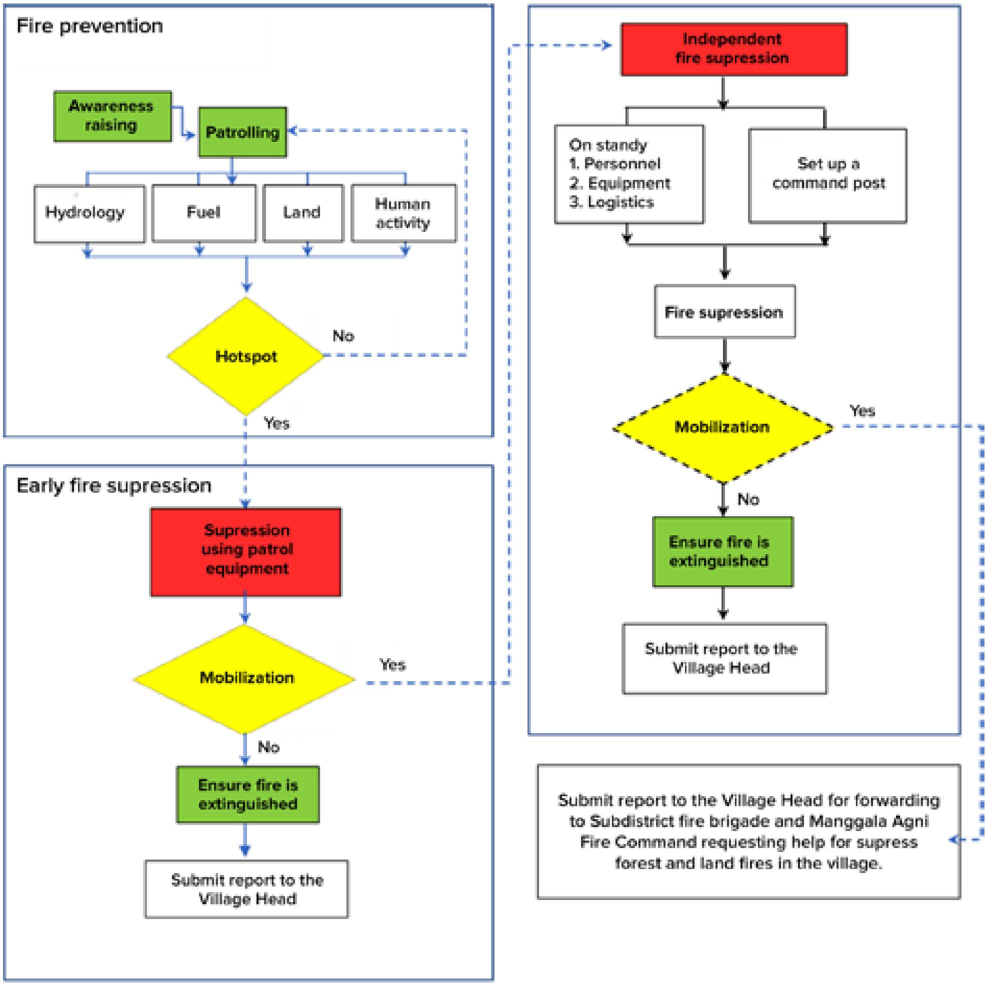


Figure 7.10. SOPs for MPAs in forest and land fire control

c. MPA activity plans and implementation reports

Monthly work plans are prepared to schedule MPA operations so each member knows what needs to be done. The MPA Chair monitors the outcomes of these operations, draws conclusions, and makes recommendations for reporting to the village head and other relevant institutions. Reports are prepared for all activities carried out during the month and submitted to the MPA for recapitulation at the end of each month and reporting to the village head. Translations of activity plan and activity report sheets are presented as Figures 7.11 and 7.12 below.

MPA Activity Plan Sheet

... Village for month... year ...

Activity Time	Activity Type	Implementer	Cost	Note
	1. Awareness raising			
	2. Patrolling			
	3. Construction and maintenance of infrastucture and firefighting equipment: a. monitoring dipwells b. fire breaks c. canal blocks d. vehicles e. firefighting equipment			
	4. Firefighting			

Date, ...
Made by — Approved by

MPA Chair — **Village head**

Figure 7.11 MPA activity plan sheet

MPA Activity Outcome Report Sheet

... Village for month... year ...

Activity Time	Activity Type	Implementer	Cost	Note	Result
	1. Awareness raising				
	2. Patrolling				
	3. Construction and maintenance of infrastucture and firefighting equipment: a. monitoring dipwells b. fire breaks c. canal blocks d. vehicles e. firefighting equipment				
	4. Firefighting				

Conclusions:
1. ...
2. ...
3. ...

Recommendations:
1. ...
2. ...
3. ...

Date, ...
Made by

Approved by

MPA Chair

Village Head

Figure 7.12. MPA activity report sheet

d. Awareness raising and recruitment of new members

Awareness raising activities are aimed at increasing community members' understanding of the dangers of forest and land fires, and also at recruiting new MPA members. With more members, MPAs will be able to implement their roles more effectively. Each awareness raising activity is expected to result in an agreement with community members on measures for controlling forest and land fires, as well as other related activities. Figure 7.13 provides a translation of a standard awareness raising activity report form, while Figure 7.14 is a standard statement letter for new MPA members, which was originally adopted from the Director General of Forest Protection and Nature Conservation Regulation No. P.2/IV-SET/2014, and later updated based on Director General of Climate Change Control Regulation No. P.3/PPI/SET/KUM.1/1/2018.

Awareness Raising Activity Report Form

On... (day) ... (month) .. (year), the ... Village MPA conducted awareness raising on fire prevention and firefighting with villagers relating to fire prone land in...

The awareness raising was dynamic, and discussions were held between villagers, the MPA and village authorities. Agreements were reached on:

1. ...
2. ...
3. ...

This report is made to support a safe village, free from fire hazard.

Date, ...
Made by

MPA Chair

Annexes

1. List of landowners' names
2. List of names of villagers around the fire-prone location

Figure 7.13. Awareness raising activity report form

New Member Registration Form

... Village MPA

Name :

Nationality :

Position :

Full address :

Telephone :

I hereby submit my application to become a new member of the MPA in ... Village, ... Subdistrict, ... Regency, ... Province. I am willing to carry out MPA duties and responsibilities independently or as part of a group, and work together with relevant institutions in fire prevention, suppression and post-fire handling activities.

This statement is made in all sincerity.

Date, ...

Duty stamp Rp 6,000

(Applicant's full name)

Figure 7.14. New member registration form

e. Patrolling

Other causes of forest and land fires, in addition to climate conditions such as El-Niño events, are landscape degradation and human activities. Accordingly, potential fire-prone areas in landscapes need to be identified. Such areas are characterized by degraded and open land with a predominance of shrubs, and a history of fire occurrence. As fires can be triggered through negligence or started intentionally, community members need to be increasingly vigilant and aware of behaviours that trigger fire risk. With this in mind, patrol volunteers must be able to identify contributory factors with the potential to result in forest and land fires. They should report such information periodically using patrol report forms like the one shown in Figure 7.15 below.

Forest and Land Fire Prevention Patrol Report

... Village

Patrol volunteer's names:

1. ...
2. ...

Location	Patrol results					Assessment of the actions that need to be taken
	Pile of fuel	Drought condition	Soil humidity	Groundwater level	Distance to the nearest water source	
Fire-prone 1						
Fire-prone 2						
Fire-prone 3						
Etc.						

Date, ...
Made by,

Patrol volunteer

Figure 7.15 Forest and land fire prevention patrol report

f. Construction and maintenance of canal blocks and monitoring dipwells

One of the factors triggering severe land and forest fires is the destruction of hydrological conditions in peatlands. Consequently, MPAs needs to monitor the condition of existing canal blocks, and propose new ones to improve hydrological conditions and create fire breaks in fire-prone areas. A canal block proposal and maintenance report form is presented as Figure 7.16.

Canal Blocking Construction and Maintenance Recommendation Report
... Village

Location	Activity	Width	Depth	Physical construction	Details of budget use	Work outcome
Fire-prone 1	Construction					
	Maintenance					
Fire-prone 2	Construction					
	Maintenance					
Fire-prone 3	Construction					
	Maintenance					
Etc						

Date, ... Made by	Acknowledged by	Approved by
MPA Secretary	**MPA Chair**	**Village head**

Figure 7.16. Canal blocking construction and maintenance recommendation report

g. Firefighting preparedness

Following an analysis indicating conditions having significant fire risk potential, the MPA reports to the village head to decide on preparedness actions. The MPA and village authorities then explain the situation to community members, and instigate measures to prepare personnel, equipment, logistics and resources for tackling any forest and land fires that may break out. These preparedness measures are as follows:

a. Personnel

- Analyse personnel availability and requirements for each potential work area
- Prepare firefighting teams to be on standby for each of these work areas, with numbers of team members adjusted to personnel availability
- Prepare activity schedules for each team to prepare for firefighting.

b. Equipment

- Check the readiness of vehicles, firefighting equipment and documentation for the needs of each team
- Prepare equipment for each team
- Prepare a control book for tool and equipment use by each team
- Prepare operational requirements for each team:

c. Hand tools

- Machetes, axes
- Shovels, mattocks, rakes, fire rakes, fire beaters
- Backpack pumps

d. Pumps and fittings

- Fixed fire pumps
- Portable fire pumps
- Suction pipes, transport pipes, nozzles, Y connectors, coupling adaptors, direct valves and collapsible water tanks

e. Vehicles and transport

- Motorcycles and carts for transporting firefighting equipment
- Fuel for vehicles and pumps

f. Logistics

- Prepare food and beverages taking into account the time necessary for fire suppression
- Prepare medicines and first aid kits.

h. Early suppression procedures

Early suppression

- Do a "scene size-up" at the fire site. Important steps for a "scene size-up" include:[23]
  - Collecting field data
  - Assessing hazard level
  - Determining necessary resources
  - Determining action priorities
  - Developing an action plan
  - Taking action
  - Evaluating progress
- Perform early suppression by immediately smothering the fire source with soil or submerging burning objects in the ground using shovels, mattocks, etc.
- Beating the fire and pulling fuel away from its source using fire beaters, shovels or tree branches
- Spraying/pouring water onto the fire using backpack pumps and/or a portable pump and/or floating pump
- Mopping up (sweeping) to make sure the fire is completely extinguished
- **Once a fire has been extinguished** – conducting a thorough assessment and reporting on firefighting activities
- **When a fire cannot be suppressed** – requesting assistance from the nearest fire brigade or Manggala Agni Fire Command through the village head; localizing the spread of fire by keeping unburned fuel away; and providing information on conditions, what has already been done, and the fire's potential to spread.

Direct suppression techniques

- Make rapid and thorough observations of fire and wind conditions.
- Spread wet soil directly on the fire source.
- Bury burnt objects in the ground using shovels and mattocks.
- Spray water in the direction of the fire.
- Use peat injection to extinguish deep fires down to the groundwater surface level.
- Spray the peat until it becomes saturated and then compact it.
- Beat and pull away burning material using fire beaters, shovels or tree branches.
- If a fire is not too large and the wind not too strong, apply direct suppression starting from the flame tips.

23 https://sarunpad.wordpress.com/2011/04/22/penyelenggaraan-sar-dalam-bencana/

- Once extinguished, conduct an assessment and report to the village head. If a fire cannot be suppressed, report immediately to the village head to ask for help extinguishing the fire from the nearest fire brigade and Manggala Agni Fire Command.

i. Equipment maintenance

- **Vehicles**
  - On completing patrols, volunteers should park MPA vehicles at the secretariat and make a report for team members patrolling the following day.
  - Vehicles must always be kept in good condition, so it will be necessary to conduct routine monthly services and replace any damaged parts.

- **Hand tools**
  - Hand tools include fire beaters, shovels, mattocks, axes, buckets and backpack pumps.
  - If numbers are sufficient for each MPA member, then volunteers can store hand tools themselves. If numbers are insufficient for all members, then tools should be kept in an equipment store.

- **Water pumps**
  - Water pumps should be stored in an equipment store situated in the MPA secretariat.
  - When not used for a long time, pumps should be turned on once a week for around 10 minutes.
  - Pump fuel tanks must be kept at least 3/4 full.
  - When pumps are on, make sure their motors sound normal, they are operating properly, and there are no water, oil or fuel leaks.
  - After use, make sure all equipment is complete and nothing is lost or missing.
  - Make sure pumps have no loose or broken/damaged parts.
  - Keep pumps clean and stored safely in the equipment store.
  - Submit pump inspection reports to the secretary or the logistics section.

… Village MPA Water Pump Weekly Inspection Form
Week… Month… Year ….

Inventory label number:
Water pump type:
Water pump brand:

No	Part inspected	Inspection outcome	Note
1	Engine oil condition		
2	Fuel condition		
3	Date of last oil change		
4	Pump machine cleanliness		
5	Are there any leaks when the pump is operating?		
6	Are there any abnormal noises after the pump has stopped operating?		
7	Are there any leaks after the pump has stopped operating?		
8	Hose		
	a. Suction		
	b. Transport		
	c. Nozzle		

Date, …
Inspected by

Acknowledged by

Logistics

MPA Chair

Figure 7.17 Water pump weekly inspection form

… Village MPA Operational Vehicle Weekly Inspection Form

Week… Month… Year ….

Inventory label number:
Vehicle type:
Vehicle brand:

No	Part inspected	Inspection outcome	Note
1	Engine oil condition		
2	Fuel condition		
3	Date of last oil change		
4	Engine cleanliness		
5	Are there any leaks when the engine operating?		
6	Are there any abnormal noises after the engine has stopped operating?		
7	Are there any leaks after the engine has stopped operating?		
8	Brakes		
9	Tyres		
10	Lights		

Others, …

Date, …
Inspected by

Acknowledged by

Logistics

MPA Chair

Figure 7.18 Operational vehicle weekly inspection form

j. Equipment labelling and borrowing procedures

The purpose of labelling and borrowing procedures are to maintain an equipment inventory and provide instructions on how to operate certain pieces of equipment as some require special attention during operation. Steps that should be applied in labelling and borrowing equipment are as follows:

- For labelling and maintaining an inventory, all equipment should be labelled or tagged with marker codes indicating their condition and status. For example:
  - Green tags for new equipment that has never been used
  - Blue tags for equipment that is already in use and operating properly
  - Yellow tags for equipment that still works, but not optimally and requires special care
  - Red tags for equipment that is damaged and in need of repair
  - Brown tags for equipment that has recently been used in the field, but has yet to be inspected.
- For borrowing, it is important to note that firefighting equipment is essential and must always be available in the equipment store when required. However, equipment can be lent out under certain conditions, providing the village head approves a prerequisite borrowing request letter, and the equipment will be returned in good condition. In the event or any damage or breakage, it is the borrower's responsibility to repair the borrowed equipment.

7.7 CLOSING

This lesson on MPA strengthening was prepared based on direct experiences and joint activities with six MPAs in Bengkalis Regency, Riau Province. For ensuring forest and land fire suppression efforts are effective, it is essential for MPAs – and other stakeholders – to have an in-depth understanding of their roles and responsibilities. Important things for them to have a thorough and comprehensive understanding of are: tools required and standard operating procedures; work plans; awareness raising and patrolling; early suppression procedures; and equipment handling and maintenance. Hopefully, this lesson can enrich similar papers that have already contributed to improving the performance of MPAs in handling the increasingly complex problems they are faced with, and be applicable to different contexts in other regions. Finally, we hope the shifting forest and land fire control paradigm can be accompanied by institutional strengthening and more concrete and focused support, particularly in strengthening MPAs, so volunteers in MPA groups can carry out their roles and responsibilities as effectively and efficiently as possible.

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Lesson 8

Establishing a forest farmer group institution in Dompas Village

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Heru Komarudin, Zulkardi and Fitri Nurfatriani

8.1 BACKGROUND

In Indonesia, government programmes and assistance to rural communities are generally channelled through community groups. Through its technical ministries, the Government of Indonesia requires the establishment of formal institutions tailored to its programmes and planned objectives. Examples of such institutions include farmer groups or *kelompok tani* (Poktan) and farmer group associations or *gabungan kelompok tani* (Gapoktan) formed by the Ministry of Agriculture; forest farmer groups or *kelompok tani hutan* (KTH) and forest farmer group associations or *gabungan kelompok tani hutan* (Gapoktanhut) formed by the Ministry of Environment and Forestry; family welfare empowerment groups or *pemberdayaan kesejahteraan keluarga* (PKK) formed by the Ministry of Home Affairs; and joint enterprise groups or *kelompok usaha bersama* (KUBE) established by the Ministry of Social Affairs.

Recent agriculture sector data listed 587,464 farmer groups and 63,392 farmer group associations (Ministry of Agriculture 2018), while forestry sector data showed 25,905 forest farmer groups (Ministry of Environment and Forestry 2019). This means such institutions, most of which have been established through government-driven processes, can be found in almost every rural village across the country. As villagers often have several livelihood sources linked to programmes from different technical ministries, the same people can sometimes be members of more than one type of group.

In conducting participatory action research (PAR) with the Dompas Village community in Bukit Batu Subdistrict, Bengkalis Regency, Riau, the Center for International Forestry Research (CIFOR) was aware of the need to establish a forest farmer group (KTH)[24] institution as a formal requirement for operating inside the forest estate.[25] The establishment and empowerment of this institution was an essential element of the **Participatory Action Research on Community-based Fire Prevention and Peatland Restoration** project, as actions would be driven by the forest farmer group. KTHs are groups of farmers who manage forestry sector enterprises, both inside and outside the forest estate. Associations of several KTHs are referred to as Gapoktanhut, which serve to further develop such enterprises. KTHs also function as media for learning, and play roles in capacity building, developing forest product enterprises, and increasing sustainability awareness.

24 At the time of writing, there were 23 KTHs in Riau Province involved in village forest (*hutan desa)* and community plantation forest (*hutan tanaman rakyat)* schemes. These KTHs were distributed throughout Kampar, Bengkalis, Pelalawan, Meranti Archipelago, Indragiri Hulu, Rokan Hulu, Siak and Indragiri Hilir regencies.

25 According to Law No. 41/1999, a forest estate is a specific area designated and/or stipulated by the government to be retained as permanent forest.

Establishing and empowering a KTH institution turned out to be quite a challenge. Observations during the early months of participatory action research (PAR) showed community institutions already existing, but lying dormant. Their motivation to implement activities had come from short-term assistance projects with little facilitation. Once these projects ended, so did their activities, as groups would wait passively for the next project to arrive. In contrast, through the PAR cycle of reflection, planning, action and monitoring phases, the research team worked together with community members and existing formal and informal groups to ascertain conditions in the village, and initiate collective action. Activity plans were formulated, implemented, monitored and reflected upon collectively for improvement and lessons learned.

Figure 8.1. The KTH as a driving force for community-based fire prevention and peatland restoration

8.2 LESSON OBJECTIVES AND TOPICS

The objective of this chapter is to document the processes involved and PAR outcomes in strengthening existing community groups in Dompas to become integral parts of a forest farmer group (KTH) institution to play a driving role in community economic empowerment, fire prevention and peatland restoration. It is intended to share knowledge and experiences, and can hopefully prove a useful reference for communities and stakeholders, particularly activists and development agencies, involved in empowering rural communities.

Facts on the ground reminded us of how important it is to never disregard differences in targeted community groups; operational areas (forest estate and APL other use areas); facilitation programme activities and enterprises; and the strength of social ties between partners. Much of the evidence indicated institutions' successes or failures depending largely on the extent to which such differences had been considered or neglected. Consequently, discussion topics in this section are directed at answering the following questions:

- what is required when establishing new groups;
- how can existing or future groups be made increasingly active; and
- what strategies and approaches are needed to empower groups to achieve independence?

8.3 CONCEPTUAL FRAMEWORK OF PARTICIPATORY ACTION RESEARCH FOR COMMUNITY-BASED DEVELOPMENT

Community-based development is an approach in line with international development that focuses on improving independence, social justice and participatory decision making in local communities. This approach does not accept that human development is inherent in economic growth, and encourages changes in social, political and environmental values and practices (Korten 1984). Accordingly, its main focus is human development.

8.3.1 Conceptual framework for collective action

Collective action occurs when more than one individual contributes to an effort to achieve an outcome (Ostrom 2004). According to Ostrom, collective actions in rural communities are reflected in joint planting and harvesting activities, use of public facilities and irrigation system management, and forest patrols. Collective action is useful for improving farmers' bargaining positions and improving access to input and output markets (Paumgarten et al. 2012). In the context of disaster management, collective action plays an important role in increasing capacity to adapt to environmental changes, including climate change, as social networks are important components in adaptive capacity building (Ireland and Thomalla 2011). In the forestry sector, villagers joining groups and forming collective actions play an important role in supporting Indonesia's community forestry policy (Febriani et al. 2012).

A focus of PAR interventions is to unify the partial collective actions taken by certain individuals and groups by forming stronger collective action units within larger groups. In this way, sustainable interventions, collective action processes, and community empowerment and development can become more efficient and effective. As long-term sustainability is the goal, it is vital for all community members to participate. To achieve this, PAR researchers need to understand factors influencing support for collective action or causing inaction, particularly when collective action is aimed at encouraging policy reform.

The PAR in Dompas adopted Ostrom's Institutional Analysis and Development (IAD) framework (Figure 8.2), through which PAR activity preparation processes needed to consider context, action arenas and patterns of interaction, which are formed in action implementation processes and assessed using evaluation criteria to determine outcomes.

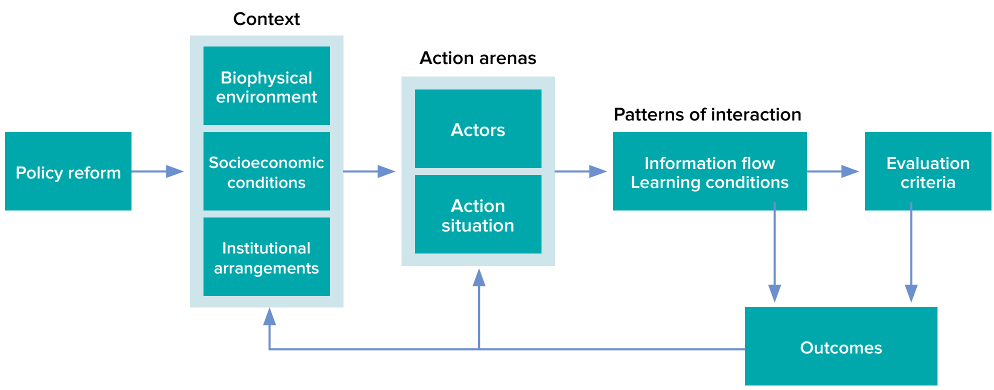

Figure 8.2. Collective action to support policy reform based on the Institutional Analysis and Development (IAD) framework from Ostrom (2010)

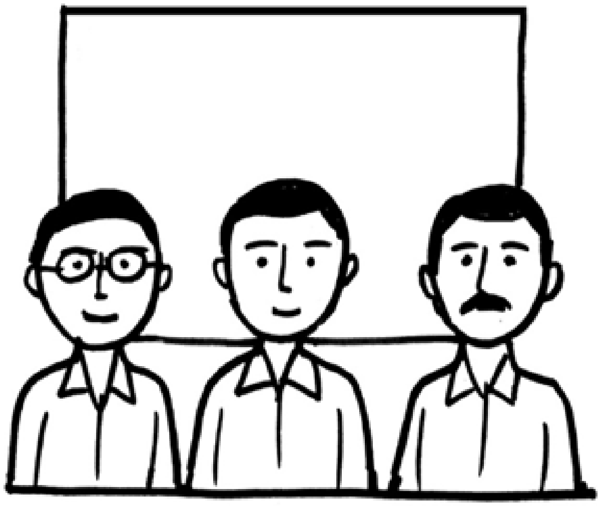

Figure 8.3. Interventions in participatory action research are carried out to form collective action

8.3.2 Strategies, approaches and methods in community-based empowerment and development

In community development, strategies and approaches aimed at fostering a sense of ownership and responsibility are important for encouraging collective action, as outcomes are more likely to meet expectations with the adoption of community-driven development (Nguyen and Rieger 2014). Studies on community development by Dasgupta and Beard (2007) and Kusumatantya (2013) highlight key points to consider when formulating strategies for community-based empowerment and development (Figure 8.4). Community-based empowerment and development projects can be successful if their designs consider aspects that encourage the realization of community institutional governance, prioritize community participation, and adopt principles of democracy and transparency (Dasgupta and Beard 2007). Further, project designs should include strategies and approaches that consider community group conditions (group size, community cohesion, social hierarchy and power relations); community capacity to carry out collective action; prevailing social, political and economic contexts (e.g., through policy support analyses); and develop and support stakeholder roles; prioritize the roles of initiators and champions in establishing community groups; and provide guidance and facilitation (Dasgupta and Beard 2007; Kusumatantya 2013). Once activities have commenced, it is important to have continuous monitoring and evaluation. In addition, programmes or activities deemed successful should be replicated to extend their benefits.

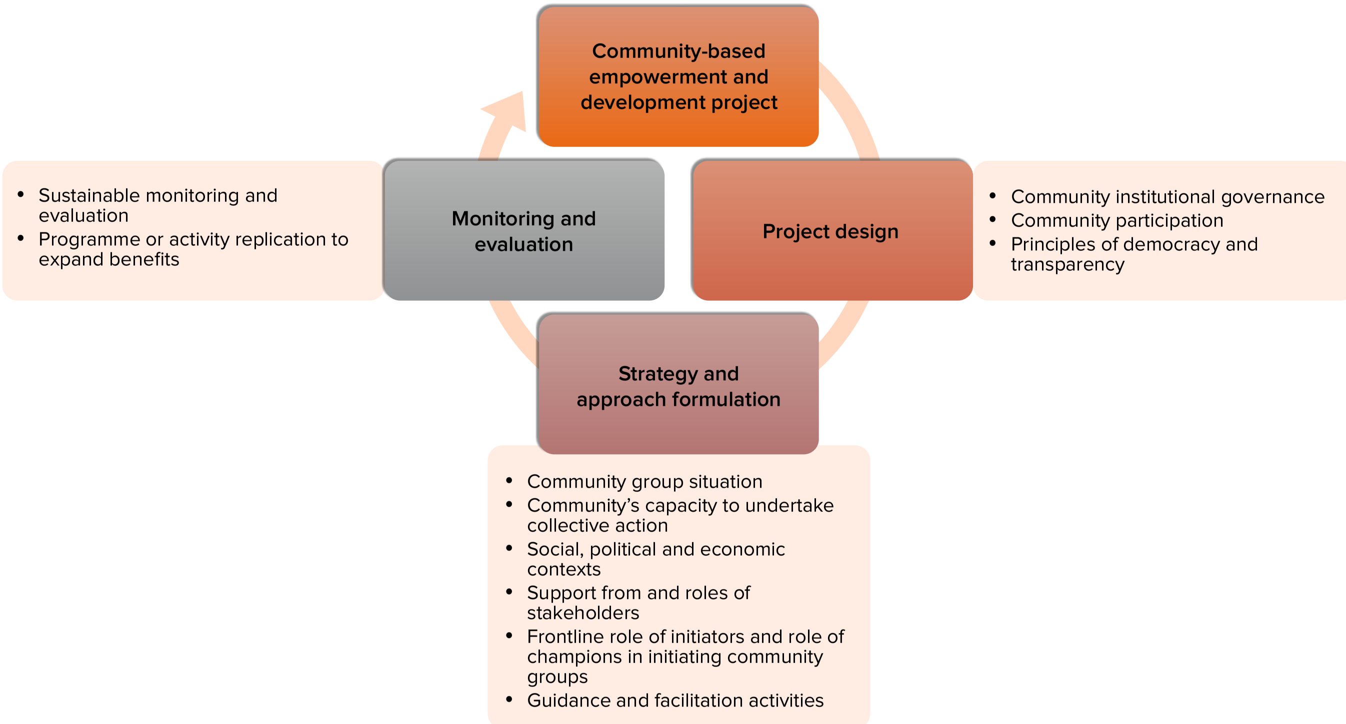

Figure 8.4. Considerations in formulating community-based empowerment and development projects

Note: Based on Dasgupta and Beard (2007) and Kusumatantya (2013)

Our PAR in Dompas Village involved field observations, individual interviews, focus group discussions (FGDs), actions, and reflections through further discussions with villagers, the village government and community groups. To help the community identify individuals and institutions with roles to play, and understand objectives and activities, the FGDs applied ZOPP (*Zielorientierte Projektplanung*) or goal oriented project planning methods. ZOPP is a planning technique for setting priorities and plans through participatory formulation of matrices (World Bank 1996). It involves discussions of two groups of topics: objectives, activities and institutions at play; and stakeholder roles, interests, expectations and outputs.

8.4 LESSONS LEARNED IN ESTABLISHING AND STRENGTHENING A KTH INSTITUTION IN DOMPAS

8.4.1 Contexts, action arenas and patterns of interaction

Lessons learned from the establishment of a forest farmer group institution in Dompas through PAR are summarized in the Institutional Analysis and Development (IAD) framework presented in Figure 8.5. In terms of policy, provisions relating to community-based fire prevention and peatland restoration were already available in legislation on and commitment to strengthening the governance and implementation of forest and land fire prevention at both national and regional levels. This policy support, along with institutional, biophysical and socioeconomic conditions were the main considerations in formulating action situations with the main actors. We identified and studied patterns of interaction between different parties: between individuals within groups; between individuals in groups with external parties; and between groups and external parties. We observed participation rates being low initially at the commencement of PAR, but increasing steadily as PAR processes were implemented consistently. We also saw bonds becoming stronger within and between groups, and group members becoming more creative in practicing collective action in their respective action arenas. This is discussed in more detail below.

8.4.2 Actors in fire prevention and peat restoration

- **Objectives, activities and institutions involved**
  In the initial phase of the project, the community identified problems that may arise in managing public, private and co-management land. Discussions revealed four groups of problems: technical capacity for cultivation, and biophysical, social and financial conditions. To address these appropriately, researchers and community members analysed existing problems, then converted problem statements to positive action objectives. Objectives under each problem group are listed in Table 8.1 together with required activities and institutions involved in conducting those activities.

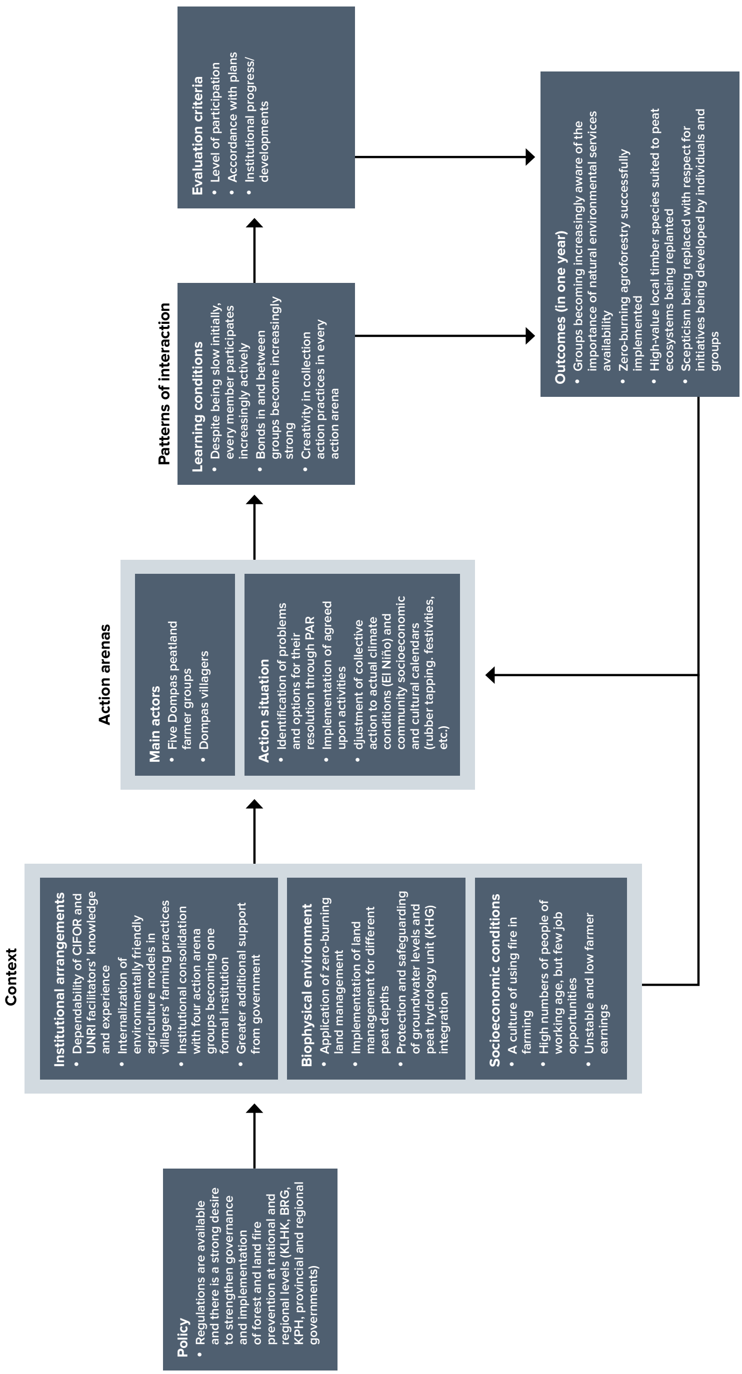

Figure 8.5. Reflection on collective action in Dompas using the IAD framework

Table 8.1. Objectives, activities and institutions involved in ZOPP

Objective	Activity	Institutions involved
Technical expertise 1. Increase knowledge of best cultivation and management practices 2. Increase farmer experience	**Technical expertise** 1. Training on best cultivation and management practices 2. Facilitation of comparative studies and discussions in action arenas	1. CIFOR and University of Riau (UNRI) 2. CIFOR and UNRI
Biophysical aspects 1. Reduce the risk of flooding in the rainy season 2. Reduce the risk of fire in the dry season 3. Reduces pests 4. Remove weeds from action arenas	**Biophysical aspects** 1. Managing hydrology and canal blocks, and building new canal blocks 2. Building fences and conducting regular pest patrols 3. Weeding and applying herbicides and compost	1. Dompas Village Government and Fire Care Community (MPA) group 2. Dompas Village Government, MPA and CIFOR 3. Action arena managers 4. Action arena managers
Social aspects 1. Build group trust 2. Eliminate social envy 3. Get support from surrounding community members 4. Give attention to community groups 5. Increase cooperation between members and groups 6. Reduce incidences of theft/criminal acts	**Social aspects** 1. Facilitating community meetings and government awareness raising activities 2. Holding discussions with the community 3. Facilitating awareness raising 4. Facilitating awareness raising and increasing participation 5. Developing work plans, implementing and monitoring 6. Conducting regular integrated patrols	1. Dompas Village Government and MPA 2. Dompas Village Government 3. Dompas Village Government 4. Action arena managers 5. Action arena managers 6. Action arena managers

Continued to the next page

Table 8.1 continued

Objective	Activity	Institutions involved
Financial aspects 1. Capital for land preparation, farming facilities, seeds, fertilizers, herbicides and insecticides 2. Yield can be marketed to generate revenue 3. Acquire knowledge in financial management 4. Transparent and equitable sharing of profits 5. Secure additional income	**Financial aspects** 1. First year planting with funding assistance 2. Partnering with traders 3. Conducting financial management training 4. Stakeholder discussions and determining profit-sharing mechanisms 5. Implementing plans consistently	1. CIFOR with financial support from the Temasek Foundation 2. CIFOR and UNRI 3. CIFOR and UNRI 4. Action arena managers, landowners, Dompas Village Government and MPA 5. Action arena managers

- **Stakeholder roles, interests, expectations and outputs**
  Once institutions had been identified, the next stage of the PAR process was a participatory analysis to establish the roles, interests, expectations and outputs of each of the institutions involved (Table 8.2).

Table 8.2. Stakeholder roles and interests, and expectations and outputs

Stakeholder	Roles and interests	Expectations and outputs
Government	1. Keeping the project going 2. Guiding and facilitating training and procurement of supporting facilities 3. Monitoring activities, motivating and exchanging ideas (brainstorming) on project activity development 4. Mediating any conflicts that arise	1. To support project success, the government must focus on the groups managing the action arenas 2. Government officers receive no share of revenues as they are salaried by the state

Continued to the next page

Table 8.2 continued

Stakeholder	Roles and interests	Expectations and outputs
Land/action arena managers	1. Developing partnerships with relevant stakeholders 2. Planning and implementing action plans 3. Making work plans 4. Implementing and/or being involved in land preparation 5. Planting, maintenance, harvesting and marketing of commodities 6. Earning additional income from managing Action Arenas 2 and 3	1. Managers need support in developing partnerships with relevant stakeholders 2. Managers must be facilitated in creating work plans and monitoring systems 3. Managers must be facilitated in managing work schedules and monitoring systems 4. Proposed commodities must be able to command high prices
Landowners	1. Providing land for use as PAR action arenas 2. Knowing workloads in land management 3. Securing a share of profits 4. Developing partnerships with relevant partners 5. Continuing to support the project	1. Land becomes more productive 2. Active participation in project activities 3. Secure an agreed 20% share of profits 4. Sign formal, written agreements 5. Lend land for a long time
MPA	1. Being co-workers in land management 2. Motivating land managers 3. Helping identify seedling sources to ensure availability 4. Preventing fires 5. Mitigating natural disaster risk	1. For performing these roles, the MPA will receive an agreed 10% of profits to help cover operational costs
CIFOR and UNRI	1. Facilitating all activity processes in Dompas 2. Assisting in funding and providing technical assistance for project implementation 3. Monitoring and evaluating	1. Remain enthusiastic and patient in facilitating and working with the community

8.4.3 Collective action rollout in a formal context

With community groups in each action arena taking only partial collective action, a common awareness emerged of the needs to strengthen cooperation between groups and invite outsiders to collaborate. Taking input from various parties into account, a forest farmer group (KTH) institution was chosen as the ideal platform for addressing these needs.

Box 8.1. Formulating collective action

Referencing the IAD framework, the CIFOR research team and community groups agreed to implement six actions – to be realized within predetermined action arenas – directed not only at peatland rehabilitation, but also at developing institutions to improve the community economy. The six actions were as follows:

1. Rehabilitating 2.2 hectares (ha) of burnt land belonging to Dompas Village through tree planting and constructing ponds for fishing enthusiasts. Collective action in Action Arena 1 would be carried out by the MPA group, with resulting revenues used to help fund its operations.
2. Rehabilitating 3.3 ha of burnt land owned by villagers to be used for an agroforestry enterprise combining timber and pineapple crops. Collective action in Arena Action 2 would be carried out by two women's groups, each comprising 30 members, while the MPA would prevent fires by maintaining groundwater levels in canals and conducting routine patrols. Proceeds from the arena would be shared between landowners, the women's groups and the MPA.
3. Rehabilitating 3.7 ha of burnt land owned by villagers to be used for an agroforestry enterprise combining timber and pineapple crops. Collective action in Arena Action 3 would be carried out by a 10-man farmer group, while the MPA would prevent fires by maintaining groundwater levels in canals and conducting routine patrols. Proceeds from the arena would be shared between landowners, the management group and the MPA.
4. Cultivating 1.9 ha of land owned by three households as Action Arena 4; a pilot site for increasing land productivity by combining rubber and coffee crops. Proceeds from the arena would belong to each family, but they would be responsible for sharing their knowledge, experiences and lessons learned with other villagers.

Continued to the next page

Box 8.1 continued

5. Planting 311 hybrid coconut trees, one in the yard of each household in the village. This action was aimed at securing wider attention and support from villagers not involved in the five groups mentioned above. Harvests from these high-yielding hybrid coconut trees would belong to each family, with coconut marketing coordinated by a village institution.
6. Repairing existing canal blocks and constructing new ones to maintain peat moisture and water availability, particularly in the PAR action arenas.

Figure 8.6. Collective action on fire prevention and peatland restoration

Important things to note in establishing a KTH are to:

1. Identify groups that have **social capital and the same vision and mission**, and then formulate:
   a. KTH name, vision and mission;
   b. its management structure, along with the division of duties, roles, responsibilities and authority;
   c. articles of association or *Anggaran Dasar* (AD), bylaws or *Anggaran Rumah Tangga* (ART) and/or group rules.
2. Complete the administrative requirements for establishing a KTH, namely:
   a. minimum of 15 members, with all members domiciled in one village/ward administrative area;
   b. implementing forestry activities, such as agroforestry, environmental services provision, and propagation, planting, maintenance and harvesting of forestry plants;
   c. having reports and other relevant documents.
3. Submit an application to register the already established KTH.

The Dompas Village KTH was established on 3 July 2019 with its first members being those of the four community groups involved in managing the PAR action arenas. Named *Dompas Ghedang Cemerlang*, the KTH was registered in Riau Province, and formalized through Riau Provincial Forestry Office Decree No. Kpts.188/PDASRA/3799.

Dompas Ghedang Cemerlang has a long-term goal of improving the community economy through alternative peat-friendly, zero-burning livelihoods. To achieve this goal, its members agreed to develop joint ventures and alternative sustainable livelihoods by making use of idle land, utilizing best practices in integrated cultivation governance, considering peat ecosystem sustainability, restoring degraded peatlands, and preventing reoccurring fires.

Box 8.2. KTH establishment process

Formalizing a KTH institution to cover collective action to encompass all groups in four action arenas required a series of discussions in each arena and between groups in different arenas. With an awareness to strengthen collective action on a more permanent basis, the groups agreed to merge into a larger formal group. Rules of play were agreed and included in the KTH's articles of association and bylaws through two discussions between action arena groups; one at a meeting in the village hall on 2 July 2019, and one in the PAR secretariat the following day.

Despite the risk of elite capture remaining, with the village head having the position of "Guide", progress in group dynamics was apparent from the KTH management structure comprising a chair, vice chair, secretary, treasurer and several section heads. These section heads represent each of the different enterprises, such as pineapple agroforestry, for instance.

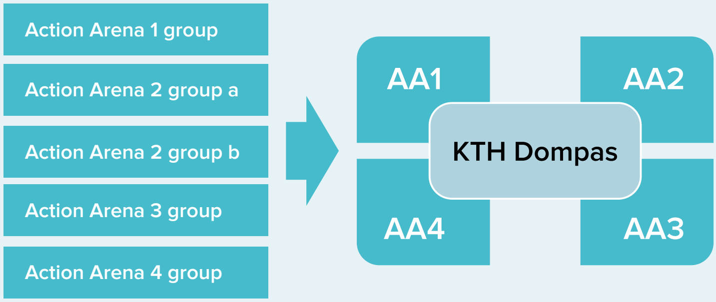

Figure 8.7. Action arena groups combined to form a larger collective action group

8.4.4 Maintaining morale in a larger group

Establishing and registering the KTH were the first steps in achieving group independence in realizing its agreed vision and mission. Important follow-up measures for the new structure were to:

1. Formulate annual work plans and identify sources of funding for activities;
2. Request supervision from forestry extension workers and KTH trustees[26] in facilitating the following three aspects of sustainable management:
   a. Institutional governance, including capacity building, reporting and formation of cadres;
   b. Estate management, including increasing knowledge of forest estate boundaries and realizing various activities;
   c. Business management, including farming enterprise management and establishing a cooperative;
3. Build a collaboration network with partners and relevant stakeholders to develop group enterprises.

Box 8.3. Group discussion dynamics

When groups merge to become larger more formal institutions, challenges to collective action automatically became more complicated. Classic and frequently occurring problems when organizations become more formal are their tendency to become less flexible and more bureaucratic, and for their work programmes to be less neatly arranged and implemented.

Institution managers and members were aware of this possibility from the outset. Accordingly, they reached an agreement to hold regular bimonthly meetings to maintain cohesion and synergy, share and convey progress made in each action arena, and discuss any other outcomes of work that managers had undertaken.

Meetings that place more emphasis on problems will lead to discussions where participants expect solutions. In reality, however, as solutions are never instant, processes for obtaining the best possible outcomes should involve formulating steps required to achieve such solutions, and identifying collective action measures that can involve the wider community and other institutions outside the KTH.

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26 According to Minister of Environment and Forestry Regulation No. P.89/2019, KTH facilitation is carried out by forestry extension officers/facilitators. KTH performance shall be evaluated by facilitators, for example, through their monitoring and evaluation systems http://simping.bp2sdm.menlhk.go.id/

8.5 LESSONS LEARNED

- Shared reflections on the project's first year showed villagers, CIFOR and UNRI moving in the right direction and having synergy. All stakeholders directly involved in the Participatory Action Research on Community-based Fire Prevention and Peatland Restoration were satisfied with the first year's achievements and optimistic that better outcomes would be achieved the following year.
- Despite there always being a certain amount of subjectivity in assessing, within one year of interventions for fostering collective action and public awareness of fire prevention and peatland restoration, there was clear evidence of a growing awareness of the importance of environmental sustainability. This shared awareness had led to stronger social ties, successes in implementing the transformation to zero-burning farming, and maintaining local tree species biodiversity.
- Community groups were highly motivated to learn and improve, as evidenced by their continued enthusiasm, even among those whose collective action and plant survival rates had been less successful than others. Such groups were consistently happy to learn from their experiences, while those who outperformed others felt a sense of pride in sharing their keys to success. All of these factors strengthened bonds between groups and group members.

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Lesson 9

COmmunity-Based Peatland RestOration MonItoring SystEm (CO-PROMISE)

Beni Okarda, Herry Purnomo, Imam Basuki, Usman Muchlish,
Shintia Arwida and Himlal Baral

9.1 INTRODUCTION

The aim of the Community-based Peatland Restoration Monitoring System (CO-PROMISE) is to provide a database for storing data, complete with spatial information, for monitoring the outcomes of peatland restoration activities. The system is designed to be easy to use without compromising data quality. CO-PROMISE utilizes an Open Data Kit (ODK) platform, comprising the ODK Collect application installed on Android devices, and KoBo ToolBox-based cloud storage combined with the Microsoft Power BI application to design displays and present monitoring results in central online control panel. The system allows monitoring data to be stored periodically, displayed on its dashboard and adjusted to user needs.

This guide is part of the Participatory Action Research on Community-based Fire Prevention and Peatland Restoration (PAR-CBFPR) project. In this research facilitated by the Center for International Forestry Research (CIFOR), local communities conducted a series of fire prevention and peatland restoration activities using an approach introduced by the Government of the Indonesia's Peatland Restoration Agency (BRG) known as the 3Rs (Rewetting, Revegetation, Revitalization). The approach involves peatland rewetting, tree planting, and revitalizing local community livelihoods. Peatland rewetting is carried out by constructing canal blocks to increase groundwater levels on previously drained and degraded peatlands, and maintain them at 40 cm below the surface to accord with the stipulation in applicable legislation.

Project aims are to maintain and control groundwater and moisture levels to make peat less fire prone; replant Ministry of Environment and Forestry-recommended natural peat ecosystem vegetation to absorb carbon dioxide from the atmosphere; and revitalize local community livelihoods by implementing agroforestry systems with pineapple and coffee cultivation, and hybrid coconut cultivation in village home gardens.

To monitor progress and impacts, an integrated monitoring system was built that could involve local community members in data collection. The system was applied for peatland, tree, pineapple and coconut monitoring. Peatland monitoring involved measuring the impacts of canal blocking as part of the peat rewetting process. Local community members were involved in taking weekly groundwater and soil moisture level measurements in action arenas where canal blocking had taken place, and control areas with no canal blocks. They also collected peat subsidence measurements over longer monitoring intervals.

Tree monitoring involved recording numbers, growth and survival rates of trees planted in the revegetation process. Local community members were trained to conduct tree inventories and periodic monitoring of tree growth. Pineapple and coconut monitoring involved numbers planted in efforts to enhance the local community economy. Community groups had chosen these commodities using the business model canvas approach in discussions during the initial phases of the project.

All monitoring data was stored in a cloud-based storage system and displayed in an online dashboard accessible to all stakeholders involved in the project and other parties with interests in restoration activities.

9.2 MONITORING SYSTEM

9.2.1 System components

CO-PROMISE comprises monitoring components for restoration activities carried out in the PAR-CBFPR project based on the 3Rs peatland restoration approach. Parameters for each component provide information on restoration activity progress and impacts.

In peatland monitoring, the impacts of canal blocking are shown through groundwater level, soil moisture, solar radiation and peat subsidence parameters. To determine the peat rewetting impacts of canal blocks, values for each of these parameters in action arenas where canal blocking had taken place were compared with those in control area not affected by canal blocks. Parameters used for monitoring revegetation through the planting of tree species recommended for ecosystem recovery were numbers planted, species, survival rates and growth, as indicated by increases in tree height and stem diameter. The results of this monitoring are useful indicators for determining species with good growth rates for peatland revegetation.

For local community livelihood revitalization, monitoring involved collecting data on commodities planted as part of the PAR. On peatland areas, pineapple monitoring provided information on numbers planted, fruit yields, and plant survival rates. On non-peatland areas, hybrid coconut monitoring involved calculating numbers planted, survival rates, and numbers of families benefiting from hybrid coconut cultivation. All data collected from monitoring was supplemented with location coordinates and photographic documentation.

Table 9.1. Monitoring components

Activity type	Action		Monitoring type	Monitoring parameters
Peat rewetting	Canal blocking		Peat groundwater level monitoring	• Groundwater level • Soil moisture • Solar radiation • Subsidence
Revegetation	Tree planting		Tree monitoring	• Numbers of trees • Survival rates • Tree species • Tree heights
Revitalization of local livelihoods	Cultivation of high-value commodities	Peatland: Pineapple	Pineapple monitoring	• Numbers of plants • Number of fruits • Survival rates
		Non-peatland: hybrid coconut	Hybrid coconut monitoring	• Numbers of plants • Survival rates • Plant heights • Owner information

9.2.2 System workflow

CO-PROMISE uses the ODK Collect application installed on Android-based devices which enables data inputting even when no internet access is available. Villagers trained in using the application can conduct monitoring, input measurement data, and upload it to the data centre once an internet connection is available. To minimize data entry errors, input values have been set to fall within viable ranges, while handwritten records are also taken for cross-checking when any data irregularities are encountered.

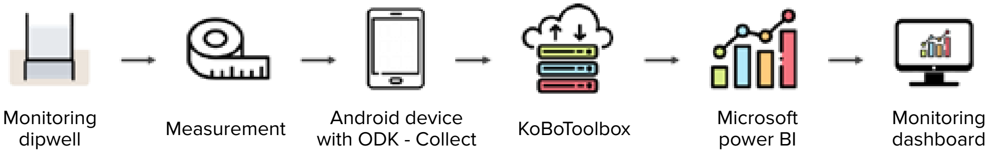


Figure 9.1. Peat groundwater level monitoring system workflow

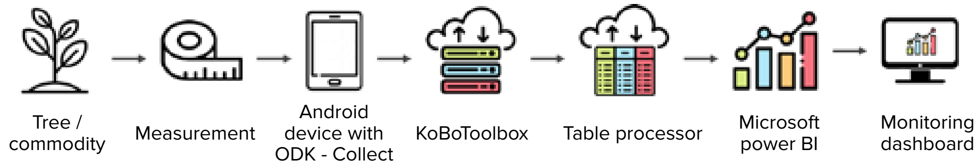


Figure 9.2. Tree, coconut and pineapple monitoring system workflow

The peat groundwater level monitoring workflow is slightly different to those for the other three types of monitoring. It is designed to be carried out weekly to determine peat hydrological dynamics, so data can be displayed shortly after measurement. Once data is submitted from the field, the online database will update automatically. Microsoft Power BI performs data updates twice daily and automatically updates the monitoring dashboard. Data resulting from tree, pineapple and hybrid coconut monitoring is converted to a table/spreadsheet format file first for checking before being displayed on the dashboard.

9.2.3 Use of barcodes

To secure structured periodic monitoring data, a unique identification number (ID) is used for each object of monitoring. Monitor dipwell IDs are used for peat groundwater level monitoring; tree IDs for tree, coffee and coconut monitoring; and planting block IDs for pineapple monitoring. The system uses alphanumeric identification to create unique identification numbers. Arrangements of letters and numbers in the IDs provide information on action arena location, monitoring type, and a unique ID number for each monitoring object.

Figure 9.3. Tree/planting block ID structure

Figure 9.4. Monitoring dipwell ID Structure

Long ID characters and large sets of data are time consuming to type manually, and typing errors can frequently be an issue. These were a persistent problem when the system was being piloted. To avoid typing errors and shorten the time involved for inputting data, the original ID character arrangement was replaced with a Code 128 type barcode system, where barcodes could be printed on weatherproof material, attached to individual monitoring objects, and scanned using devices' cameras through the ODK Collect application.

9.2.4 Installing monitoring dipwells and subsidence measuring poles

The placement of dipwells and subsidence poles in peat hydrology monitoring sites is essential for accurately determining and measuring the rewetting impacts of canal blocking. Dipwells and subsidence poles were installed in action arenas affected by canal blocks and in control areas with no blocking for the purpose of comparison. Four monitoring dipwells were installed inside each action arena and control site. Inside the action arenas, monitoring dipwells were installed along canal sides at distances of 100 m apart, and two others were installed 100 m away from the canals (Figure 9.5). The distance of 100 m was chosen based on considerations of hydrological conditions in the action arenas. Though Ritzema et al. (2014) reported canals affecting peatland water levels at distances of up to 1,000 m perpendicular to them, the reflection stage showed distances between canals in some action arenas being less than 400 m. With this in mind, we decided to take impact measurements around 100 m from canals in locations certain to be affected by canal blocking, and not by canals in adjacent areas. This considered that areas equidistant to two canals would be affected by each one.

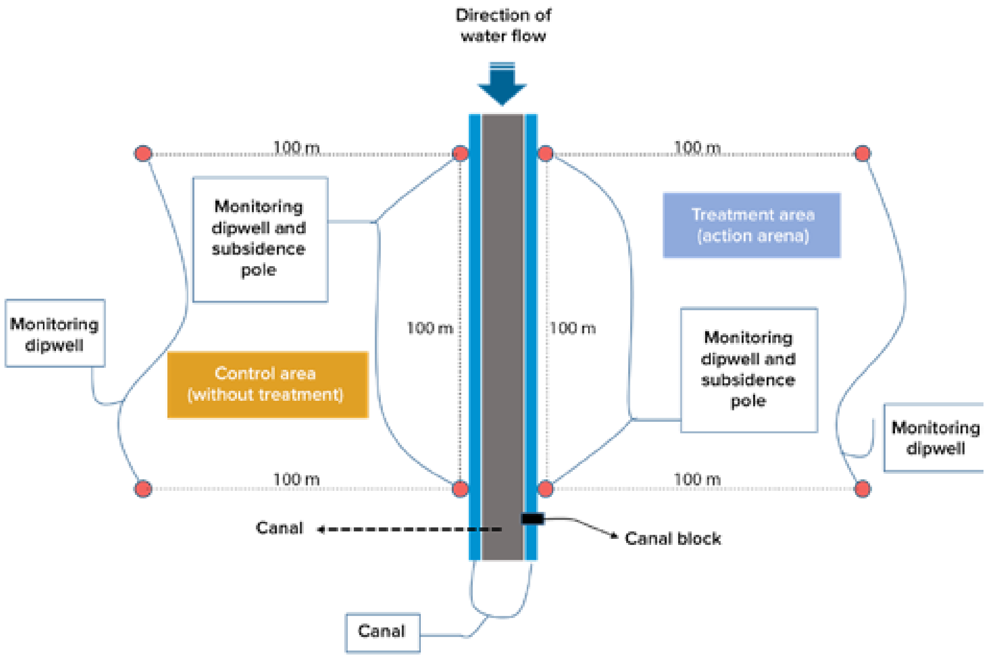


Figure 9.5. Peat groundwater level monitoring dipwell and subsidence pole placement

9.3 USING THE ODK COLLECT APPLICATION IN MONITORING

9.3.1 General instructions

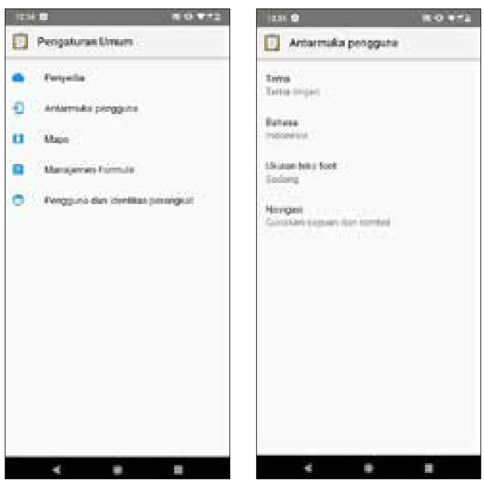
Initial installation and device interface settings

1. Open **Play Store**, then find and install the **ODK Collect** application on your Android device.

Figure ▶

2. Open the **ODK Collect** app on your device and select the three dots in the upper right corner, then select **General settings**. Then select **User interface**. For ease of use, select the desired language on the **Language** feature and select **Navigation** to **Use swipes and buttons**.

Figure ▶



Server settings and form capture

1. Open the **ODK Collect** app on your device and select the three dots in the upper right corner, then select **General settings**.

Figure ▶

2. Under **General Settings**, find and select **Providers**. Under **Link (URL),** enter the server URL: http://koboform.cifor.org. In this step, you are also asked to enter the **User name** and **Password** you have already been given.

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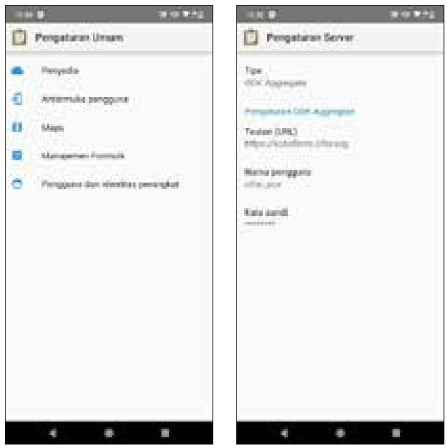

3. Download the latest form or update the form by tapping on **Retrieve blank form**. Make sure your device is connected to the internet.

Figure ▶

4. A selection of forms linked to your account will appear. **Select all** (or any of the forms you want) by tapping the check mark on the right side, and then select **Retrieve**. To ensure the form is ready to use, please return to the main menu and select **Fill in blank form**, and make sure the form you downloaded is listed.

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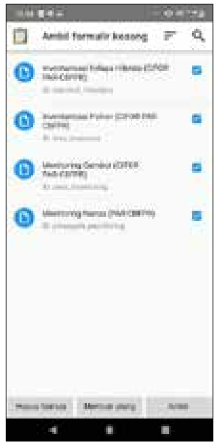


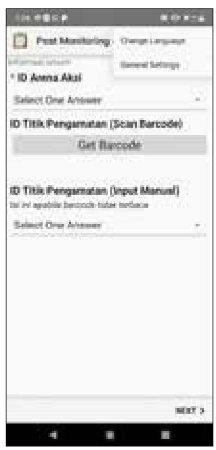
Data entry and storage

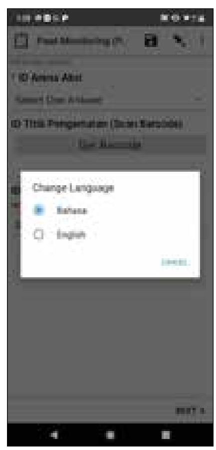
1. To begin entering data, select **Fill in blank form** on the **Main Menu** page and select a survey form to get started.

Figure ▶

2. The platform was designed using two languages (Indonesian and English). To change the language, select the three dots in the top right corner, then select **Change Language**, which will show the language options. In the initial setup, the language used is English.

Figure ▶





3. To move to the next page use the **Next** tab, tap the **Back** tab to move to the previous page. You can also switch pages by swiping right or left.

Figure ▶

4. To complete the form and save it to the device, select **Mark this form ready to submit** and select **Save form and finish**.

Figure ▶

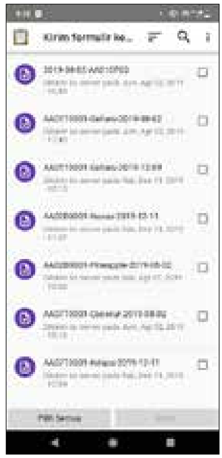
Sending data

1. From the main page, select **Send form to Server**.

Figure ▶

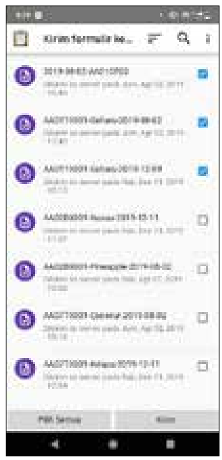
2. A series of saved forms will be displayed.

Figure ▶



3. **Select all** (or select the forms you want to send), then select **Send**.

Figure ▶



Reviewing and downloading data

Open the browser on your internet-connected computer or device and enter the server address URL: http://koboform.cifor.org. Enter your user name and password. You will need administrator access to open monitoring data.

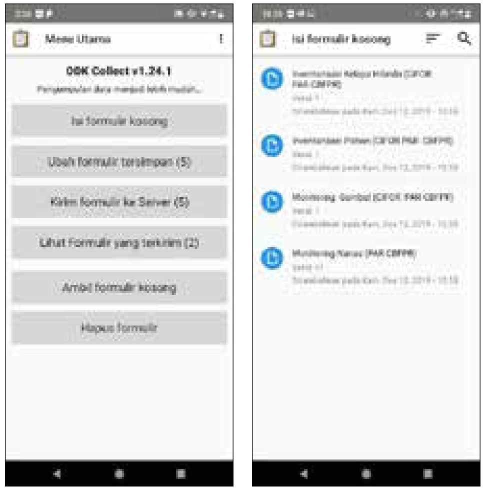
Select the type of monitoring data you want to review or download. To view forms that have already been sent to the server, select **View data** in table to view each form, or select **Data analysis** to see all results, or select **Download data** to download in XLS or CSV or another table format. **Photo attachments** and **GPS locations** are also available on this page for review and download.

9.4 MEASUREMENT AND DATA FILLING

9.4.1 Peat groundwater level monitoring

1. On the main page, select **Fill in blank form** and choose the [**Peatland Monitoring (CIFOR PAR-CBFPR)**] form to start entering data.

Figure ▶

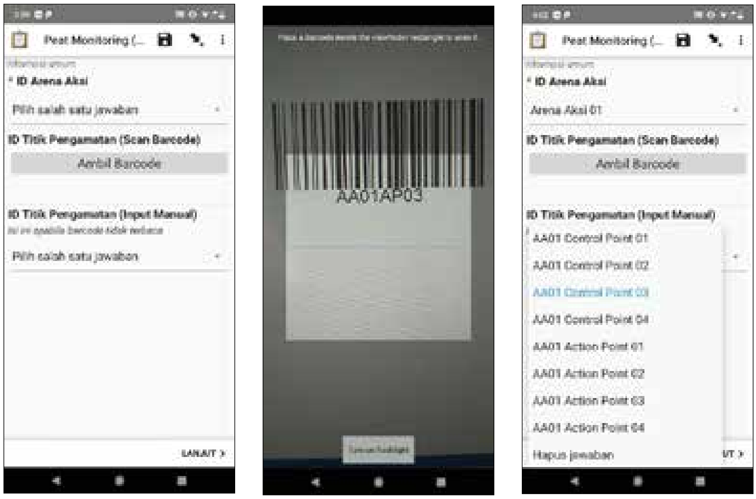


2. The first page contains identity information for the monitoring point or monitoring dipwell. Select the action arena where the monitoring dipwell is located using the drop-down menu.

Figure ▶

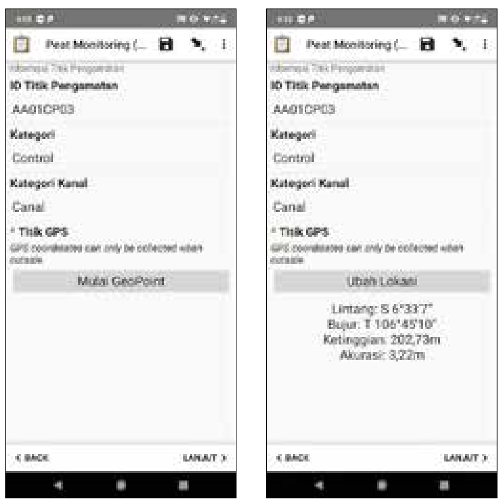
3. Check the ID label attached to the dipwell and enter the ID as the identification process. This can be done by scanning the barcode or using the drop-down menu. Once the barcode has been scanned successfully, the manual selection ID option will disappear. On completion, proceed to the following page by tapping the Next button.

Figure ▶



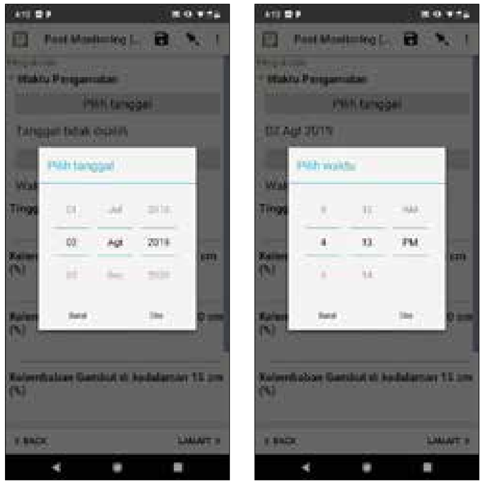
4. On the following page, the entered Monitoring Dipwell ID and category will appear for re-checking. Enter its coordinates by selecting **Start GeoPoint**. When the coordinates have been obtained, information on longitude, latitude, elevation and an accuracy value will appear. On completion, proceed to the following page by tapping the **Next** button.

Figure ▶



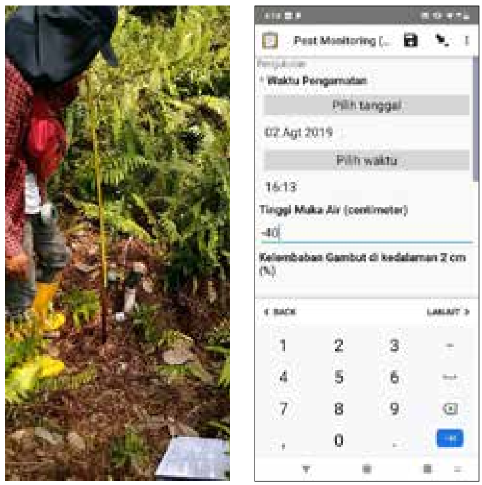
5. The next page contains fields on measurements. Enter the **Observation Time** by selecting the time and date of data collection. The date and time should be displayed automatically using the device's time and date information.

Figure ▶



6. Measure **Groundwater Level** using a measuring pole and enter the resulting value in the form field. The unit of measurement for Groundwater Level is centimetres, and will be a negative value.

Figure ▶

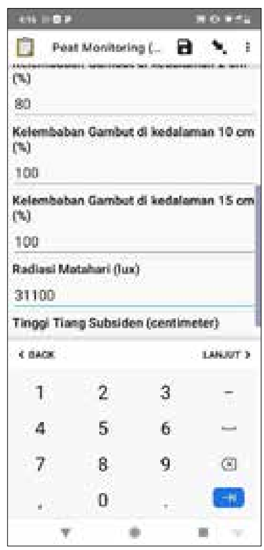


7. To measure **Peat Moisture**, use a moisture meter taking measurements at depths of 2, 10 and 15 cm below the soil surface. Enter the resulting values in the form field.

Figure ▶

8. **Solar Radiation** measurements are taken by using the Lux Light Meter app. Enter the resulting value in the form field.

Figure ▶

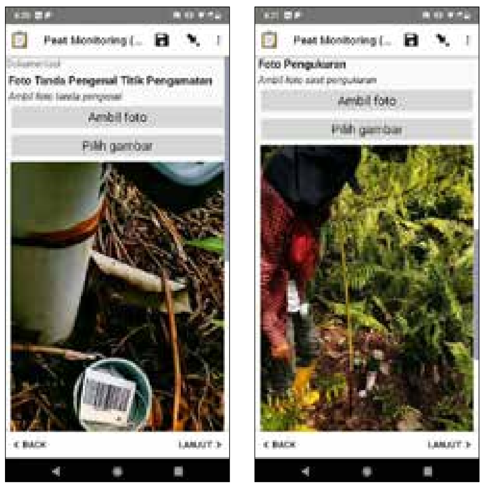


9. **Subsidence Pole Height** measurements are taken using a tape measure. Measuring the height from the tip of the pole to the ground surface. Subsidence pole height measurement are taken with a longer interval than other parameters bearing in mind subsidence occurs at a slower rate. On completion, proceed to the following page by tapping the **Next** button.

Figure ▶

10. The next page contains fields on activity documentation. To attach a picture to the form field, tap the **Take photo** button to take a picture using the camera, or the **Select picture** button to use a picture from the device's gallery.

Figure ▶



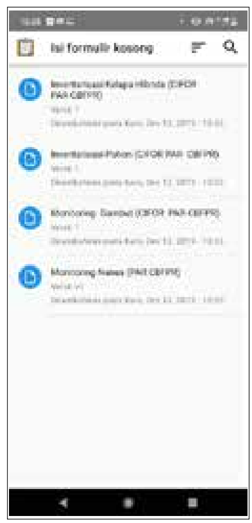
11. Additional information can be entered in the **Notes** field if needed. Once all steps have been completed, tap **Yes** in the **Survey complete!** field. On the end page, the monitoring date and dipwell ID will appear as the form name. Check it to indicate it is ready to send, then select **Save form and finish**.

Figure ▶

9.4.2 Tree monitoring

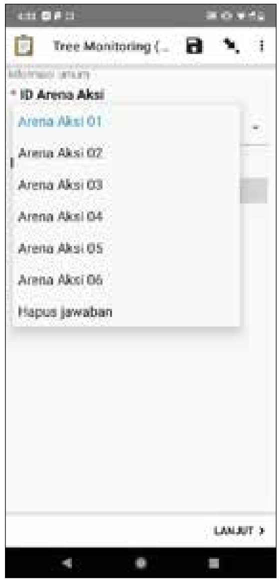
1. On the main page, select **Fill in blank form** and choose the [**Tree Inventory (CIFOR PAR-CBFPR)**] form to start entering data.

Figure ▶



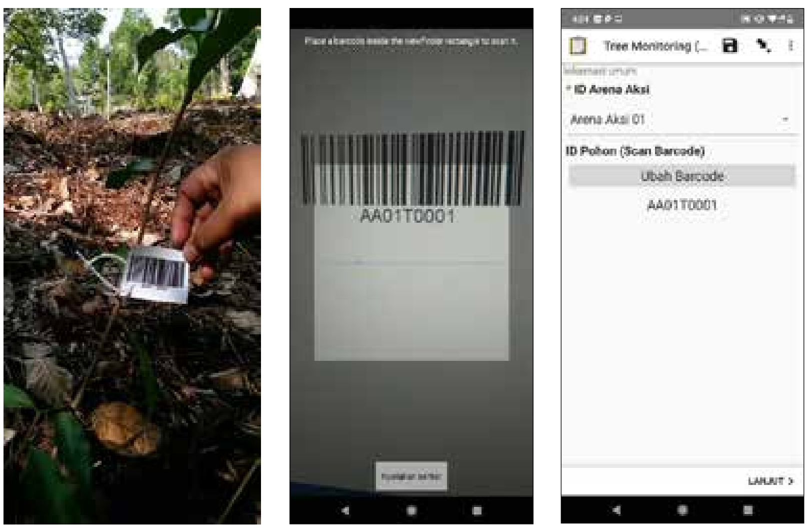
2. The first page contains location information. Select the action arena where the tree is located using the drop-down menu.

Figure ▶



3. Attach a barcode label to the tree ensuring it is properly affixed. Then commence entering **Tree ID** data using the barcode scanner, or by typing the barcode number listed on the label manually if the barcode is difficult to read. On completion, proceed to the following page by tapping the **Next** button.

Figure ▶



4. This page contains information on the planted tree: species, planting date and location coordinates. Double check the Tree ID displayed at the top of the page. Enter the species name manually using the keyboard, and enter or select the planting date. Enter its coordinates by selecting **Start GeoPoint**. When the coordinates have been obtained, information on longitude, latitude, elevation and an accuracy value will appear. On completion, proceed to the following page by tapping the **Next** button.

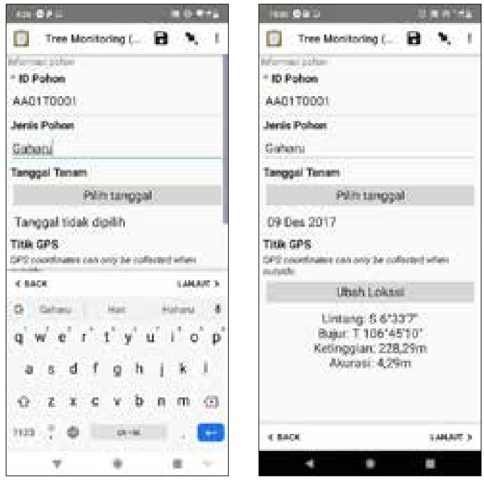


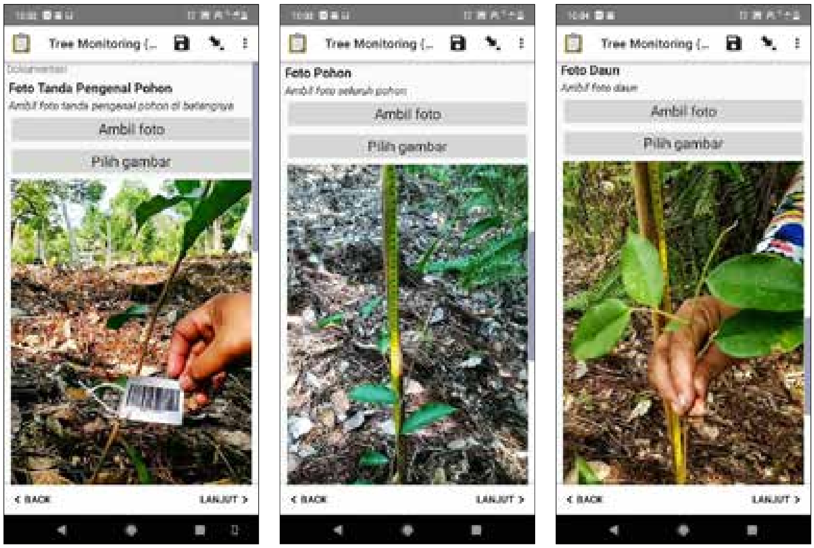
Figure ▶

5. The next page contains fields on measurements. The **Measurement Date** should be displayed automatically using the device's date information. Measure tree height using a tape measure and enter the resulting value. The unit of measurement for height is metres. Initially, only height data is necessary, but as the tree grows larger, stem diameter measurements will also be required. On completion, proceed to the following page by tapping the **Next** button.

Figure ▶

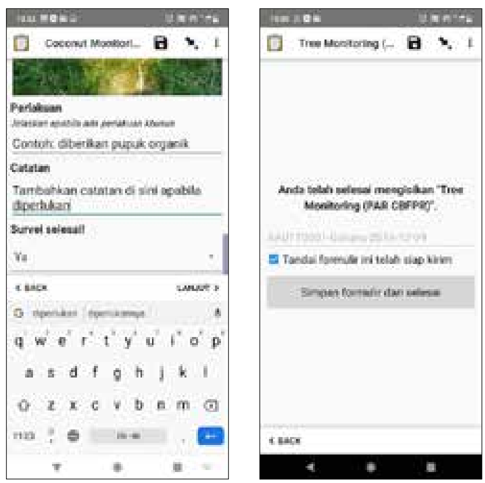
6. This page contains activity documentation information. Attach photos of the tree ID label, the whole tree and a leaf. To attach a picture to the form field, tap the **Take photo** button to take a picture using the camera, or the **Select picture** button to use a picture from the device's gallery.

Figure ▶



7. The next page contains a field on **Treatment** for inputting treatment applied to the tree. Additional information can be entered in the **Notes** field if needed. Once all steps have been completed, tap **Yes** in the **Survey complete!** field. On the end page, the monitoring date, tree ID and species will appear as the form name. Check it to indicate it is ready to send, then select **Save form and finish**.

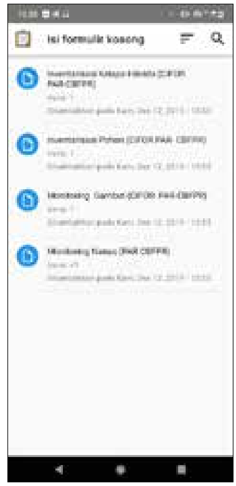
Figure ▶



9.4.3 Coconut monitoring

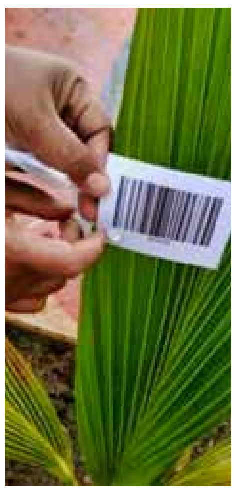
1. On the main page, select **Fill in blank form** and choose the [**Hybrid Coconut Inventory (CIFOR PAR-CBFPR)**] form to start entering data.

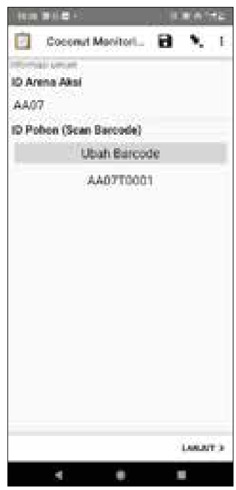
Figure ▶



2. The first page contains location and identity information. As Action Arena 7 is the only location where hybrid coconuts are being planted, Action Arena 7 will be displayed automatically. Attach a barcode label containing the coconut tree ID, then commence entering **Tree ID** data using the barcode scanner, or by typing the barcode number listed on the label manually if the barcode scan fails to read. On completion, proceed to the following page by tapping the **Next** button.

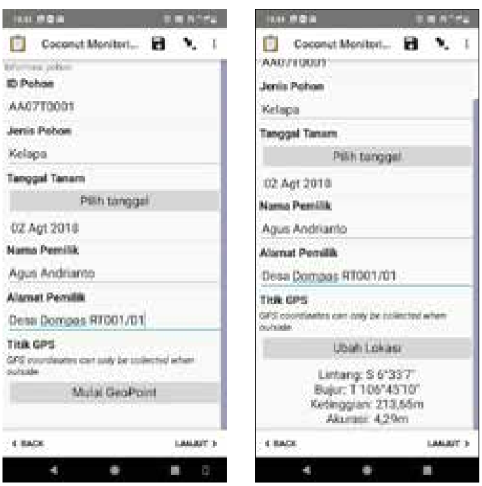
Figure ▶





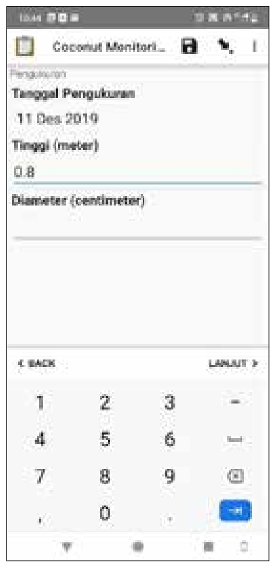
3. The next page contains fields for information on tree ID, species, planting date, owner's name, owner's address and location coordinates. As the form is devoted specifically to hybrid coconuts, *Kelapa* will be displayed automatically in the **Tree Species** field. The Tree ID entered on the previous page is listed at the top of the page for rechecking. Complete the **Owner Name** and **Owner Address** fields by asking the person in question. Enter coordinates by selecting **Start GeoPoint**. When the coordinates have been obtained, information on longitude, latitude, elevation and an accuracy value will appear. On completion, proceed to the following page by tapping the **Next** button.

Figure ▼



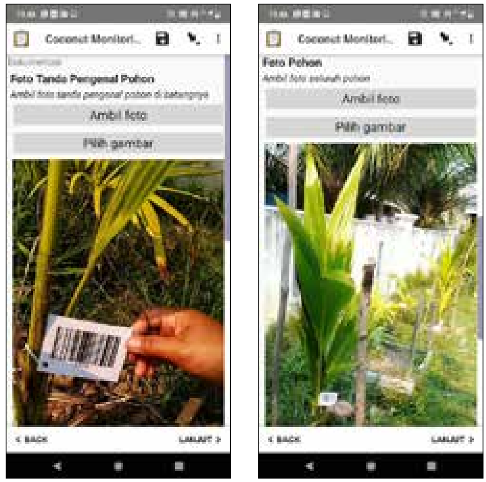
4. The next page contains fields on measurements. The **Measurement Date** should be displayed automatically using the device's date information. Measure tree height using a tape measure and enter the resulting value. The unit of measurement for height is metres. Initially, only height data is necessary, but as the tree grows larger, stem diameter measurements will also be required. On completion, proceed to the following page by tapping the **Next** button.

Figure ▼



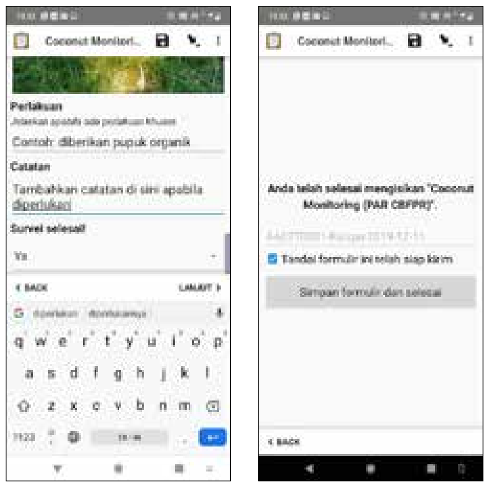
5. This page contains activity documentation information. Attach photos of the tree ID label and the whole tree. To attach a picture to the form field, tap the **Take photo** button to take a picture using the camera, or the **Select picture** button to use a picture from the device's gallery. On completion, proceed to the following page by tapping the **Next** button.

   Figure ▶



6. The next page contains a field on **Treatment** for inputting treatment applied to the tree. Additional information can be entered in the Notes field if needed. Once all steps have been completed, tap **Yes** in the **Survey complete!** field. On the end page, the monitoring date, tree ID and species will appear as the form name. Check it to indicate it is ready to send, then select **Save form and finish**.

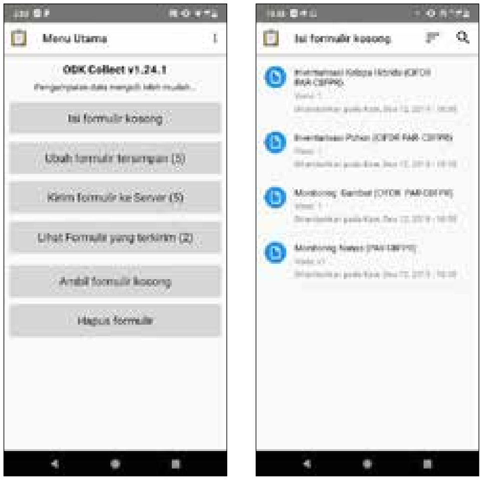
   Figure ▶



9.4.4 Pineapple monitoring

1. On the main page, select **Fill in blank form** and choose the [**Pineapple Monitoring (CIFOR PAR-CBFPR)**] form to start entering data.

Figure ▶

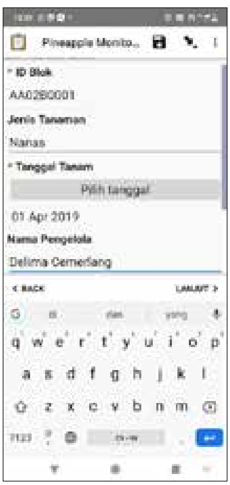


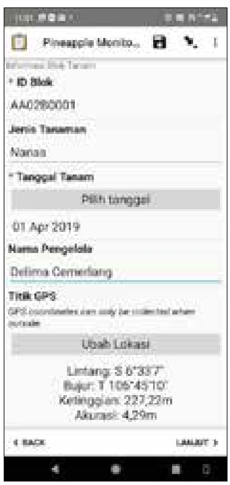
2. The first page contains information on the pineapple planting block. Select the **Action Arena ID** by choosing the appropriate arena from the drop-down menu. As pineapples are only being planted in Action Arena 02 and 03, only two options will be available. Next, enter the **Planting Block ID** data using the barcode scanner, or by typing the barcode number listed on the label manually if the barcode scan fails to read. On completion, proceed to the following page by tapping the **Next** button.

Figure ▶

3. The next page contains fields on planting block ID, crop type, the name of the group managing the planting block, and location coordinates. As the form is devoted specifically to pineapples, Nanas will be displayed automatically in the **Crop Type** field. The planting block ID entered on the previous page is listed at the top of the page for rechecking. Enter coordinates by selecting **Start GeoPoint**. When the coordinates have been obtained, information on longitude, latitude, elevation and an accuracy value will appear. On completion, proceed to the following page by tapping the **Next** button.

Figure ▼



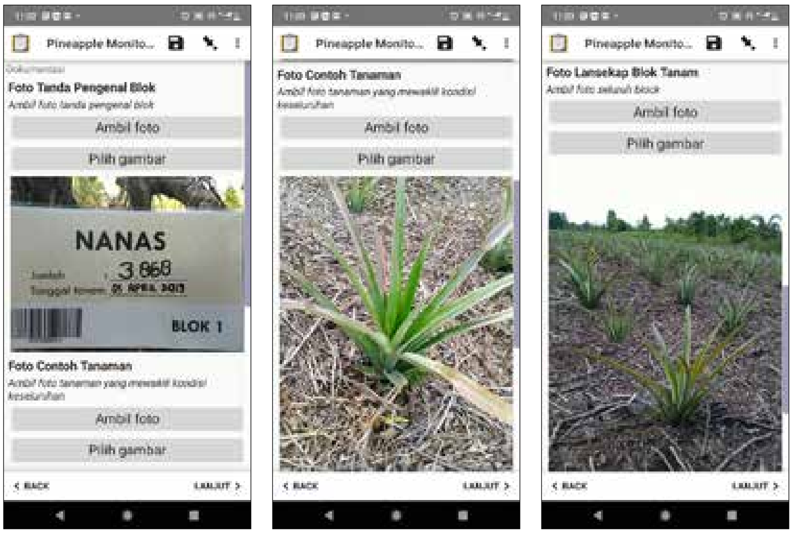


4. The next page contains fields on numbers of plants and fruits. The **Monitoring Date** should be displayed automatically using the device's date information. Count numbers of pineapple plants and fruits in the planting block and enter the resulting values in the appropriate fields. On completion, proceed to the following page by tapping the **Next** button.

Figure ▼

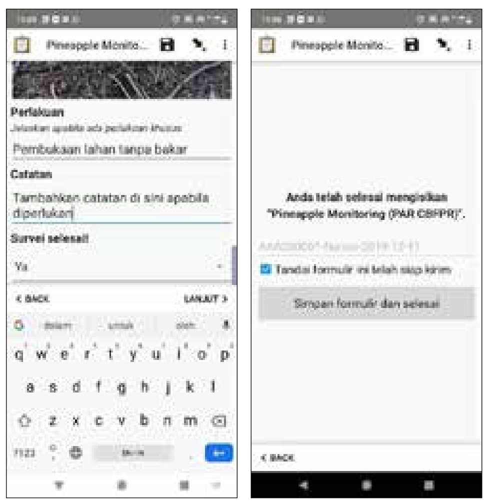
5. This page contains activity documentation information. Attach photos of the planting block barcode ID label, one pineapple plant representative of general crop condition, and one showing the planting block. To attach a picture to the form field, tap the **Take photo** button to take a picture using the camera, or the **Select picture** button to use a picture from the device's gallery. On completion, proceed to the following page by tapping the **Next** button.

Figure ▶



6. The next page contains a field on **Treatment** for inputting treatment applied to the crop. Additional information can be entered in the Notes field if needed. Once all steps have been completed, tap **Yes** in the **Survey complete!** field. On the end page, the monitoring date, planting block ID and plant type will appear as the form name. Check it to indicate it is ready to send, then select **Save form and finish**.

Figure ▶



9.5 DATA VISUALIZATION

Data visualization and interpretation are important for understanding prevailing conditions. The CO-PROMISE monitoring platform uses Microsoft Power BI to display monitoring results through an online dashboard. The software provides a customizable interface, and has a direct connection to the KoBo Toolbox database enabling data to be displayed immediately after monitoring results are sent to the server.

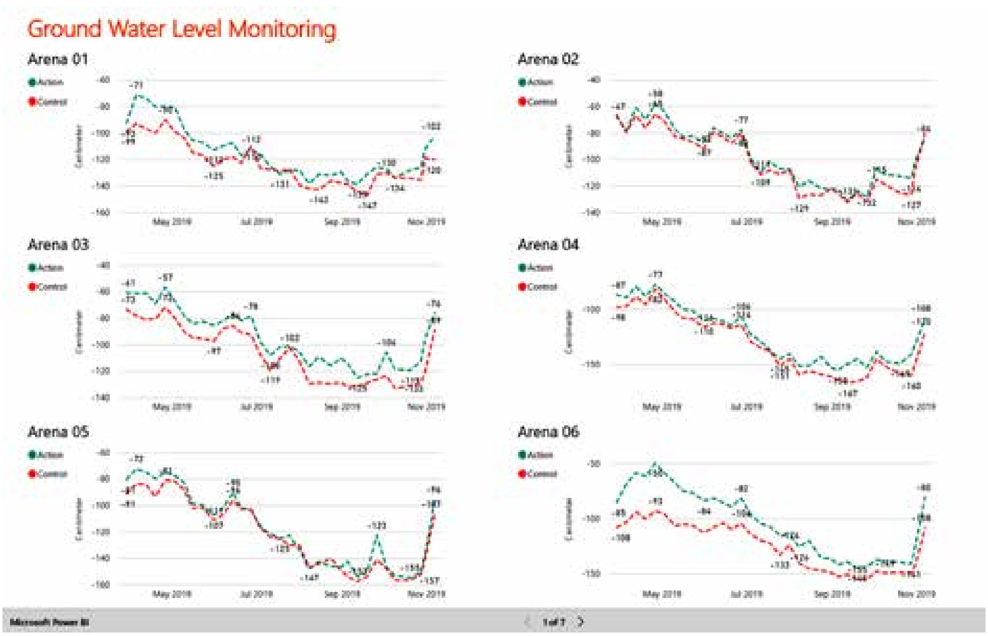


Figure 9.6. Screenshot of the peat groundwater level monitoring dashboard
https://www.cifor.org/fire-and-peatland-restoration/research/monitoring-of-the-action-arena/

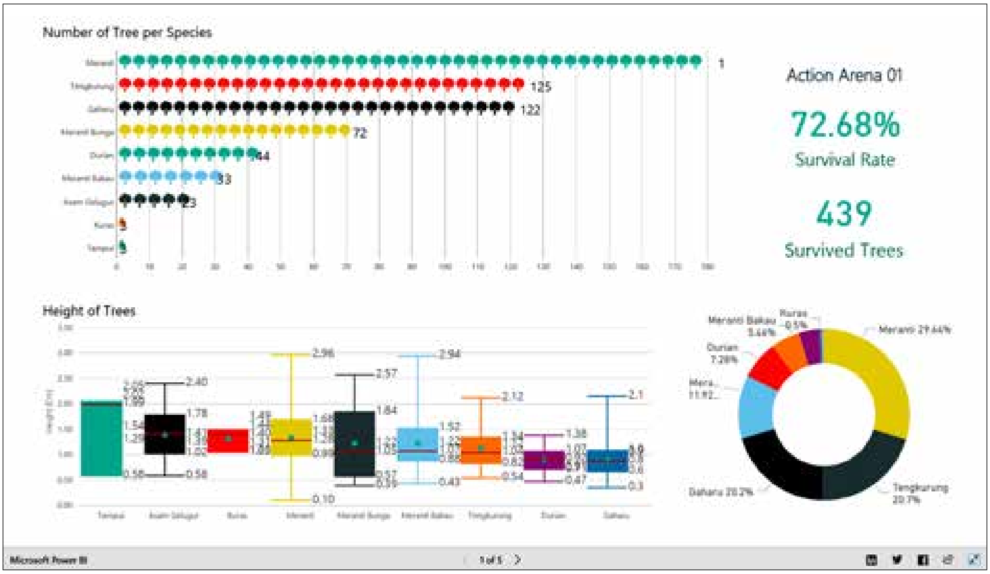


Figure 9.7. Screenshot of the tree monitoring dashboard
https://bit.ly/treemonitoring

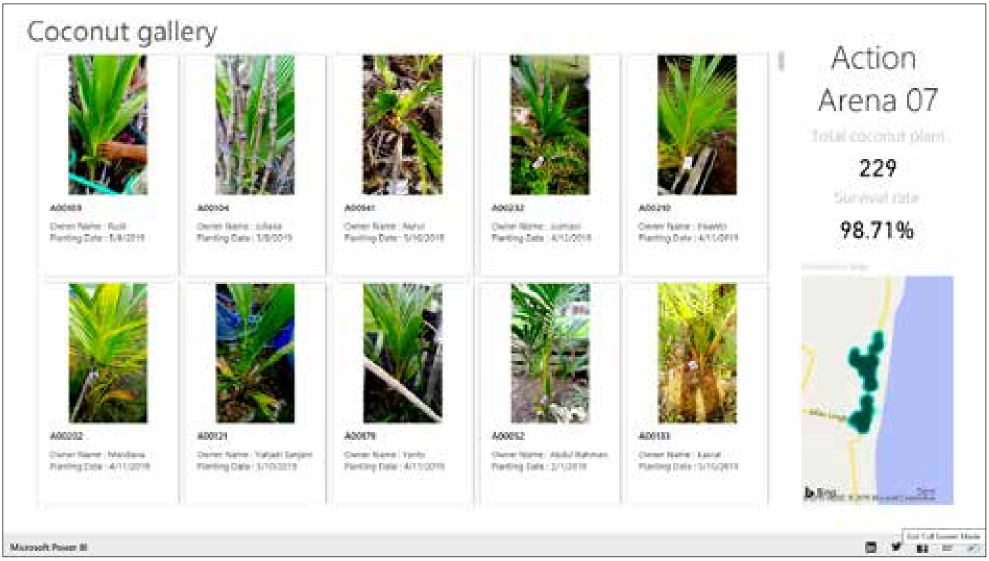


Figure 9.8. Screenshot of the coconut monitoring dashboard
https://bit.ly/coconutmonitoring

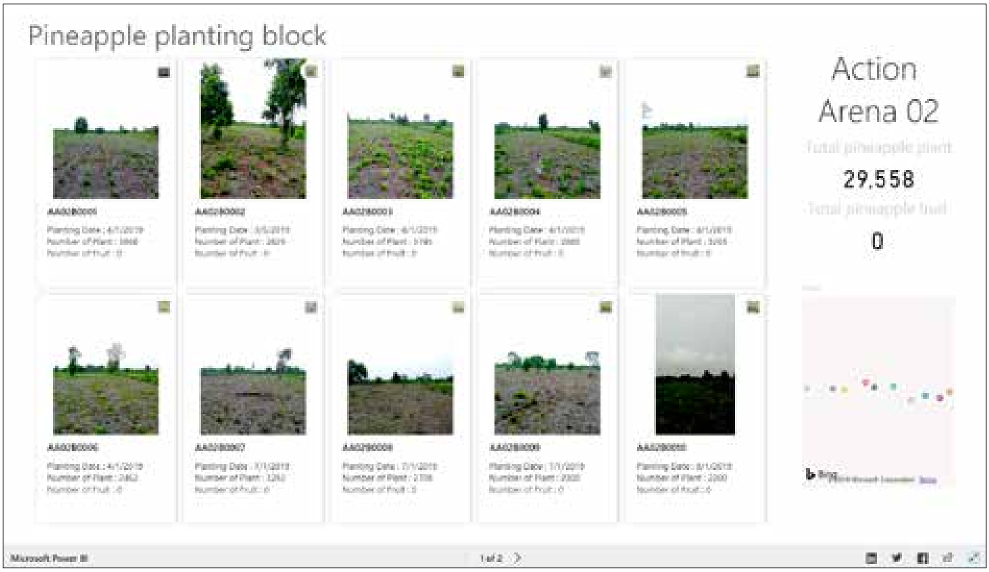


Figure 9.9. Screenshot of the pineapple monitoring dashboard
https://bit.ly/pineapplemonitoring

9.6 QUALITY ASSURANCE AND QUALITY CONTROL

Quality Assurance (QA) and Quality Control (QC) are important for ensuring data integrity and minimizing errors. As a proactive process, quality assurance involves training; providing step-by-step guides and instructions in question forms; reviewing and writing monitoring data in logbooks as backup in the early stages of monitoring; providing pictorial documentation; and maintaining communications between data managers and community members responsible for collecting measurement data. It is a continuous process of preventing, detecting and correcting measurement errors to ensure the quality of the system's data.

Quality control, meanwhile, is a more reactive process incorporated into the system for detecting and preventing monitoring errors. It is applied through the use of barcodes for identifying objects of monitoring; defining types of data in forms; setting up accuracy tolerances for geolocation; applying mandatory fields for completion in forms; and applying data error ranges when forms are set up. Through quality control, the app can detect data inputting errors and prevent the user from proceeding to the next page in the form. Both of these processes were set up to prevent data loggers inputting erroneous monitoring data.

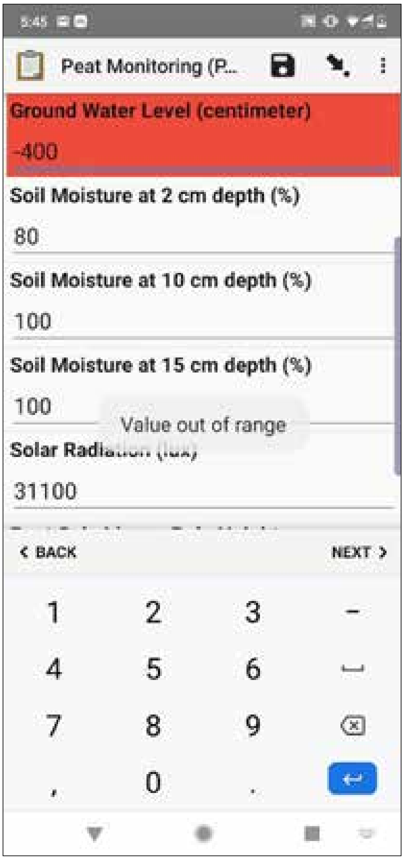


Figure 9.10. Example of erroneous data detection with the entered value falling outside the viable range

9.7 LIMITATIONS

- The monitoring system still requires data loggers to visit sites to take measurements.
- All data is stored on the CIFOR server, and platform use is still limited to activities relating to CIFOR. Nevertheless, the platform is very open to modification for using in the interests of various parties.
- The accuracy of devices' GPS coordinates is still relatively low. Even though ODK Collect applies a GPS averaging method and a minimum accuracy to three meters, considering the existing plant density, measurement results still appear scattered and do not show structured patterns.

9.8 REFERENCES

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.

Ideas, narratives and arguments on preventing natural disasters and restoring ecosystems focus on raising awareness and fostering participation from all parties. Conventional research helps in understanding socioecological systems and their interactions, but governments, communities and donors want research that makes a difference. There is an urgent need for tangible change. Research conducted with full participation and an action-oriented approach is the solution. Participatory Action Research (PAR) is designed to bring real change on the ground. PAR is transdisciplinary in nature; it integrates approaches from various disciplines and draws on both local and global wisdom. This book aims to provide an understanding of the concepts, philosophical foundations and steps involved in implementing PAR, and is complemented by examples of fire prevention and community-based peatland restoration efforts implemented in Riau Province, Indonesia. We hope it can serve as a valuable resource for researchers, private sector operators, communities, NGOs, governments and practitioners involved in natural disaster prevention and ecosystem restoration.

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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