Tropical Peatland Restoration Toolkit

By PM.Haze

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a People's Movement to Stop Haze

Contents

1. Overview

Background and objectives

In 2019, PM.Haze with the support of various partners embarked on a peatland restoration project to enable the revegetation and rewetting of degraded peatlands located in the village of Sungai Tohor, Riau Province, Indonesia. This toolkit was developed as part of our efforts in knowledge management so that it can be used by others who are interested in developing similar community-led programmes. This toolkit is also a work-in-progress; information contained within is based on our experience with Sungai Tohor and existing literature, and we aim to regularly update this document to reflect our latest understanding and future experiences.

This toolkit aims to give a layman overview of how to plan, develop and maintain a community-led peatland restoration programme for degraded peatlands. In a community-led approach, the focus is to empower the community and enable them to carry out restoration work. While the targeted outcomes are restoration of peatlands and prevention of fires, it is also critical that the community understands and benefits from the restoration activities. This toolkit should only serve as a reference or decision-making aid rather than a step-by-step guide; it is recommended to tailor implementation plans to suit the project situation.

Areas of focus

There are a variety of activities that can be implemented in a community-led peatlands restoration project, which includes activities such as fire prevention and management. In this toolkit, we will focus on 3 key aspects: i) Community engagement, ii) Rewetting and iii) Revegetation. This includes elements such as:

1. Initial assessment of the restoration area and community.
2. Community engagement to get support from the local community.
3. Planning, implementation, and monitoring of
    - Rewetting (canal blocking) and
    - Revegetation work.

Why is community involvement important?

Community involvement is an essential aspect of peatland restoration, by aligning with local needs and perspectives, it can help ensure the long-term success and sustainability of restoration efforts. Outcomes include:

- Increased ownership and stewardship: When communities are involved in peatland restoration, they are more likely to feel a sense of ownership and responsibility for the success of the restoration. This can lead to increased engagement and participation in ongoing management and monitoring activities.
- Improved local knowledge: Communities often have a wealth of local knowledge about the environment and natural resources, including peatlands. By involving communities in peatland restoration, practitioners can tap into this knowledge and ensure that restoration efforts are informed by local perspectives and realities.

- Improved social and environmental outcomes: Community involvement can help ensure that peatland restoration efforts are aligned with local needs and priorities. This can lead to improved social and environmental outcomes, as communities are more likely to support and benefit from restoration activities that are tailored to their needs.
- Improved stakeholder engagement: Community involvement can help build trust and engagement with other stakeholders, including local government, businesses, and environmental organizations. This can help to ensure the long-term success of peatland restoration efforts, as these stakeholders are more likely to support and invest in restoration activities that have broad-based support.

2. Prerequisites

Based on our surveys and experience in small-scale peatland restoration, we have identified several prerequisites that have significant impact on the feasibility and success of a restoration project. It is recommended to have a complete understanding of these success factors before or during the initial stages of engagement with the community before commencing work.

2.1 Restoration area and supporting community has been identified.

There are many ways to identify and originate projects that will not be discussed in this toolkit. Briefly, such approaches include through formal channels such as Peatland and Mangrove Restoration Agency (BRGM) or non-profit groups such as Friends of the Earth Indonesia (WALHI), or informal means such as through local community support networks that share information on firefighting or restoration needs.

2.1.1 Selection of potential restoration sites

It is important to consider the location of the restoration site, including its proximity to urban areas, critical habitats, and other important natural resources. The site should be accessible and within a reasonable distance of the communities that will be involved in the restoration process.

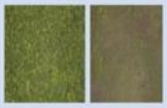
Factors such as vegetation cover and health, as well as peat water levels affect the rate of restoration of peatlands. A geospatial survey will give insight on the typology of the degraded peatlands and the corresponding intensity of land management that is required to restore the peatland. Classification of peatland based on their typology and extent of degradation helps to identify sites to be prioritised for restoration, as well as provide an indication of site-specific requirements for maximised effectiveness of restoration measures.

Peatlands are highly dependent on hydrology, and it is important to consider the water levels and water management practices in the area. The site is preferably in an area with stable water levels and a well-defined hydrological regime. The site should have a sufficient depth of peat to support healthy peatland ecosystems, and the peat should be of good quality and not highly degraded.

The vegetation in the area should be considered, including the presence of invasive species, the diversity of native species, and the overall health of the vegetation. Sites with a high diversity of native vegetation are generally preferred for peatland restoration. Areas surrounded by good canopy cover and healthy trees are also ideal for peatland restoration.

The table below describes the intensity of management required and therefore the resources required to carry out restoration.

Increasing intensity of Land Management

Category	Type	Intact Peat forest	Drained and no clearing	Drained and selectively clearing	Drained peat with history of fire or significant clearing
Examples	Photographs from the field				
	Aerial photographs				
Vegetation	Canopy cover	*High*	*Low*	*Low*	*None*
	Richness	*High*	*Medium*	*Medium*	*Low*
	Tree health	*Healthy*	*Not as healthy (<DBH)*	*Not as healthy (<DBH)*	-
Carbon storage capacity	Carbon emissions	*C negative*	*C neutral to positive*	*C positive (~1.5 tons CO2 ha-1 yr-1)*	*C positive (~5.0 tons CO2 ha-1 yr-1)*
	Water Table Height	*High*	*Low*	*Low*	*Low*
	Peat Subsidence	*Not significant*	*Not significant to Significant*	*Very Significant*	*Very Significant*

Maps from official local sources can be used alongside other publicly available sources. Examples of map sources include:

- Geospatial Information Agency web app that can display data from various ministries and independent agencies in Indonesia.
- Digital Elevation Model & Bathymetry Model from Geospatial Information Agency.

Other considerations that can improve the success of restoration include:

- Higher elevations are preferred to mitigate risks of flooding due to heavy rainfall that can damage vegetation at a lower elevation.
- Sites which are common fire hotspots are also avoided to reduce the risks of the vegetation being damaged by recurring fires.
- Other human factors that are specific to the location that may impact short- and long-term success of the restoration work.

2.1.2 Initial understanding and acceptance or willingness of community leaders.

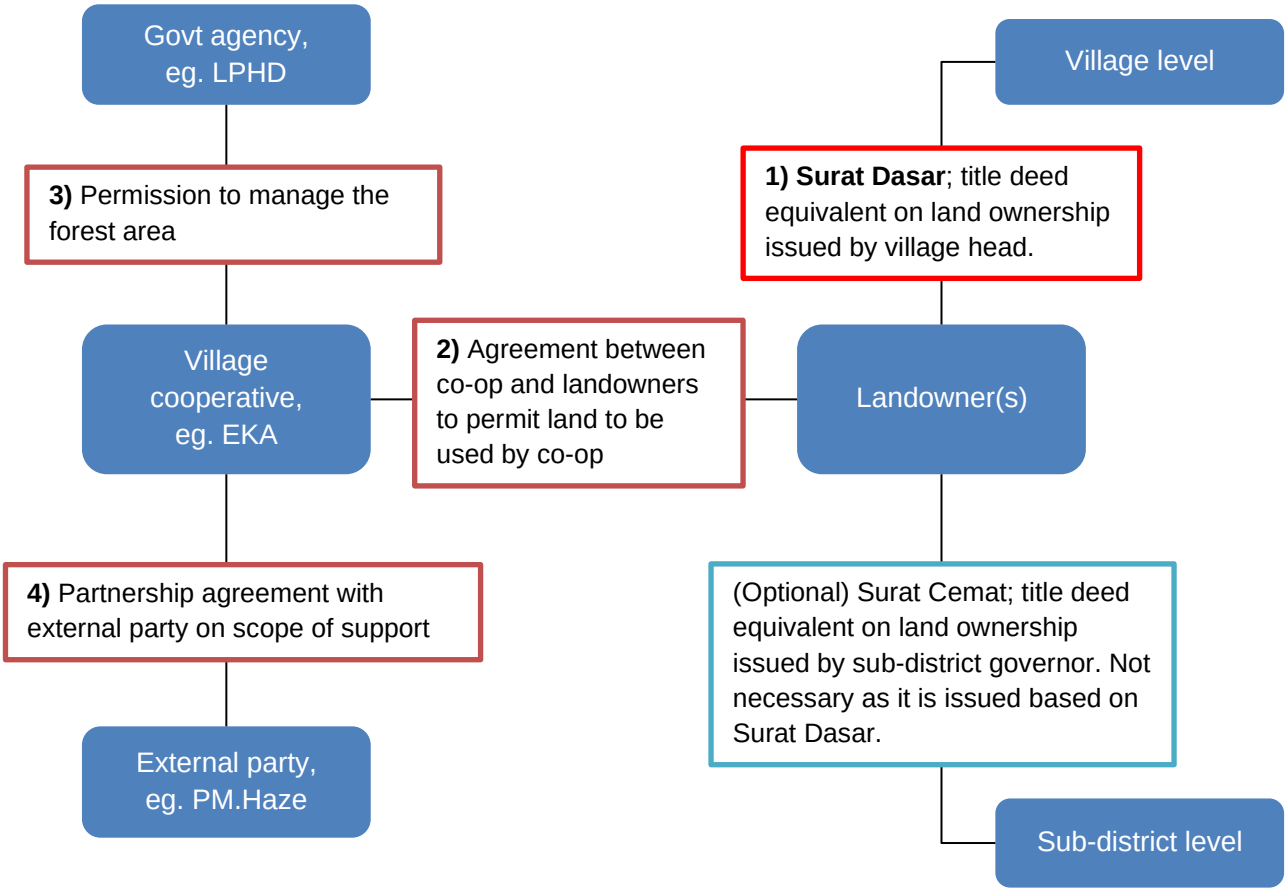
It is important to consider the level of stakeholder engagement and the willingness of local communities to participate in the restoration process when selecting a potential restoration site.

A community-led peatland restoration project requires the local community to be heavily involved in the restoration work. It is therefore crucial that the key decision makers and community leaders are engaged early in the discovery and development of the project to secure their interest and support, which is necessary for activating the wider community to participate in the restoration activities, improving knowledge transfer and competency building.

2.2 Ownership and rights to operate in the restoration areas are clear and documented.

The site should be accessible for restoration activities and should not conflict with other land uses, such as agriculture or forestry. It is also important to consider the ownership and access rights of the site, as well as any legal or regulatory constraints that may impact the restoration process.

In this toolkit, we will assume that land ownership falls under non-corporate or non-government owners. In this scenario, the landowners should hold onto a document called “Surat Dasar”, the title deed equivalent to prove land ownership. This is the basic document required before all other documents are obtained. The diagram below shows the various parties, the contractual relationships between parties, and the recommended sequence of obtaining these documents.



Other than the Surat Dasar, it is not necessary for the other documents to be in order before engaging the decision-makers. After determining the feasibility of the project, the village cooperative can then separately obtain the permissions to manage the forest area from the government (LPHD) and sign the agreement with the landowners to work on the land. Obtaining these documents can occur concurrently with preparation work prior to restoration. However, it is highly recommended to have all these documents in place before commencing restoration work on the land to avoid any complications.

2.3 Availability of a local project manager

The importance of a local project manager cannot be understated. A competent and trustworthy project manager on the ground is essential, particularly when physical access to the location might be restricted, such as travel restrictions due to pandemic or natural disasters. Hiring of the project manager should be done immediately after identifying the restoration location. Based on the restoration scope of rewetting, revegetation and community engagement, the following job description serves as an example of what is expected of a restoration project manager.

Job description

The role of the project manager is to maintain regular and effective communication with the community, to ensure that the community is actively engaged and carrying out the restoration work in a timely manner. As such, it is imperative that the project manager has the necessary communication and project management skills to ensure that the community is well-supported in their activities. As the scope of the restoration work covers a wide range of activities that may not be fulfilled by an individual, it is recommended to engage consultants or contractors to provide one-time services to cover activities that is not provided by the project manager.

The time commitment expected of the project manager throughout the project cycle varies. Initial engagement to establish trust with the community will require consistent and regular visits to the village in-person. This can range from monthly visits of 1-3 days per visit to ensure that administrative and preparatory matters are progressing. At the beginning of restoration work, weeklong visits might be warranted to guide the community in setting up and organising the work. Once the community is on track, the duration and regularity of the visits can be reduced. The project manager is also expected to conduct and oversee community events on an ad-hoc basis, which should be timed alongside these visits.

Details of the community engagement process can be found in the later section; the project manager is expected to understand and lead these engagement efforts.

Responsibilities and capabilities

In the event where the project is of a considerably larger scale, the role of the project manager can be split amongst a team, with each team member handling a set of tasks. Responsibilities and corresponding capabilities include but are not limited to:

Responsibilities	**Skills, qualifications, experience**
Establish a trust-based relationship with the community and key leaders and decision makers.	Personable character with strong communication and language skills. Bahasa Indonesia is required, and basic English is preferred.

Reporting and relay information to internal stakeholders.	Relevant experience and software skills in writing reports and presentation materials.
Conduct training sessions to educate community on rewetting, revegetation, and other relevant skills as required.	Relevant educational background in tropical agriculture, botany, forest conservation or experience in peatland-related work.
Organise and manage restoration activities and events, including building canal blocks, nursery for seedlings, transplantation, measurement, and data recording. Able to come up with scope of work, costing and budgeting, and ensure the execution of tasks required of the restoration project.	Relevant agriculture or construction-related project management experience.
Represent the organisation to negotiate and discuss administrative matters with appointment holders and officials.	Appreciation of local politics and issues, including macro events that might impact the project and the community.
Prepare and organise fire response efforts when fires and haze occur.	Understanding of fire-fighting processes and the equipment and resources required.

3. Establishing a baseline

Setting a baseline is an important step in the peatland restoration process, as it provides a starting point for measuring the success of the restoration effort. There is no general or reference baseline as each site is unique, therefore a site-specific baseline must be constructed. This step can be undertaken as part of the initial discovery or engagement process but should be completed prior to starting restoration work. Key indicators should correspond to the programme activities. For this toolkit, the focus will be on i) The community's understanding of the importance and benefits of peatland restoration, ii) vegetation growth and iii) hydrology of the restoration area.

A comprehensive baseline assessment of the site should be conducted to gather data on the key indicators identified above. This may involve field surveys, remote sensing, and other methods of data collection, depending on the type and scope of the restoration project. The data is then analysed to determine the current state of the site, such as the extent of degradation, the diversity of native vegetation, the water table within and around the restoration area, and the level of awareness and understanding of the community in peatlands and restoration methods.

A rapid field assessment guide was developed as part of our peatland restoration work, which can be used for both establishing a baseline and future monitoring. More information can be found in our Rapid Field Assessment Methods for Monitoring.

Based on the results of the baseline assessment, a monitoring plan should be established to track changes in the key indicators over time. The monitoring plan should specify the methods and frequency of data collection, as well as the process for analysing and reporting the data. More information monitoring and its process will be described in the final section.

4. Community engagement

The most essential aspect to a successful peatland restoration project is the community involvement. For the restoration to be sustainable in the long term, the community must see the benefits of the restoration and be willing to participate and take on the role as caretakers of the peatlands. As such, the engagement process must be customised based on the level of understanding and commitment of the community.

4.1 Stakeholders mapping

First, it is important to understand who are the internal and external parties that influence the community and their decisions. The table below is based on what we have learnt so far for small-scale restoration:

Stakeholder	**Role and importance**
Village cooperative or local NGO, eg. EKA	Local organisation that manages peatland restoration efforts. Often formed by key members of the community who also participate or are involved in other non-profits or government agencies like EKA and WALHI.
Village head	Main decision maker for the village who also authorises issuance of Surat Desar (title deed of ownership).
Smallholders	Landowners of (degraded) peatlands.
Community and villagers	Local villagers whose lives and livelihoods are affected by fires and peatland degradation. They can also provide additional manpower for canal blocking and revegetation efforts.
Government (appointed) agency, eg. LPHD	Lembaga Pengelolaan Hutan Desa (LPHD) or Villager Forest Management Institution, the government agency that authorises use of land for community development.
Non-profits, eg. WALHI	Other non-profits that may operate in the area; usually providing similar support in education, rewetting, revegetation, and community building efforts.

There might also be unofficial or informal groups that are supporting the community. We recommend working with small-sized, officially registered entities for the following reasons:

i. Registered entities have legal operating rights; this makes it easier to legitimise the restoration work when official stakeholders participate or get involved.
ii. They can front the operations, especially if the supporting entity, e.g. a foreign-based organisation, is not legally allowed to operate.

iii. A small organisation with less decision-makers and processes allows flexibility for a faster and more efficient turnaround time from project origination to execution, eliminating the need to establish more formal frameworks that may be required with a larger organisation.

4.2 Engagement process

The engagement process is ideally done laterally and bottom-up, starting from the village community that will be directly involved with the restoration efforts to supporting organisations, before gradually moving upwards to organisations at the city and provincial levels only when required. The following steps are recommended:

1) Assessment of needs and interests with community leaders: The first step in the community engagement process is to assess the needs and interests of the local community. The local project manager, preferably with the help of an introducer, engages the leaders and decision-makers, pitching the project, and conducting focus group discussions or other forms of engagement to better understand the priorities and concerns of the community. It may also be useful to understand local politics to avoid and mitigate potential conflict.

2) Development of communication and outreach strategies: Based on the assessment of community needs and interests and in consultation with its leaders, the project manager can plan activities that will engage and involve the community in the restoration process. This may involve the use of traditional and modern communication tools, such as community meetings, flyers, social media, and other forms of outreach. Approvals and consensus between the village head, district head and key members of the community must be obtained at this stage. This can be done through informal settings such as group discussions where key stakeholders are present. Formal means of approval such as MOUs can be acquired at later stages (preferably after work has commenced) for campaign or marketing purposes, further cementing the partnership.

3) Implementation of community engagement activities that are aligned with communication and outreach strategies: This may involve organizing community meetings, training sessions, and other forms of engagement that allow the community to participate in and contribute to the restoration effort. Refer to the next section for more details.

4) Feedback, evaluation, and improvement: Regularly collect feedback from the community and evaluate the impact of the community engagement activities. This can help to ensure that the engagement process is effective and that the needs and interests of the community are being addressed. Based on the feedback and evaluation, continuously improve the community engagement process to ensure that it remains relevant and effective over time. This may involve adjusting the communication and outreach strategies, the types of engagement activities, and the overall approach to community engagement.

5) Building a support network: After work has commenced and with local leaders fronting these engagements, carefully establish contact and connections with higher levels of the local

government and relevant ministries to build rapport and acknowledgement. This can lead to uncovering other restoration opportunities.

Types of community engagement activities

Engagement activities aim to educate the community on the importance of ecological restoration and the importance of sustainable small-scale agriculture on peatlands. In our approach, we work with the community to develop an engagement programme based on a tiered model, tailored to the participants' level of understanding, interest and influence in the community.

Introductory induction sessions

Before the restoration project starts, village leaders will hold an induction session of the project. The induction session aims to introduce the project and gain support from the community. Community stakeholders, such as village and district officials and schoolteachers are invited to attend the induction session. The process and outcomes of the restoration project should be communicated, answer the community's questions, and provide reassurance in the event the restoration work impacts their daily life, such as the repair of canal blocks which might affect peat water distribution. This is a necessary step to take at the early stages of restoration work.

Workshops for continuous engagement

In later stages and for participants who are interested to learn more, workshops will be conducted to generate interest in peatland restoration and educate the villagers about the relationship between fires and peatlands. The workshops should cover: i) Sustainable agriculture on peatlands; ii) fire prevention techniques on peatland areas; iii) Technical knowledge on implementation and monitoring of peatland restoration. Examples of such workshops include: Knowledge on useful peatland species, maintenance of nursery and transplanting of seedlings, canal block maintenance, monitoring and documentation skills etc. Group size should be kept small to manage costs and improve learning and engagement. These workshops are ideally carried out by the project manager.

Alternatively, skills or knowledge that the community wishes to learn can be considered, even if these workshops do not directly contribute to peatland restoration. These workshops aim to improve the livelihoods of the community by providing alternative sources of food or income, such as beekeeping, carpentry, and backyard farming. It may be necessary to bring in experienced trainers from outside the community for such workshops.

In addition to skill or knowledge gaps, there might also be socioeconomic gaps such as lack of women participation in restoration efforts. Identifying these gaps, analysing the reasons before engaging community leaders is important to tackle culturally sensitive issues. This can be done through focus group discussions with the support from experts from local organisations dealing with such topics.

Town halls for progress updates

For community members who are not involved in the project directly, town hall sessions can be held at a community space to provide progress updates. To incentivise a large group of people to attend these sessions, easily accessible entertainment activities such as karaoke sessions can be held after the town hall sessions. Town hall sessions can also be hosted in conjunction with workshops.

Annual surveys and feedback

At the end of each year, an awareness survey should be conducted to assess the community's level of understanding on peatland restoration. Feedback about the project and the engagement programme should also be gathered. A sizable number of participants is recommended (>50 people) to obtain statistically significant results. Incentives such as distributing seeds and entertainment activities can be provided to improve participation. Surveys can also be conducted in conjunction with town halls.

5. Rewetting

Rewetting through the blocking of drains and canals is part of the two-pronged approach towards restoration. It helps to retain water inside the peat, restoring hydrological balance, reducing fire risk, and supporting revegetation efforts. Barriers in the form of canal blocks can be built by placing dam or bund infrastructure with the aim of reducing surface run-off and increasing water storing capacity within the blocked canals.

5.1 Selection of location and canal blocks

To optimise rewetting, siting of new canal blocks should be determined by studying the hydrology of the demarcated degraded peatland ecosystem. Such a study analyses the seasonal changes in water levels, peat depth and quality, drainage infrastructure and can be conducted by water management and peat hydrology experts. However the costs to carry out such studies can be high. The local community may also have their preferences in canal block location; this needs to be considered carefully with hydrology data to avoid building canal blocks that cause unintended flooding in nearby areas or are unable to survive prolonged flooding during wet seasons.

Without these studies, it is recommended to repair existing canal blocks which are already present within the community. This reduces the impact of new canal blocks on the livelihoods of the community, which may be using the canal for productive purposes or have accustomed their lives around the existing water infrastructure. Canal blocks should also be selected or built close to the degraded area that will be revegetated.

Mapping of the location of these canal blocks will help in the evaluation and selection process. Through mapping, locations of broken canal blocks are indicated and potential locations for new canal blocks can be assessed. Broadly, the steps taken are:

1. GPS is used to record the coordinates of all canal blocks of interest.
2. The collected data is used to plot the coordinates of the canal blocks and intended restoration area onto a map through GIS software or similar.
3. With this map information and in consultation with the community (or hydrology experts if available), the community can plan and prioritise canal blocks to build or repair.

5.2 Construction of canal blocks

In this toolkit, we will only cover the repair or reconstruction of small-sized canal blocks less than 10 metres in width. Canal blocks may be in various states of disrepair, from being completely submerged or destroyed, to partially damaged due to flooding or lack of maintenance.

While there are several types of canal blocks, two types will be highlighted in this toolkit. The main types and their advantages and disadvantages are:

1. Box dam: Box-like structures made of wood and infilled with bags filled with sand or manually compacted peat. Can be constructed using local labour and typically comes with a spillway to allow small boats and materials to pass from the top of the canal.

    a. They are easy to build and allow the community to continue using the canal as a waterway for their economic activities.
    b. However, without maintenance they do not last longer than 2-3 years, requiring regular maintenance to replace supports or bags that are washed away.
2. Compacted peat dams: Consist of peat soil excavated from a nearby location and backfilled into the canal and compacted by the excavator driving across it. Does not require local labour and a spillway to the side can be built to allow waterway access if required.
    a. These dams aim to reduce water flow significantly, can be built faster and cheaper than a box dam, and last longer up to 5-10 years if built well.
    b. However, as it aims to reduce water flow completely, spillways are avoided, preventing the community from using it. It is also easy to undo the dam through excavation, unlike the box dam which is made of structures.

A combination of canal block and dam types can be implemented within the same area to achieve desired rewetting and community outcomes. For the design and construction of canal blocks, please refer to the engineering plans from the Detail Engineering Design (DED) by Badan Restorasi Gambut (BRG). Documented in Bahasa, the designs contain detailed information on the materials required and construction methods to build types of box dams.

5.3 Implementation considerations

Scheduling considerations

Canal blocks should be constructed during the dry season, which is typically from April to August. This reduces the risk of flooding which might damage an uncompleted dam caused by washing away of materials. As such, it is recommended to start the procurement and logistical work at least a few months before work commences, to ensure that the canal block is completed before entering the wet season starting in November until March. Note that duration required for procurement and logistics is affected by the accessibility of the canal block.

Holidays and festivals

It is important to consider the festivals and holidays that the community observes and avoid scheduling work during these periods. For Muslim communities, these are periods such as Ramadan lasting 30 days, followed by the holidays Eid ul-Fitr (Idul Fitri) and Eid ul-Adha (Idul Adha) which lasts 1-3 days each. For best results, align the work schedule after consulting with the community.

Resource requirements

Depending on the size and width of the canal block, anywhere from 8 to 15 persons are required to carry out the construction or repair work. It is important to have experienced individuals to supervise and lead the canal building and repair work. Repairing a canal block can take at least a week. The deeper the canal block, the more time and materials will be required to fill the canal. Note that there might be seasonal fluxes of villagers going to cities/overseas to look for higher-paying jobs that can cause short-term manpower shortages.

5.4 Monitoring and maintenance

After the canal blocking works have been completed, it is important to monitor the site to ensure that the desired hydrological changes are being achieved. This may involve monitoring the water table, vegetation, and soil conditions. This can be done through dipwells that are constructed at strategic locations around the restoration site. Other soil parameters such as humidity and pH may also be recorded if such tools are available.

Ongoing maintenance is also an important aspect of canal blocking. This may involve regular inspections, cleaning and removing any debris from the blocked canals, and monitoring for any signs of erosion or other issues that may impact the effectiveness of the canal blocking works.

6. Revegetation

Revegetation is a critical next step following rewetting. It helps to stabilise the soil, reduce erosion, and maintain the water table by providing foliage cover, slowing down evaporation, peat decomposition and lowering the risk of fire.

This toolkit will focus on the execution aspect of revegetation on degraded peatlands; discussions on agriculture (or paludiculture) will not be covered. We will also assume that the intention of revegetation is to achieve rewetting to the greatest extent possible. This intent should be established during the initial stages of community engagement to set the right expectations with the community on the economic outcomes of the peatland restoration project. A complete guide on revegetation can be found in “A practical guidebook on the revegetation of degraded peatland areas” by Wibisono and Dohong.

6.1 Vegetation study

A vegetation study, conducted by a local botanist or equivalent, should be performed prior to revegetation work. The study aims to determine the structure of the existing peat forest and identify peat swamp species that can provide restoration and economic benefits. It is critical to use only native species that can survive in the acidic and wet conditions of peatlands. Most species suitable for paludiculture are tree species, which may take time to reach maturity. Hence, fast-growing pioneer species that can rapidly establish forest cover and provide shade for other species to grow must be cultivated and planted first.

The experienced individual should propose the study methodology and select appropriate pioneer species that has higher chances of survival in degraded peat. If there are already secondary forests growing on burnt land, pioneer species can be selected from these areas. Otherwise, it is also possible to introduce other native species that may not be present in the specific restoration location. The general steps involved are:

1. Document native plant species through seedlings, saplings, treelets, and trees identified in nearby peat forests.
2. Understand the ecosystem services that these species provide.
3. Identify target species that can best support the restoration programme.

The botanist can employ help from the local community to carry out the study as well as to complement the botanist’s knowledge on the value and suitability of plant species. This is especially useful when the community retains generational knowledge on specific plant species they are using. A science-based approach should be taken to quantify the value of each species before a qualitative approach is taken to align with the community. An example of such a study can be found in the Appendix, where native species are selected based on the following criteria:

- Richness and abundance
- Fast-growing pioneer species and climax species
- Species with fire retardant properties
- Species with economic value or unique value to the community

6.2 Nursery and growing of saplings

A nursery is a simple shelter to ensure that saplings are grown in a protected environment. Before the nursery is built, it is recommended to select a suitable location that will allow seedlings and saplings to grow without disturbance. The nursery site should be well-drained, has access to water and is relatively flat and free from flooding. The site should also be located away from any potential sources of contamination or pollution. The design of the nursery should be simple and low-cost and should have a shade structure or screen to protect seedlings from excessive sun and wind. The nursery should also have an irrigation system to ensure adequate water supply.

Once the nursey is built, the community will collect the stem cuttings and saplings of the selected species to be put into polypropylene bags, mixed with some burnt peat to acclimatise the saplings to the soil. The saplings will be in the nursery for a few months or until they reach a certain height. The botanist should advise on the duration of growth and height of the saplings of each species before transplanting to the degraded peatland.

The nursery should be well-maintained to ensure that adequate water and compost is provided to the saplings throughout their growth. The nursery should be regularly monitored for pests and dieseases, and appropriate biological or chemical control measures can be taken to mitigate the situation accordingly. Weeding is also required. Finally, controlling the amount of sunlight and shade received by each species of saplings is critical to for healthy growth. The community can participate and benefit financially through wages provided to carry out nursery maintenance.

6.3 Transplanting

Before transplanting the saplings, the planting site must be properly prepared. This includes removing any debris or vegetation such as ferns that may interfere with planting and ensuring that the site has the appropriate hydrological conditions, such as proper drainage and water levels. Clearing of land can be done by the community by hand, or by machinery if access is possible.

Transplanting of saplings are done in batches to the prepared area. The replanting technique can be recommended by the botanist or the technical guide and will depending on the ecological conditions of the site, the availability of planting material, and the desired outcomes of the restoration effort. Seedlings should be handled carefully to ensure their survival and healthy growth after transplanting. This includes minimizing root damage, protecting seedlings from extreme weather conditions, and ensuring that they are properly hydrated before and after planting. Planting density, diversity or mix should also be considered to avoid overcrowding of similar species and to attract birds or other seed carriers.

6.4 Implementation considerations

Scheduling considerations

Replanting during the wet season of around November to April is recommended, when soil moisture levels are high and temperatures are cooler, which is favourable for growth and development of seedlings. However, it is important to note that if the tendency for flooding is high, especially after rewetting efforts, it may be necessary to plant during the dry season to avoid waterlogging issues. The species that are being transplanted will also inform the schedule.

Similar to the earlier considerations made in rewetting, revegetation work should also avoid the common holidays and festivals celebrated by the local community.

Resource requirements

The initial construction of a small nursery may require about 10 workers about 1-2 weeks to build, using easily obtainable materials for the shelter structure. Collection of saplings and transplantation to the degraded site will only require polybags. On average it can take about 10 workers to plant 1,000 seedlings in 10 days, including the initial land clearing by hand. Other estimates, such as the technical handbook, suggests that one hectare of land may require around 3-5 workers per day for manual land preparation, planting, and maintenance. This estimate assumes that the site has been cleared of any major obstacles or vegetation and has been levelled and drained to the extent necessary. Community members may participate and earn wages from these activities.

6.5 Monitoring and maintenance

After the saplings are planted, regular monitoring and maintenance of the planting site is recommended, including measures such as weeding, fertilisation, and pest and disease management, as well as ensuring proper hydrological conditions. Watering during dry season is also necessary to ensure growth and prevent fires. Once seedlings reach a suitable height, the replanting site can be left to naturally regenerate.

Standard measurements should be taken for each species of plant, such as number of surviving plants, average height of the seedlings over time, diameter of the plant stem/trunk, etc.

7. Future work

Currently, there is a vast amount of information and research available on peatland restoration, but it is not organized or easily accessible. As a result, individuals must have a clear understanding of what they are looking for before beginning their search. To address this, the next version of the toolkit aims to provide a more concise yet comprehensive overview of the information on peatland restoration. This will enable readers to better understand the scope of information required and available and guide them towards more detailed sources of information, including open-source information from institutions such as BRG and CIFOR.

In addition to addressing existing information gaps, the toolkit will also seek out additional sources of information, including those in Bahasa and from temperate peatland restoration efforts in Europe. To better serve readers in Indonesia and Malaysia, the toolkit should also have a Bahasa version.

To enhance the practicality of the toolkit, it might also be worth localising it for different regions of Indonesia. This is essential as there are significant differences in human and physical conditions across the country, which may require unique approaches to community engagement and peatland restoration. Overall, these efforts will help make peatland restoration information more organized, accessible, and practical for those working to restore Indonesia's valuable peatlands.

Appendix and Attachments

1. Rapid Field Assessment Methods for Monitoring, PM Haze, 2019
2. Handbook for Infrastructure Development: Peat Wetting through Canal Blocks, Peatland Restoration Agency Indonesia, December 2019 (in Bahasa Indonesia, 3 sets, each for a type of canal block)
3. A practical guidebook on the revegetation of degraded peatland areas (in Bahasa Indonesia), Wibisono and Dohong, August 2017 (in Bahasa Indonesia)
4. Botany Study Report for Sungai Tohor, PM Haze, 2018