Government of Central Kalimantan

Government of Indonesia

Government of the Netherlands

Master Plan for the Rehabilitation and Revitalisation of the Ex-Mega Rice Project Area in Central Kalimantan

SUMMARY GUIDELINE FOR PEATLAND REHABILITATION IN THE EMRP AREA

Technical Guideline No. 2

MARCH 2009

Euroconsult Mott MacDonald and Deltares | Delft Hydraulics
in association with
DHV, Wageningen UR, Witteveen+Bos, PT MLD and PT INDEC

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BKSDA	Balai Konservasi Sumber Daya Alam
CKPP	Central Kalimantan Peatlands Programme
EMRP	Ex-Mega Rice Project
MP	Master Plan
NTFP	Non-Timber Forest Product
PSF	Peat swamp forest

1 Introduction

1.1 Objective of this brief guideline

The Master Plan for the Rehabilitation and Revitalisation of the Ex-Mega Rice Project area is presented in a Main Master Plan Synthesis Report and a series of Technical Reports. These documents present technical analyses and strategic approaches for preserving and rehabilitating peatland values and revitalising agricultural development in the area. While useful and necessary, however, this information does not provide an easily accessible guide to policy makers and to organizations planning peatland rehabilitation projects. The current document presents the findings and conclusions of the Master Plan team regarding the steps that have the most direct practical relevance for the implementation of peatland rehabilitation in a condensed format that is accessible to non-experts.

This brief guideline aims to help develop a checklist of activities that may or may not be needed in the case of a specific peatland rehabilitation project. It briefly explains what rehabilitation measures exist, what their expected effects are, under what conditions they may (not) be effective, and how to best implement them.

The current guideline provides an overall framework and summary for the development of an integrated peatland rehabilitation program. Further specific technical details are presented in a series of accompanying Technical Guidelines and Reports on fire management, canal blocking, reforestation and a community-based approach for rehabilitation and revitalisation of the Ex-Mega Rice Project area.

1.2 Aims and components of peatland rehabilitation

Peatland rehabilitation aims to enhance the value of peatlands that have been degraded by drainage, fires, logging, of a combination of those. These values can be those of the original natural peatland:

- biodiversity,
- forest wood resources,
- carbon storage,
- hydrological regulation,
- or they can be agricultural production, which of course was not present originally.

Many degraded peatlands have lost all or nearly all of these values: they have no biodiversity of forest cover to speak of, are emitting carbon to the atmosphere, may be contributing to floods, and are often not suitable for agriculture. If left alone, values may never or only be very slowly restored in such areas.

Even if rehabilitation interventions have started, it will take decades before natural peatland values can be restored to anything approaching the original situation; such rehabilitation may therefore be a major and costly effort that will show success mostly in the long-term. It is possible, in some degraded peatlands, to develop productive agriculture in the relatively short. In such cases, however, it must be considered that productivity may not last very long because the area will become undrainable in many cases. This happens where the base of the peat is below the drainage base.

1.3 Defining rehabilitation objectives

From the above it follows there are different approaches to peatland rehabilitation, with different outcomes. Before developing a rehabilitation project, objectives much be defined and sometimes hard choices made. The first consideration should be whether the aim is to recreate a system that resembles the original natural peatland forest system as much as possible, for the long term, or an area that yields agricultural production in the short term (in many cases accepting that the area will be even more degraded in the long term).

It would be best to define rehabilitation objectives on the basis of cost-benefit analysis, taking into account the benefit and cost of restoring peatland forest and carbon storage, the benefit of developing agriculture, and the long-term cost of loss of agricultural land on peatland. In particular, one of the highest cost interventions is tree planting. With more than 400,000ha of degraded peatland without forest cover, careful allocation of public resources should be made towards this goal.

1.4 Developing a rehabilitation approach

Peatlands are highly complex systems, developed over thousands of years in a fine balance between the system components: hydrology, forest and the shape of the landscape. Once peatlands are degraded (by drainage and/or fires and/or deforestation), all these components are out of balance: water levels are generally too low and too variable; the forest cover is gone or in bad condition, the shape of the peat surface has changed, and fire risk remains high due to a combination of these factors.

Peatland rehabilitation will require restoring some sort of balance and continuity to all system components. This will require active intervention in one or all of three areas: fire management, hydrology, and vegetation cover. Successful rehabilitation will also require close involvement and the support of local communities as emphasised in the Master Plan.

2 Fire management

Fire management is a precondition for successful peatland rehabilitation and the Master Plan proposes a specific program on fire management in the area. All degraded peatlands remain at high risk of fire because A) fuel loads are high, B) water tables are generally low, C) there is often an interest in clearing parts of the land. Even if few fires occur for some years and fire risk may appear low, this is usually the result of temporary conditions such as having a few wet years (as in 2007 and 2008). Without reducing the fire risk in degraded peatlands or deploying effective capacity to prevent and suppress fires, the results of efforts to restore vegetation cover and hydrology of the areas risk may be lost in any dry year, and rehabilitation success is likely to be limited. This is a key factor that is stopping development of rehabilitation initiatives.

2.1 Fire management components

Fire management consists of several components:

1. Fire information system, providing a fire danger map and fire early warning:
    A. A fire danger map should take into account landscape characteristics (forest cover, drainage conditions, accessibility, fire history), and should be updated every few years or so as conditions evolve.
    B. A fire rating rating system should produce regular (daily, monthly) updates on fire risk on the current conditions (recent present and recent fires, weather, fuel load) and preferably forecast conditions (weather, land management factors).

2. Fire prevention, i.e. making sure fires cannot start of spread through:
    A. Awareness raising, informing communities and relevant organizations of the risks and costs of land clearing by fire on peat.
    B. Enforcement of relevant laws, relating to directly to fires and to activities linked to fires (such as illegal logging, and development of sensitive areas including peatland over 3m).
    C. Water management, keeping water levels as high as possible in the dry season.
    D. Vegetation management, promoting a closed canopy cover that will help reduce fuel load by keeping the top soil moist.
    E. Land management, reducing waste products from agriculture that would provide fuel load.
    F. Access management, keeping people out of the most vulnerable areas, certainly at the times of the highest risk.

3. Fire preparedness, developing and mobilizing fire suppression response, through:
    A. Development of clear and tested local organization, system and procedures.
    B. Training.
    C. Hardware including vehicles, infrastructure and equipment.

4. Fire suppression, i.e. stopping fires once they have started, through:
   A. Mobilizing and co-ordinating the relevant fire fighting organizations.
   B. Putting out fires, with water or other means.

5. Fire event evaluation and follow-up, learning lessons for the future, through:
   A. Recording timing, location, magnitude and probable cause of events, the fire prevention measures and suppression response to the events, and an evaluation of the success of measures and response.
   B. Reporting the above, and sharing with the relevant organizations and communities.

6. Fire management organization(s). While a single co-ordinating organization may be needed and effective, fire management needs to be a co-operative effort between a number of relevant organizations. At the least, this should include organizations involved in Forestry (as much degraded peatland is formally forest land), Agriculture (as land clearing is the main direct cause of fires) and PU (peatland drainage, for agriculture and roads, enhances fire risk).

2.2 Questions and bottlenecks

From what we have learnt in the EMRP Master Plan project, as described in the Technical Report produced by the relevant Cluster, it is clear that none of the fire management components described above is in place yet. A fire information system was developed recently but needs further development. Peatland rehabilitation pilot projects have included aspects of fire prevention, canal blocking and tree planting, but on a small scale and without evaluating its effectiveness. The same applies to fire preparation and suppression efforts to date, where the technical report states:

> "The development of fire management in Indonesia over the last 20 years has been beset with many problems, and although eventually experiences have been gained, lessons have been learned and general progress has been made, still the process is ongoing and many more improvements need to be achieved before the fire issue can be really under control. Most problems are the result of a lack of knowledge and understanding about fire management; the overwhelming proportion of the fire problem and its underlying causes; capacity shortages; insufficient budgets; egocentric government sectors competing with each other over stature and available budgets; failure to coordinate; and reactive responses to situations that were allowed to develop into emergency situations."
>
> "The development and status of forest and land fire management in Central Kalimantan followed the overall development of forest and land fire management in Indonesia, experiencing the same problems."

This problem has been recognized by the Central Kalimantan Government, which over the last 5 years with other stakeholders has been working to improve the fire management situation in the province, with, among others, a provincial regulation in 2003, Governor decrees and guidelines issued on forest and land fire control in 2005, the Palangka Raya Declaration of 2005, the establishment of Pusat Informasi Lingkungan (Environmental Information Center), the establishment of community fire control teams, the blocking of canals in peatlands and issuance of edicts by the Governor and Head of Police outlawing the use of fire (e.g. Maklumat Kapolri 2007). Recently the provincial government in cooperation with district governments stepped up the attention and government action on fire prevention with a rural development approach, combined with a stricter enforcement of law and regulations. In 2007 the Provincial Government started to implement a 2007-2010 Action Plan for Fire Prevention, Fire Suppression and Penalizing Fire Perpetrators, concerning forest, land and agricultural field fires.

2.3 Lessons learnt and priorities

Although progress on fire management has been limited, experience to date suggests that fire prevention measures can be successful. This may be less sure for fire preparation and suppression, as there appear to be no examples of larger peatland fires (i.e. fires covering several hectares) well away from population centres (as is the case in most of the EMRP area) that have successfully been extinguished. Records of successful fire extinguishing efforts appear to apply to fires close to population fires where water was easily available, and maybe some smaller fires away from population centres and open water. There probably is scope for an effective fire suppression system if coupled with an effective fire early warning system (e.g. watchtowers) and a high density of fire fighting teams, but such a system is expensive and its effectiveness under extreme drought conditions has yet to be proven. . Key will be early detection of fires and the rapid deployment of fire suppression teams to extinguish fires before they become too large to suppress.

In the long term, effective and economically viable fire management will probably have to rely largely on fire prevention. Certainly effective fire prevention should be in place before fire suppression can be expected to be very successful. And development of an effective fire prevention strategy for a peatland area must start with a thorough problem analysis showing where fires start and what causes them, and thorough analysis of the success rate of prevention measures to data showing what works and what doesn't. Finally, such evaluation should include years when fire risk was high; e.g. fire management success claims for 2007 and 2008 were not credible as both years have been very wet and fire risk therefore low.

2.4 Brief recommendations

In brief, the following approach to development of a fire management system for a particular area may be recommended:

1. Make sure a fire management organization is in place.
2. Evaluate concrete historic and recent fire events, and assess what caused them, how they developed and what could have prevented or stopped them.
3. Focus on fire prevention, including awareness raising, enforcement and bringing up water levels where needed but in priority areas develop the capacity for the rapid suppression of fires.
4. Once evaluation is in place and fire prevention has started, consider development of fire preparation and suppression capacity. These may be seen to be part of the awareness raising campaign as well, and may therefore support fire prevention.

3 Hydrological rehabilitation

Fires will rarely start, and very rarely spread far, in natural peatland because the natural peat surface is moist and fuel load therefore low. The peat surface is kept moist by two things: high water tables and a healthy forest cover that reduces the drying effects of wind and direct sunlight. A healthy forest cover, in turn, is also dependent on high water tables that sustain peatland tree species. Drainage canals in peatland therefore contribute to fire risk in two ways: they dry the peat by bringing water levels down, which dries the peat even further by reducing vegetation cover. Canals contribute in a third way by providing easy access to areas, indeed it has been found that almost all peatland fires start near villages, roads or canals.

Hydrological rehabilitation, involving raising peatland water levels by blocking canals, is therefore a key component of fire prevention. Without it, no fire management strategy can be successful in the long term, as all dry peatlands sooner or later will experience fires that can not be suppressed.

Apart from fire prevention, hydrological rehabilitation is also the basis of overall rehabilitation of peatlands. High water table are required to reduce peat decomposition and the resulting carbon dioxide emissions to the atmosphere (which contribute to global warming) and subsidence of the peat surface (which results in increased flooding; in the peatland and in downstream of the peatland; Figure 3). High water tables, approaching natural conditions in peatlands, are also required to allow reforestation of degraded peatlands through natural succession or planting.

3.1 Hydrological rehabilitation objectives

While the objective of hydrological rehabilitation must be to restore components of the natural peatland hydrological system in the long term, the effects of canal blocking in the short term will often be limited to bringing up groundwater levels near canals. This is because the landscape forms and other hydrological characteristics of the peat surface in the EMRP area have been altered fundamentally over the last 10 years, since drainage was implemented. Two major complicating changes are:

1. Peat surface subsidence has been highest near canals, creating a ‘mini’ dome landscape with higher surface gradients than would occur naturally. This new landscape, and the limited importance of groundwater flow in much of the area, result in a relatively limited zone of influence around canals in the short term (Figure 1); higher water levels in canals may hardly affect groundwater depths well away from canals.
2. The original ‘hummock-hollow’ topography that is typical of natural peatland forest, and responsible for keeping the peat surface wet through slow discharge of surface water, is removed. This, with the higher surface gradients and shorter distance to discharge channels, results in much faster discharge of surface water. These high peak flows in canals in turn make construction of effective and durable dams much more difficult.

In all, it is clear that actual restoration of something resembling a natural peatland hydrological system (with lower surface gradients and increased storage of water at the peat surface) will only occur after decades, even if canals would be blocked now, because so much damage has already been done to the hydrological system.

While the short-term hydrological benefits may be limited in some cases in the EMRP area, canal blocking is still essential for rehabilitation because it A) limits access for people, B) further limits fire risk by rewetting the canal sides that are most susceptible to burning, and C) limits long-term subsidence in the entire peat landscape by setting a new drainage base (Figure 2). Over time, as continued subsidence will smoothen the peatland shape towards the new drainage base, peatland surface gradients will lessen, surface roughness will increase and the rewetting effect of canal blocking will extend further and further away from canals. Without canal blocking the opposite would happen: slopes would get steeper, rainfall will be discharged faster and the peat surface will be dryer resulting in higher fire risk, CO_2 emissions and peak flows.

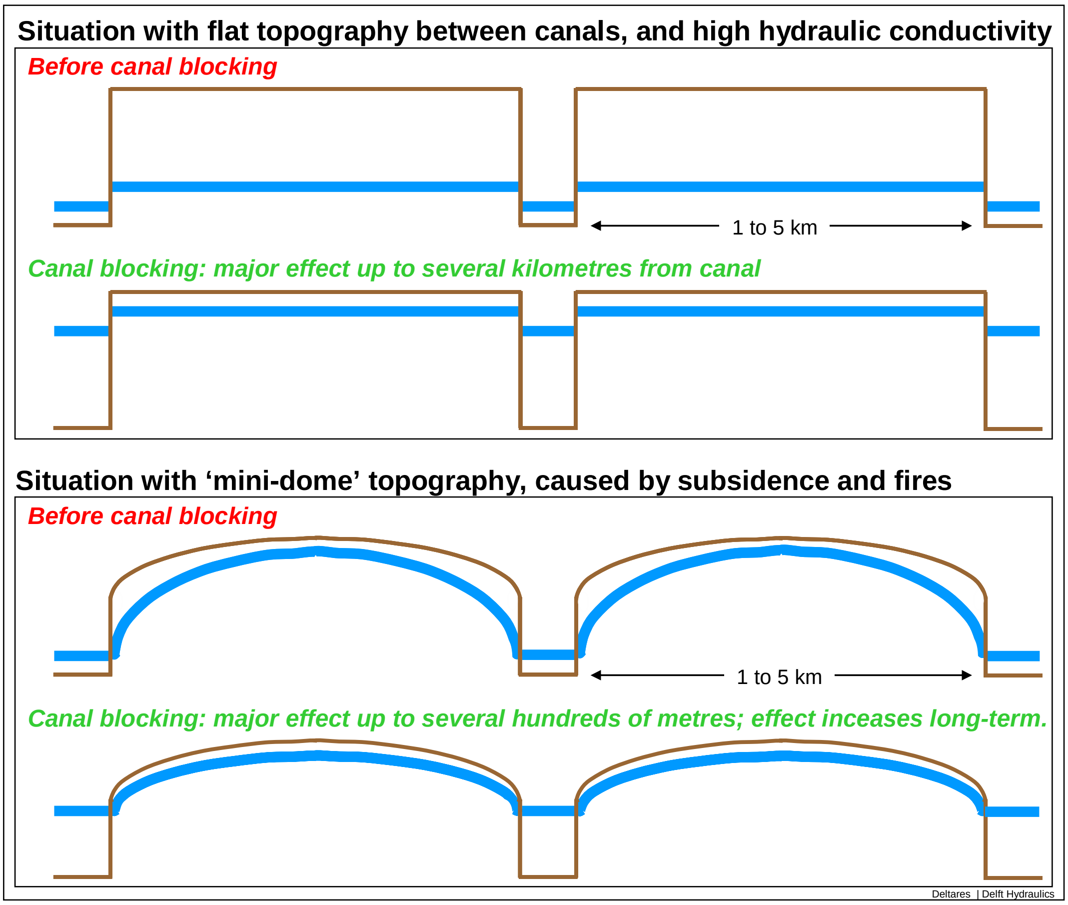


Figure 1 The impact of the mini-dome topography on effectiveness of raising water levels through canal blocking.

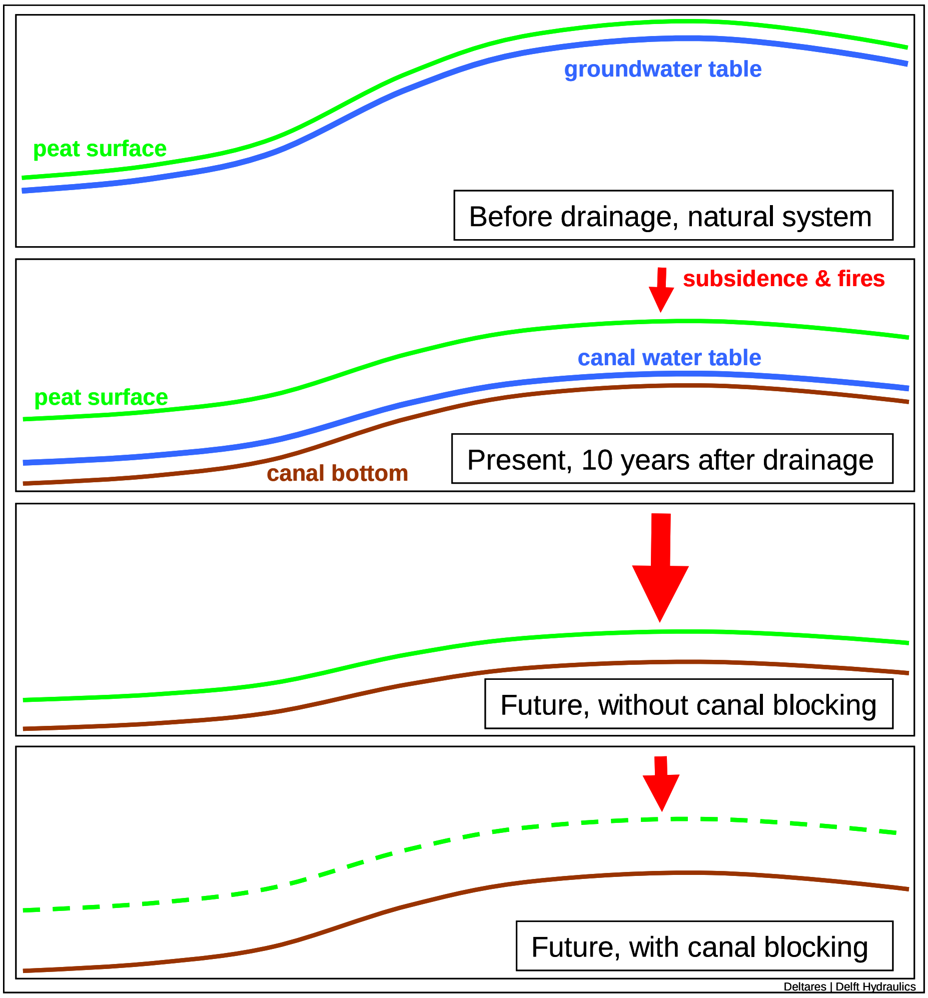


Figure 2 Effect of drainage on peatland shape (cross section along canal). NB the assumption is that the canal bottom will be somewhat lowered in future due to scouring and maintenance for access.

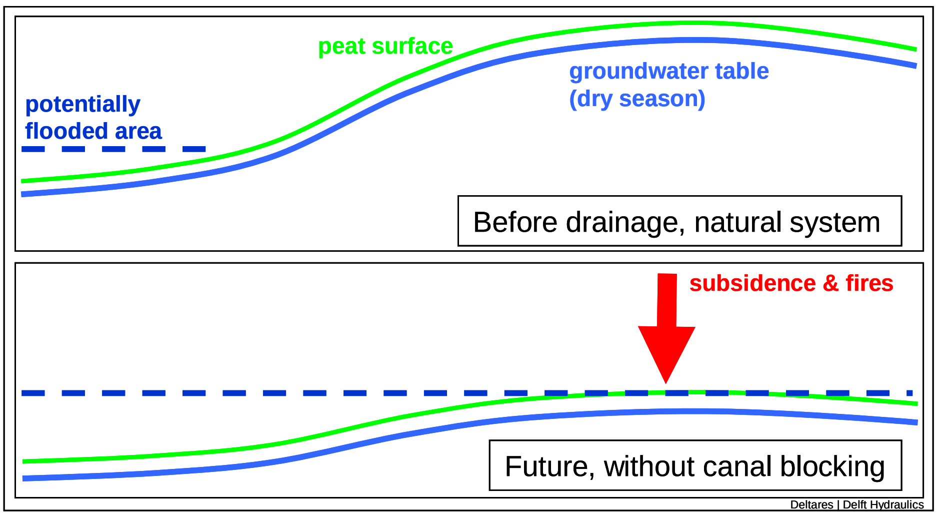


Figure 3 Effect of drainage on inundated area.

3.2 Considerations in designing a peatland canal blocking scheme

While the concept of canal blocking is simple, implementation is not. There are a number of steps to be followed, and constraints to be considered, when designing a hydrological rehabilitation plan.

3.2.1 Functions of dams

First of all, it is important to consider what really is the target of dam construction:

A. Where dams only serve to bring up water levels as high as possible as is the case in most rehabilitation areas, and if possible flooding upstream of it is not a problem, it will probably best to construct dam crests as high as possible and to have as many dams as possible from whatever materials are available locally, with the smallest possible water level differences across them.

B. If a dam serves to keep water levels within a certain range and it is necessary to minimize flooding, as is the case in plantations and possibly adaptive management areas, the level of the dam crest needs to be designed accordingly and a bypass is often needed for further water level control.

C. In some cases, it may be necessary to make the dam passable by boats and allow easy access by local communities, company personnel (in plantations) or indeed dam maintenance personnel. Access would require specific design of the dam if boats need to cross over it, or bypasses around it which then also have specific design (water depth, flow velocity) and material (strength) requirements. This situation may become common in adaptive management zones, if the Master Plan approach would be followed. However construction of passable dams is not recommended in conservation zones, where assess by people should be limited.

3.2.2 The implication of dam crest levels

Design of the crest level of dams is one of the most important aspects of canal blocking. If the crest is below the surrounding topography, most or all discharge will be over the dam crest. This means that water levels are not pushed up as high as they could be (increasing the long-term subsidence rate, Figure 2) and that peak flows will damage the dam. The result is a dam that is less effective and less robust than would have been the case if the crest level had been higher. A crest level above the surrounding topography not only means a more effective and robust dam, but also lower peak flows downstream of the dam. This is because if peak water levels are pushed up over the surrounding topography, much more water can be stored at the peat surface than if all water flow is confined to the canals. The difficulty with a higher crest level, however, is that sufficient bypass flow capacity must be found or created to lead water flow around dams.

3.2.3 Local landscape

The peatland landscape should be known in detail when interventions are designed; this information may be derived from field surveys or laser altimetry:

A. If the peat surface around canals or upstream of the dam is more or less horizontal (with a slope of less than 0.5m per km, over the first few hundred metres at least), there is a chance of inundation of significant areas. If this is not acceptable, the dam crest may be lowered or bypasses constructed. It should be realized, however, that this is likely to reduce the overall effectiveness of the canal blocking system.
B. Where bypasses are required around dams, it will be best to select a location where a flat area or depression already exists that may be utilized to discharge water.

3.2.4 Peak flows expected at the dam location

Peak flows largely determine the destructive forces that dams will have to withstand, and can be determined through hydrological monitoring and/or hydrological modelling/analysis. Note that peak flows depend on upstream catchment area, slope, drainage density and peat hydraulic conductivity; all of these are highly variable in space so local hydrological assessment will often be needed.

A. Where high peak flows are expected, and flooding upstream of a dam is not acceptable, it may be best to have dam crests above the highest water levels (to reduce damage to the dam) and to discharge water though bypasses around them. Such bypasses should be normally very wide and shallow, in order to accommodate large quantities of flood water at low flow velocities (so as to minimize scouring). As construction of large numbers of very wide bypasses may not be feasible, suitable natural bypass locations should be found wherever possible.
B. Where peak flows are expected to be limited relative to canal width, it may be easiest to allow (extreme) peak flows over the dam.

3.2.5 Accessibility of the area and order of dam building

Accessibility to dam building locations determines what types of dams can be built, and how fast:

A. Where a firm berm of excavated peat is present along canals, the area may be accessible for excavators and it may be possible to construct dams of compacted peat. With excavators available, it may also be much easier to fill up canals with peat material, which would further reduce water flow.
B. If excavators can not enter the area, all dam construction must be manual which may limit the number of dams that can be constructed as well as options to fill up canals with peat material. Also, this means that canal blocking probably needs to start at the centre of the intervention area and move towards Rivers from there, as transport of dam building materials will have to be over water, through the canal.

3.2.6 Resources needed and available

The following considerations apply:

A. For cost-effectiveness and local acceptance, it will generally be necessary to maximize use of local materials, manpower and techniques in building and maintaining dams. These must be available in large quantities as large numbers of dams (hundreds) may be required.

B. For long-term effectiveness of dams, materials should be used that last for many years, preferably decades. This means these should be robust and not valuable enough to be stolen. The use of some expensive materials like geotextiles and metals should therefore be minimized; experience with dams in EMRP and elsewhere shows that these are indeed removed.

C. As the peat substrate is soft, and the peat surface changes shape through subsidence, dam materials should be relatively light and the dam construction should be somewhat flexible. This excludes the use of concrete and iron constructions, which are fundamentally unsuitable for peatlands.

D. In some conditions and locations it may be possible to construct ‘soft’ dams made entirely of compacted peat. To collect and compact the peat for such dams, and possibly to construct bypasses around them, heavy machinery (excavators) will be needed which will require access over land. This method is tested in plantations, but not in rehabilitation projects as far as we know.

E. The effectiveness and robustness of canal blocking schemes may be greatly enhanced by filling up canals as much as possible using excavated peat material deposited on the side of canals (the ‘berms’ that are often still visible). This is the case especially if the material can be made to form ‘soft’ peat dams. This may be achieved by building ‘palisades’ of vertical timber logs in canals (e.g. at 0.2m intervals) that let water pass but retain coarse floating material that is mobilized during peak discharges.

3.2.7 Optimum water steps over dams

The following considerations apply:

A. In principle, water steps over dams (the difference between upstream and downstream water levels) should be as small as possible, see Figure 4. This means that the number of dams should be as high as possible. Experience to date shows that water steps should be less than 0.4m to create a robust a robust and effective water management system; having water steps of 0.1m or 0.2m may be ideal. This has several advantages:
   a. Water levels can be kept as high as possible, minimizing further peat decomposition and degradation of vegetation.
   b. Dams will last longer as pressure on dam construction is minimized. This is both because the water pressure is reduced and because a larger fraction of peak discharge after extreme rainfall is likely to be stored on the peat surface (temporary flooding) which will reduce flow volumes and therefore flow velocities over dam crests (or through bypasses).
   c. The larger the number of dams, the smaller the impact on the system as a whole if some dams fail.
   d. The larger the number of dams, the more limited the access for people and the greater the chance for degraded forest to recover.

B. In practice, there is of course a limit to the number of dams that can be built, and therefore to the water step that can be achieved. It may be that a water step of 0.2 m or even 0.4m may be the best achievable. In any case, it should be considered whether canals can be filled in and additional peat dams created to further reduce water steps.

3.2.8 Maintenance and long-term developments

Peatland rehabilitation is a long-term process, as it will take decades for the natural system to be restored to anything resembling the original situation. Canal blocking schemes must therefore be effective in the long term; if this can not be assured it may be better to not build dams at all and let the degraded peatland find its own equilibrium shape and hydrology. Experience shows that dams will deteriorate and become less effective in time, often within a few years in the case of pilot dams built so far. Long-term effectiveness will require the following:

1. Development of a blocking scheme that is as robust as possible and requires limited maintenance, in terms of design and materials, water steps over dams, and dam crest levels.
2. Ensuring conditions that will allow ‘nature to take over’ by overgrowing canals, in time reducing the need for fully functional dams as dams deteriorate. This will take partial refilling of dams, planting of vegetation species that will invade canals, and limiting access by people that may be intent to keep canals open.
3. Ensuring maintenance for at least as long as is needed to let ‘nature take over’. This will require continued funding and staff availability of for maintenance. As access by water will be limited after canal blocking, movement of maintenance teams must be mostly over land and materials used in maintenance must be locally available (trees and peat). Hence, maintenance will probably need to be limited to reducing the worst damage in key locations.

3.2.9 Suitable dam designs

From the considerations outlined above, the Master Plan team has concluded that there are 3 dam designs that are suitable in peatland rehabilitation:

1. In order for ‘nature to take over’ in future, any rehabilitation scheme should probably include a large number of ‘soft’ dams, made of palisades across canals supporting a wide block of peat and vegetation in the canal, at water steps of 0.2m or less.
2. A number of ‘hard dams’ will also be needed that act as ‘safety valves’ in the system. Where no heavy machinery is available, such ‘hard dams’ could be box dams similar to the ones constructed for the CCFPI project in the SPI canal. In future, however, the crests of many such dams should be above the surrounding topography.
3. Where heavy machinery is available, ‘hard dams’ may be constructed from compacted peat. Such dams should be at least 15m long, and have crests at least 1m above the surrounding topography as the dam will subside significantly in time.

Any canal blocking system should be combined with large-scale partial infilling of canals and planting of tree species that will invade canals. The use of concrete dams and steel constructions should be avoided at all cost, as they are ineffective and expensive.

3.3 Lessons learnt and priorities

Some key lessons to consider are:

- A fundamental characteristic of the degraded peatlands in the EMRP area, which appears to have been considered insufficiently in canal blocking efforts to date, is that the landscape ('mini-dome' morphology) has been altered to an extent that hydrological rehabilitation will take decades, with the effect of canal blocking often limited to a zone along canals originally, and full restoration of the original conditions may not be possible.
- A second fundamental characteristic of the degraded peatlands is that peak flows have been increased greatly, complicating the task building dams that will last in the longer term. The question of long-term robustness and maintenance requirements needs to be a key concern in designing canal blocking schemes. Without this, dams may be build that are effective only in the short term.
- Detailed and accurate information on the local topography around canals is needed. Without this, dam crests may often be placed too low, resulting in reduced effect on water level and enhanced risk of dam failure, or insufficient overland bypass flow capacity may be available which is likely to result in dam destruction.
- The target water step needs to be the starting point in designing dam locations. The 'learn as you go' approach of first placing a few dams with large water steps, then adding dams with small water steps in between may not always be best in the long term. Especially where materials need to be transported over water, it is not possible to pass dams to add or modify upstream dams.

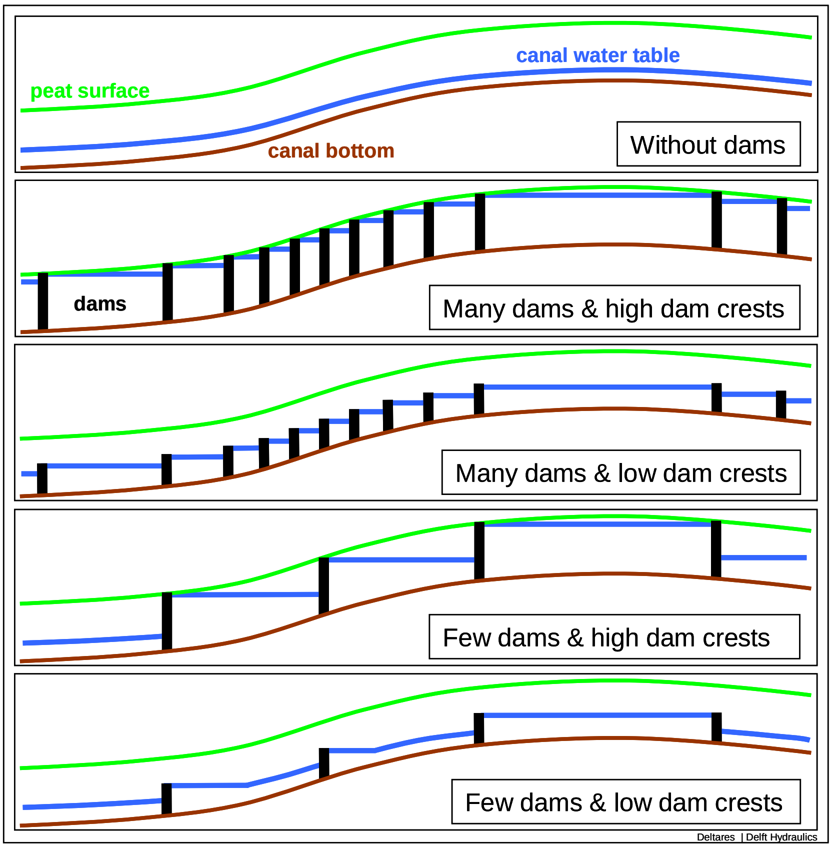


Figure 4 Effect on water level of different intervals between dams and different dam crest elevations (cross section along canal).

4 Peat swamp forest rehabilitation

Rehabilitation of peat swamp forest can be undertaken for various reasons, usually associated with restoring biodiversity values or functions of a peatland ecosystem. This is also the case in the EMRP area, where PSF rehabilitation has been undertaken under the CKPP programme by conservation agencies in order to protect Sebangau NP (WWF) and prime orangutan habitat in Block E East (BOS Mawas), and to restore PSF functions in Block A North (Wetlands International).

Once peatland hydrology has been altered by drainage canals – such as is the case in most of the EMRP area – restoration of peat and PSF to an original state is impossible and the best one can aim at is rehabilitation of the main ecological functions of the PSF ecosystem.

Managing fires is one of the main challenges in degraded peatland and curbing carbon emissions. The tools at one's disposal are managing human activities (e.g. curbing use of fire in land preparation), rehabilitating hydrology (resulting in raising water levels), and re-establishing a dense tree cover. Initially, establishing trees adds to aboveground fuel availability and fire risk, but within several years the effect is positive as humidity levels are increased. Also, establishing stands of economically desirable species lowers the fire risk as it increases incentives not to burn. Establishing a dense tree cover can therefore play an important role in overall peatland rehabilitation.

4.1 PSF rehabilitation components

PSF rehabilitation can occur in a variety of ways. The simplest form is natural regeneration, which can for example occur if the peatland hydrology has not been altered significantly and the forest can recover on its own. This can happen in much of Sebangau NP and Block E East, where forests can easily recover on their own provided that external pressures such as illegal logging can be curbed.

In much of the EMRP area, however, assisted regeneration is required. This can vary from rehabilitation of the hydrology and allowing natural vegetation to recover on its own, to having to plant tree species in a treeless area that has burnt several times and where a dense sedge-fern vegetation has taken over. In intermediate situations enrichment planting with tree species is often an option.

A degraded PSF area first needs to be assessed (surveyed) in terms of presence, density and cover of PSF species in order to develop a rehabilitation plan. This will help determine where and to what degree assisted regeneration is required. The sequencing of replanting is determined by priorities (e.g. e.g. protecting biodiversity values or curbing fires), but also the order in which hydrology will be rehabilitated (i.e. progressing downstream from more elevated areas).

4.1.1 Species selection

Species selection for assisted PSF rehabilitation should be guided by a number of principles that all contribute to success of the programme:

- The species used need to be adapted to the present situation at a given location, and if canals have been excavated and fires have occurred, this is likely to have changed considerably compared to the original PSF. In many cases the extremes are greater, with lower water tables in the dry season and increased flooding (depth and duration) in the wet season. On the whole, species with a greater tolerance of changing conditions will be required, and often one may have to resort to using pioneer species.
- Use species that do not require drainage. Species are sometimes used that require drainage, and this then forms a barrier to rehabilitation.
- More diversity is needed. On most PSF rehabilitation programmes only a handful of species are used, mainly because of limited experience with PSF rehabilitation and limited availability of propagules (e.g. seeds, fruit or wildlings). Low diversity adds to the risk, for example, due to pests and diseases. Biodiversity values should be enhanced on PSF rehabilitation programmes in areas near to or adjacent conservation areas.
- The use of exotics should be curbed, certainly in or near conservation areas, but also in overall PSF rehabilitation programmes. PSFs are not plantations, and ecological functions are not restored by adding exotics that do not belong to the system and can add new problems.
- In rehabilitating peatland near villages, using economically valuable species on PSF rehabilitation programmes can be considered, both from an economic perspective and for increasing local interest in maintaining peat swamp forests. So as not to encourage logging, programmes should mainly consider Non-Timber Forest Product species (e.g. jelutung, gemor) rather than timber species.

4.1.2 Preparation & planting

Following site selection, determining sequencing of planting and species selection, PSF rehabilitation will involve preparation and planting stages.

Preparation stage:

- Sourcing of planting material. This can be from fruits/seeds, especially if the species in question still occurs nearby, fruits predictably or regularly, and factors determining its successful germination is understood. Sometimes ‘wildlings’ are used, i.e. seedlings taken from remaining PSF. This is done if seeds/fruits cannot readily be obtained or if germination rates are low. In the EMRP, seeds, fruits and wildlings are obtainable from PSFs remaining in Block E East and Sebangau NP. However, agreements for this should be reached with BOS Mawas (for Block E) and Forestry Department / Taman Nasional (for Sebangau NP). For certain species – even commercially important species such as gemor (*Alseodaphne coriacea*) – propagation is poorly understood.
- Establishing nurseries. Nurseries will be required for propagation of planting material, as simply planting seeds or transplanting wildlings results in low rates of success. Seedlings need to be raised to a level that they are ‘hardened’ and more durable, and can also be provided with extra nutrients in a nursery environment. Nurseries should preferably be located near the rehabilitation site, as transportation is a major stress factor for seedlings. Further considerations include shading, water requirements,

(micro-) nutrient requirements, substrate (peat, compressed peat, mineral soil) and polybag size.
- Preparing of sites. Sites that are to be planted need to be prepared before planting, and this includes establishing rows at the spacing required (this is species dependent), digging of pits, marking with poles[1] and weeding. Weeding should often not only be manual, as competition (esp. with ferns and sedges) can be fierce and weeds in an area of 5-75 cm around a seedling should be killed. When needed, wells should also be dug, and a temporary shaded seedling storage area constructed.

Planting stage:
- Logistics/timing. The logistics of the planting operations need to be worked out well so that all progresses smoothly. Delays lead to poor seedling quality, high mortality, reduced success and higher costs. Timing of planting is important, both in relation to getting enough seedlings as well as in terms of growing conditions for the freshly planted seedlings. The best time for planting in the EMRP area is the start of the wet season (Oct-Dec) when water and temperature are causing least stress. Given the lower temperatures and higher humidity, late afternoon and (early) mornings are the best time to plant.
- Transport. Seedlings need to be transplanted as quickly as possible to reduce stress. During transport, desiccation needs to be reduced (shading, prevent strong winds, watering), and upon arrival at a planting site they should be stored in a shaded area until actual planting occurs.
- Actual planting. Seedlings are to be provided with nutrients and micronutrients upon planting, and watered if soil moisture is low and/or evapotranspiration is high.
- Immediate follow-up. Within the first few days immediate follow-up is required, including replacement of dead/dying seedlings, watering (if required) and removal of weeds (if they resprout around the seedling).

4.1.3 Maintenance & monitoring

Maintenance will involve weeding and replacement planting. The first inspection should be after 1-2 months to assess survival, and dead specimens are to be replaced. Normally about 10-15% replacement planting is required, but this will depend on factors such as seedling quality, planting methods, local conditions (e.g. predation) and weather. Weeding should be carried out in the first two years, e.g. after 3, 6, 12, and 24 months, but the frequency should be adapted to local conditions. In areas with large densities of ferns, competition and regrowth may be high, and more frequent weeding may initially be required until the seedling is about 1 metre tall. When trees have reached a height of 2 metres weeding is not needed anymore.

Monitoring. Growth and health of planted seedlings should be monitored, e.g. on permanent sample plots. The number of plots will depend on the size of the planted area, and on the species planted. Plots should be monitored every year, either by a skilled forester, and parameters should include growth and survival of planted seedlings, phenology and health characteristics.

[1] Use of poles is to be temporary, as they are expensive and their use adds to deforestation.

4.2 Considerations in undertaking PSF rehabilitation

4.2.1 Changes in hydrology

An important consideration in PSF rehabilitation is that hydrology has changed considerably in these peatlands of the EMRP. Even if hydrological rehabilitation has occurred (and indeed it should go hand-in-hand with PSF rehabilitation), the hydrology will remain altered to some extent. In most cases, groundwater levels will remain below their past levels, certainly in the dry season, and at the same time peat itself is affected by oxidation, subsidence and loss due to burning. Especially the latter can lead to a lowering of levels by more than 1-2 metres. At the same time, forest cover has been lost, further adding to desiccation of peat. Combined, these factors lead to greater extremes: drier conditions in the dry season, and more flooding (deeper, longer duration) in the wet season. Replanting along canals seems an obvious choice as these sites are readily accessible. However, this is where the greatest extremes occur, as most peat is lost here (e.g. fires are mainly within 1-2 km from canals) and flooding most significant. This change in hydrology should influence the choice of planting sites, planting strategies (e.g. timing) and species selection (e.g. tolerant pioneer species).

4.2.2 Succession

Restoration and rehabilitation planting programmes should take a succession-based approach, first utilising pioneer species with a broad ecological tolerance, later adding climax species/ species of mature/mixed PSF if this is appropriate. The latter would be appropriate if, for example, the aim is to increase the density of certain beneficial species characteristic of mature PSF, or if the aim is to increase biodiversity value if the area is adjacent, near or forms part of a conservation area. <Note: the *Guidelines for the Rehabilitation of degraded peat swamp forests in Central Kalimantan* includes an initial selection of pioneer species, and the succession process in PSFs is explained in further detail in the *Technical note on natural succession in peat swamp forests of Central Kalimantan*>

4.2.3 Threat reduction & value enhancement

Rehabilitation of PSFs makes little sense if the drivers of change that have lead to degradation are not largely removed. As explained in earlier chapters, peatland rehabilitation should include fire management, hydrological rehabilitation and PSF rehabilitation. These are the basic tools, and rehabilitation attempts must further focus on reducing threats and increasing local value of the PSFs. Apart from fires and desiccation, the main threat is illegal logging, which also contributes to further desiccation as forest cover is removed and often canals are excavated to facilitate log transportation. Although most large timber has been taken a long time ago, illegal logging remains rampant in the EMRP. Scarcity of timber, increasing prices and lack of employment all contribute, and although what is currently being taken are small logs (max. diameter 30-35 cm) of inferior species. This threat needs to be urgently addressed in a programme that encompasses enforcement and curbing of access, but also provision of alternative timber resources and consideration of livelihood alternatives. Equally important on PSF rehabilitation programmes is ensuring that the status of rehabilitated areas is clear, and that they are of value to local communities. Local communities should, for example, be given rights to utilise NTFPs in nearby rehabilitated forests, as only in this way will they be interested in maintaining these forests.

4.3 Lessons learned

- PSF rehabilitation is expensive, and does not make sense if factors leading to degradation (e.g. fires, desiccation, illegal logging) are not largely removed, and if rehabilitation is not carried out properly.
- There is no “one size fits all” solution to PSF rehabilitation, and all rehabilitation programmes must be tailored to local conditions (e.g. level of assisted regeneration required, species to be used, hydrological conditions, local people involvement).
- There is little history of PSF rehabilitation in Indonesia, where the largest and most diverse PSFs occur. As a result, much still needs to be studied and mistakes will be made along the way.
- Focus on as many PSF species as possible, not only the limited spectrum currently used. There are many useful species in PSFs, at least some of which could successfully be used in future rehabilitation programmes.
- If peat swamp forests (rehabilitated or otherwise) have no value to people there will be little incentive to ensure their survival.

5 Community-based Approaches

The Master Plan presents a proposed approach for the implementation of a community-based approach to the rehabilitation and revitalization of the EMRP area (see Technical Guideline 3 on Community-based Rehabilitation and Revitalisation) in line with the three main interventions of Presidential Instruction (Inpres) No 2/2007: (1) Conservation and Rehabilitation Program, (2) Agricultural Development Programme and (3) Community Empowerment Programme.

A community-based approach needs to be initiated through a community-planning process, which informs and contributes to the government-led planning process. An output of the situational analysis carried out during the community planning process is to provide an accurate "demand structure" in which the government and other actors is able to respond with an appropriate "support mechanism".

This approach has been designed to contribute to the overall goals for the rehabilitation and revitalisation of the EMRP for the following reasons:

1. A basic principle for sustainable development is to support communities' development to identify and prioritise their own needs, and create and implement their own village plans.
2. It utilises the government's participatory community-managed planning (permendagri 66/2007) RPJMDES process as a basis for organising community development and provides a way to strengthen this and the government's capacity to deliver an appropriate support mechanism.
3. Developing an accurate demand structure and support structure, creates a useful overall framework or a comprehensive approach to the challenge of the rehabilitation and revitalization of the EMRP area. The Community based approach needs to be supported by top down activities in consultation with community inputs. Top down activities include macro-infrastructure such as roads and flood control, agricultural technical inputs etc.

5.1 Components of a Community-based Approach

Five main components or inputs for the community-based approach have been identified to work synergistically with existing government strategies whilst recommending important inputs or interventions to ensure it can work effectively. These are as follows:

Component 1. Village Plans

An effective planning process needs to be supported by trained facilitators to ensure the plans are of a quality that are able to address the development needs of the community. Facilitators will act as a liaison between communities, government and NGO's to ensure that communities are well informed and to support the implementation of programs following planning.

Component 2. Local Land Use and Village Spatial Plans
The key to rehabilitation and revitalisation of the EMRP area is improving current land and water management practices in order to help farmers get better outcomes and reduce the environmental impacts of unsustainable agricultural practices. For this reason, a participative process to map, assess and plan current and future land use, water management systems and spatial development needs to be carried out by the village community with the support of technical experts including farmers themselves. This process will also act as a means to assist and educate the community on optimal use of their land and water resources and help them develop effective land care practices. Community land maps can also be used as a means of safeguarding and recognising community and villagers' rights to land.

Component 3. Community Grants
There is much evidence that communities have the capacity not only to plan but to undertake their own development. Community-driven development programs such as the National Community Empowerment Program (PNPM) have clearly shown this. Further, PNPM has also developed pilots of specific interventions to support environmental rehabilitation (e.g. PNPM Hijau in Sulawesi) and agricultural development (e.g. PNPM Agribisnis supported by the AusAID SADI project). As such, two types of community grants are recommended for the rehabilitation and revitalisation of the EMRP area.

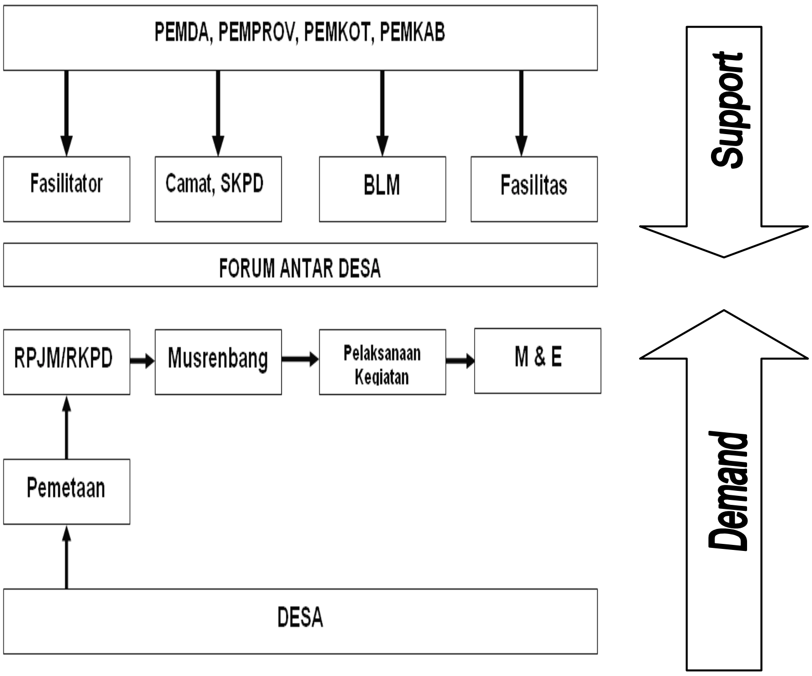
a) A General Grant to fund village infrastructure (open menú with negative list)

b) Specific Grant(s) to fund activities for regreening the environment such as tree planting, on-farm water management and for agricultural and livelihood support

These grants could build on and be delivered by the established PNPM mechanism. For the general PNPM program (PNPM Inti), a sub-district receives a grant in the region of Rp 1-2 billion. Villages then produce proposals based on village planning that are reviewed at a sub-district meeting of village representatives, who decide which proposals to support and allocate the grant to village implementation teams.

The Master Plan describes the importance of environmental rehabilitation and agricultural development in the EMRP area. The specific grants proposed here would therefore provide resources for communities to implement key parts of their own village, land use and spatial planning as described in components 1 and 2. It is recommended that the current pilots of PNPM Hijau and PNPM Agribisnis are reviewed and a pilot initiated based on lessons learned from these and the current context of the EMRP area.

Traditional top-down government interventions would be needed in addition to the community grants to further rehabilitation and revaitalisation of the area and the planning proposed in components 1 and 2 would provide a firm basis for the development of these programs. Examples include redesign of the water management macroinfrastructure, the development of fire management systems and so on. The key of this proposed community-based approach is to strengthen community-based initiatives and match the "demand" from communities with the support coming from goverment and other programs (see figure).



Component 4. Technical Support

Technical expertise will be required for training to support the village planning and implementation process as well as the government planning and response/support structure. Such technical expertise could be mobilised through the Technical Facility proposed in the Master Plan (see Annex 23 of the Master Plan).

Component 5. Communication, Knowledge Capture and Learning

For this complex multifaceted and pioneering approach to the rehabilitation of the degraded peatlands it is important to (a) ensure that an effective communication system is developed beween the village community, the different government departments and levels, NGO's as well as the Project workers and (b) knowledge of pioneering approaches need to be captured in a user friendly way that can be accessed and used as an important on going resource.

5.2 Considerations for the Development of a Community-based Approach

The EMRP area falls within the boundaries of four districts of the Central Kalimantan Province: Kuala Kapuas, Pulang Pisau, Barito Selatan and Palangka Raya. The area has a total of 227 villages and 20 sub-districts, and is home to 350,000 people – a mix of Dayaks (which constitute the dominant ethnic group), and lesser numbers of Banjarese, Javanese, Madurese, Sundanese, Batak and Bugis. The local Dayaks are mainly found in the Conservation (Deep peat protected area) and Limited Development zones (peat depths of less than 3 meters), whilst the development zones are mainly home to the transmigration population.

These different land use and ethnic groups calls for a community- based approach, which meets the needs of these different groups. The land use and spatial planning together with the village planning components will address the need to formulate appropriate responses to the different Peat management zones and ethnic groups.

The proposed approach is both people-centered and land-use / resource-based: it needs to be more that a normal community development approach. For the success of this programme it is vital to develop a community development model, which integrates environmental awareness and understanding into a sustainable livelihoods framework.

The National Community Empowerment Program (PNPM) mechanism is effective, well understood by government and communities and from discussions with people living in the EMRP area is well supported there. There is already funding coming to the EMRP area through the PNPM Perdesaan program as part of the existing PNPM program. PNPM therefore presents an opportunity to deliver finance to communities living in peatland areas to undertake rehabilitation and revitalisation activities.

However, it will not be enough to simply have a PNPM approach as the programme requires a more intensive intervention with facilitators who need to be trained to have an understanding of the bio-physical characteristics of the different Peat Management zones.

The main proposed interventions are to (a) add additional facilitators to strengthen village planning and links to regular government programs and those implemented as part of Inpres 2/2007, (b) add techical expertise to help communities and farmers plan land use and develop more effective on-farm water management and (c) increase community grants provided to the area including the development of Specific Grants to Communities for environmental rehabiliation and agricultural development.

Furthermore this approach will encourage a balanced and integrated involvement between communities, government, private and NGO sectors.

5.3 Lessons Learned

The main lesson learned from the community-based consultations was the need for an effective participatory, integrated and coordinated approach, between communities, government, NGO’s and the private sector.

Villagers expressed their confusion about the different organisations coming into the villages and setting up new groups and new ways of doing things, with many overlapping activities. One man described an NGO coming in “seperti maling ditengah malam”, “like a thief in the middle of the night”: his point was that there had been no introductions or knowing what they had come for or intended on doing. The role of the village facilitators will be important as a link/introduction for the different organisations active in the village.

The CKPP Central Kalimantan Peat Programme also lacked a strategic and coordinated framework. There is a need to identify the core strengths of the different organisations and to work together in a defined area according to strengths rather than trying to do everything in a defined location. For example, Care could take the lead in community developing, whilst working with Wetlands on water managements and regreening and with BOS on conservation.

Care has started working with the government's village planning processes; here steps were progressing to working in more closely with local government. A truly sustainable approach needs government to take the lead and for NGO's to offer consultation and support. This work needs to be built upon and developed with the government to ensure a strategic joint commitment.

Bappenas
Secretariat
Inpres 2/2007

Jl. Taman Suropati No.2,
Jakarta 10310

www.bappenas.go.id

Bappeda Central Kalimantan
Secretariat Inpres 2/2007

Jl. Diponegoro 60,
Palangka Raya 73111,
Kalimantan Tengah

www.kalteng.go.id

Royal Netherlands Embassy

Jl. H.R. Rasuna Said Kav. S-3,
Kuningan
Jakarta 12950

indonesia.nlembassy.org

Euroconsult
Mott MacDonald

S. Widjojo Centre, lt. 3
Jl. Sudirman Kav. 71
Jakarta 12190

www.euroconsult.mottmac.com

Deltares | Delft Hydraulics

P.O. Box 177
2600 MH Delft
The Netherlands

www.wldelft.nl