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






LONG-TERM MONITORING FRAMEWORK FOR THE REHABILITATION AND REVITALISATION OF THE EX-MEGA RICE PROJECT AREA IN CENTRAL KALIMANTAN

Technical Guideline No. 7

MARCH 2009

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

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

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Long-Term Monitoring Framework for the Rehabilitation and Revitalisation of the Ex-Mega Rice Project Area

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1 Introduction

The Ex-Mega Rice Project (EMRP) area in Central Kalimantan is a vast and complex system of forested and degraded peatland and agricultural land whose state is determined by the interplay of hydrological, ecological and socio-economic processes. With the proposed goal of rehabilitation and revitalisation of the area as defined in Presidential Instruction 2/2007 and detailed in the Master Plan, monitoring is required to assess to what extent the objectives of the Master Plan are being achieved as part of an adaptive management approach. Rehabilitation and revitalisation of the area has a number of uncertainties that will require long-term monitoring and possible adaptation of interventions as scientific understanding of the responses of the system and broader socio-economic outcomes increases.

This report presents a preliminary design of a monitoring framework and associated protocols to provide a basis for establishing a long-term monitoring system. While it aims to be as thorough and comprehensive as possible, it should not be considered final or complete at this stage, as much depends on the requirements of the actual projects that are now being established in the EMRP area. This guide should therefore be seen as ‘work in progress’, which will evolve to best serve the overall efforts to rehabilitate and revitalise the EMRP area.

1.1 Monitoring and Change

Monitoring is the systematic measurement of variables and processes over time to assess the stability of or changes to a system by means of recording, mapping, surveys and sampling to provide the means for detecting change over time. According to Spellerberg (2005) there are five reasons to justify ecological monitoring:

1. Ecosystem processes have not been well researched and basic ecological knowledge is required.
2. Management must have a baseline that only ecological monitoring can provide.
3. Anthropogenic influences have long-term effects and therefore long-term monitoring is essential.
4. Data obtained from long-term studies form the basis for early detection of deviation from the management regime.
5. The impacts of losses of and damage to habitats need to be evaluated.

All five reasons for ecological monitoring apply in the case of the EMRP area, and the same considerations apply for hydrological and socio-economic monitoring. In fact, the interrelations between physical, environmental, hydrological and socio-economic factors are so strong in peat and lowland areas that a specific ‘peat and lowland monitoring system’ is required. Consequently, it is necessary to develop appropriate methodologies with indicators covering these factors that can be benchmarked. These should be as simple as possible with the objectives defined clearly.

A peat and lowland monitoring system should also consider the past by examining historical records and other information in retrospective studies in order to establish the baseline for the monitoring programme. Remote sensing is a valuable tool in this respect since it can be used to examine land cover, land use and land use change over at least the previous 30 years in the case of the EMRP. What happens in the future can also be monitored more or less constantly by the increasingly sophisticated satellite and aeroplane based sensors that are being developed.

In devising a monitoring programme for the EMRP it is essential to take into account existing systems and procedures and not to ‘re-invent the wheel’. Since the EMRP area consists mostly of peatland and other lowland ‘wetlands’, it is logical to utilise information and approaches that have been developed by the Ramsar Convention (see 1.3 and Annex 1).

A programme of monitoring has to be resourced and financed over a timescale well beyond the implementation phase, preferably for the long term. The nature of any monitoring system is constrained by the size and complexity of the area and the resources available.

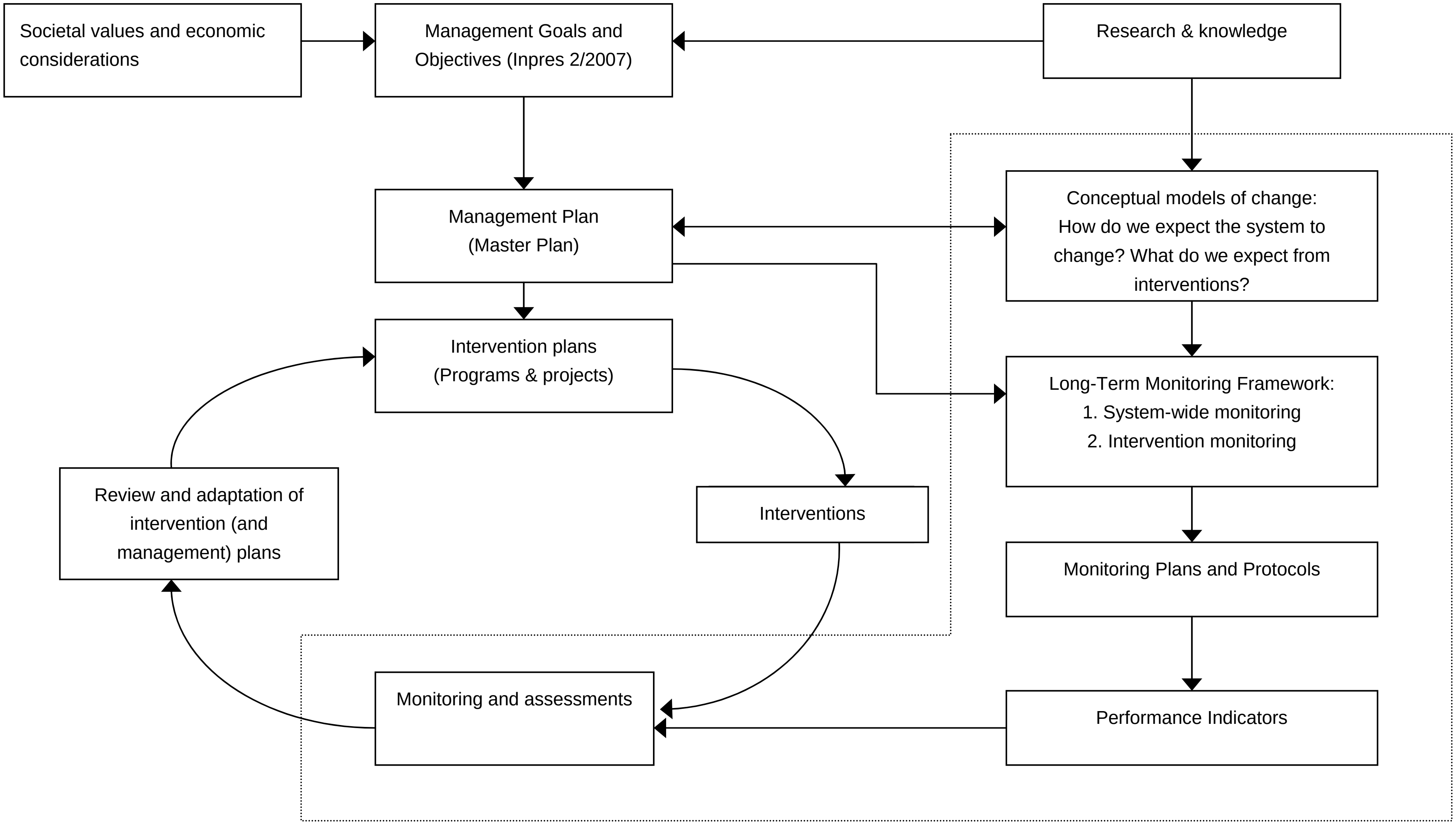
1.2 Monitoring and Adaptive Management

Rehabilitation and revitalization of the EMRP present many problems, mainly because the outcomes of planned interventions are to a large extent uncertain. Consequently, the Master Plan for the Rehabilitation and Revitalisation of the EMRP area proposes an adaptive management approach[1] whereby the outcomes of interventions are monitored to determine whether or not the expected changes to the system occur. Once it is evident what the responses to interventions are, and the situation is evaluated, a feedback mechanism should enable management activities to be modified if necessary (Figure 1). If objectives are not achieved, changes in management procedures are inevitable either by modification of existing approaches, adopting a different approach, or admitting that the objective cannot be achieved.

Consequently, monitoring and science are central to the overall management of interventions in the EMRP area and necessitate building and testing a ‘model of change’ that describes how interventions are expected to affect the system (Figure 1). Monitoring will provide the evidence required to decide whether to (a) continue with existing approaches or (b) modify interventions. Research combined with long-term monitoring will also lead to better understanding of the system and a revised model of change, to provide the basis for redefining management goals and objectives.

[1] Adaptive management is an approach suited to complex situations where detailed knowledge of the system is limited.

Figure 1: The role of science and monitoring for improved management of the EMRP area



1.3 Monitoring Peatlands – The Ramsar Approach to Monitoring

A framework for designing a peatland monitoring programme was adopted by Ramsar COP6 in 1996 and is incorporated into the Ramsar Wise Use Handbook 16, *Managing Wetlands,* 3rd Edition (Ramsar Secretariat, 2007). This monitoring framework is summarized in Table 1. The Ramsar Wise Use Handbook defines monitoring as "*the collection of specific information for management purposes in response to hypotheses derived from assessment activities, and the use of these monitoring results for implementing management*". The approach emphasises the following:

Linking Inventory, Management and Monitoring - Peatland monitoring systems should build upon the information provided in peatland inventory and assessment activities. Specific monitoring should be based on a hypothesis (model of change) derived from the assessment data and be contained within a suitable management structure. Further inventory work is required in the EMRP area, which needs to be designed to establish a baseline for long-term monitoring.

Multi-scale Approach – Peatland monitoring systems will need to operate at a range of scales from the whole peatland down to the site level. In the EMRP, monitoring should be conducted (a) at the scale of the whole area, mostly through remote sensing and other secondary data analysis, (b) in specific localities (through a mix of remote and field observations) and (c) at the site level that allows variability within localities to be assessed.

Data Collection and Analysis – Monitoring systems need to be based on standardised procedures and data management formats. Proforma data sheets for each level of analysis need to be developed, accompanied by guidelines for collecting, storing and retrieving the required information. Typically, rapid appraisal methods, including biological assessment and remote sensing, are applied at broad scales. For specific sites, however, more detailed, quantitative monitoring may be required, utilising designs that provide stronger inference about a putative impact.

Ecological and Hydrological Change – The Ramsar approach also emphasises the importance of Risk and Vulnerability Assessment and (Strategic) Environmental Impact Assessment in understanding ecological, hydrological and soil changes as tools for management. Ecological and hydrological change in the form of relatively rapid human-induced degradation of the EMRP area is widespread and still active. The functions and values of the EMRP area are being diminished by this continuing change. The main processes involved are deforestation, drainage, fire and unsustainable use of peat swamp forest products giving rise to subsidence, loss of peat swamp forest and peatland area to alternative land uses, enhanced greenhouse gas emissions, changes in water quantity and quality, and poverty. The forces for these changes are social, economic and political and they require consideration as direct and indirect "drivers of change" in long-term monitoring (see Box 1).

Table 1: Framework for designing a peatland monitoring programme (from Ramsar Wise Use Handbook [16, 3rd Edition, 2006]). The arrows illustrate the feedback which enables assessment of the effectiveness of the monitoring programme in achieving its objective(s).

Problems / Issues	☐ State clearly and unambiguously ☐ State the known extent and most like cause / driver ☐ Identify the baseline or reference situation
Objective	☐ Provides the basis for collecting the information ☐ Must be available and achievable within a reasonable time period
Hypothesis	☐ Assumption against which the objectives are tested ☐ Underpins the objective and can be tested
Methods and variables	☐ Specific for the problem and provide the information to test the hypotheses ☐ Able to detect the presence, and assess the significance, of any change ☐ Identify or clarify the cause of the change
Feasibility / Cost effectiveness	☐ Determine whether or not monitoring can be done regularly and continually ☐ Assess factors that influence the sampling programme: availability of trained personnel; access to sampling sites; availability and reliability of specialist equipment; means of analyzing and interpreting the data; usefulness of the data and information; means of reporting in a timely manner ☐ Determine the costs of data acquisition and analysis are within the existing budget
Pilot study	☐ Time to test and fine-tune the method and specialist equipment ☐ Assess the training needs for staff involved ☐ Confirm the means of analyzing and interpreting the data
Sampling	☐ Staff should be trained in all sampling methods ☐ All samples should be documented: date and location; names of staff; sampling methods; equipment used; means of storage or transport; all changes to the methods ☐ Samples should be processed within a timely period and all data documented: data and location; names of staff; processing methods; equipment used; and all changes to the protocols ☐ Sampling and data analysis should be done by rigorous and tested methods
Analyses	☐ The analyses should be documented: data and location (or boundaries of sampling area); names of analytical staff; methods used; equipment used; data storage methods
Reporting	☐ Interpret and report all results in a timely and cost effective manner ☐ The report should be concise and indicate whether or not the hypothesis has been supported ☐ The report should contain recommendations for management action, including further monitoring

Box 1: Drivers of Change in the EMRP Area

The Millennium Ecosystem Assessment distinguishes direct and indirect drivers of change in ecosystems. A direct driver unequivocally influences ecosystem processes, whereas an indirect driver operates more diffusely by altering one or more direct drivers. Important direct drivers include climate change, plant nutrient use, land conversion leading to habitat change, and invasive species and diseases. Categories of indirect drivers of change are demographic, economic, socio-political, scientific and technological, and cultural and religious.

Within the EMRP area, direct drivers are climate change, land conversion (especially to oil palm plantations) and fire while indirect drivers include population change, trends in agricultural markets including food crops, palm oil, rubber and REDD, trade policies and subsidies, governance and the role of the state, and the impact of scientific and technological innovation on production and other ecosystem services. .

Rehabilitation of the EMRP requires that the extent and direction of change is monitored so that corrective action can be taken if necessary. The effects of intervention activities may not be evident for several years after implementation, by which time it may be too late to undertake remedial action. This requires a phased approach to both rehabilitation and development in the EMRP area (in contrast to the previous development of the area), and establishment of adaptive management procedures that will allow timely corrections.

A number of initiatives are now being developed to deal with the problems of the EMRP area, with a focus on peatland rehabilitation, forest conservation and carbon emission reduction. These include follow-ups to previous projects (e.g. CKPP and the Master Plan project) as well as new initiatives (e.g. Ausaid Kalimantan Forest and Climate Partnership, CARE-SLUICES project (funded by the European Union), and several carbon investment projects). All these projects will need to provide to the Government of Indonesia, donors and others an understanding of the effect of the interventions that have been implemented. As the investment in interventions increases, so should the technical capacity and knowledge base that promotes this understanding.

2 Common Monitoring Framework

A monitoring framework is a description of the purpose, scope and main components of a monitoring activity or system (see Box 2). It is important to define the framework within which monitoring will be carried out including the monitoring basis and rationale, identification of monitoring locations, determination of methods, the frequency at which measurements and assessments will be made, and the duration of monitoring.

A **Common Monitoring Framework** is proposed in the EMRP area for several reasons. Common monitoring approaches and tools will enable clear comparison between interventions from different projects. This is essential to enable both the consolidated reporting of progress with interventions under Inpres 2/2007 but also to allow an overall evaluation of the effectiveness of interventions as part of an adaptive management approach. Furthermore, the complexity of the issues in the EMRP is such that all projects in specific intervention areas will require information on findings and developments in other areas. No project will have the capacity to develop the knowledge base by itself and a set of reference sites will be needed that can be used for a number of projects as a common control system. The use of a Common Monitoring Framework, especially at the scale of the whole EMRP area, will also be important in assessing the extent to which developments in one area may affect conditions in other areas through spill-over and leakage effects. The monitoring framework proposed here provides the basis for further development in the future as the plans and requirements of various initiatives in the EMRP become clearer.

Box 2 Learning by Doing: Why We Need Monitoring

Several projects have been carried out to investigate the means to rehabilitate the ecological and hydrological functions of peatland in the EMRP area. Dams were built in several areas, fire fighting teams set up and trees planted. These efforts were mostly pilots in small areas, aiming to reduce problems at a limited scale while allowing lessons to be learnt for implementation projects at the much larger scale needed in the EMRP area.

Unfortunately, in most cases, it was not possible to evaluate the effect of these pilot project interventions owing to a lack of resources and shortage of time. For example, the direct effect of canal blocking schemes on water tables is often unknown. Water tables were relatively high in the dry seasons in 2007 and 2008 in areas where canals had been blocked, but so have they been in other areas without intervention as these were two of the wettest dry seasons on record. For the same reason, fires have been limited throughout the EMRP area in recent years, and not just in areas where fire fighting and fire prevention measures are taken. Moreover, if 2009 turns out to be a dry year with low water tables and many fires, it will still be difficult to quantify how successful these measures have been, because the monitoring system that should provide such information is not in place at the moment. In the current situation it is therefore impossible to learn lessons from pilot interventions with the accuracy and confidence required for development of large-scale interventions.

Apart from the direct effects of interventions, the indirect effects are even less known. Assuming that dams raise water tables significantly in some areas, is this enough to reduce carbon emissions, peat surface subsidence and fire risk significantly, or should they have been raised higher? Such questions can only be answered through a thorough and prolonged monitoring effort and an understanding of the likely conditions that would have resulted had there been no project, i.e. a ‘baseline’.

2.1 Objectives of the Proposed Monitoring Framework

The main aims of the proposed monitoring framework are to:

- Assess collective progress with the rehabilitation and revitalisation of the EMRP area, identify problems and propose modifications.
- Support existing and new projects in developing the knowledge base required to understand effects of interventions and identify adaptations to current approaches.
- Provide a basis for standardization of monitoring methods applied in different projects and by different stakeholders.

A key feature of the proposed Common Monitoring Framework is the focus on three main levels of monitoring:

1. System-wide Monitoring – The highest level of monitoring with a focus on the overall status of the EMRP area. This includes peatland condition and subsidence, fire trends and patterns, overall hydrology, land cover and agricultural development, and socio-economic aspects. Monitoring of emissions of greenhouse gases (GHG) or a proxy measure of this should form a part of system-wide monitoring as a priority as Presidential Instruction 2/2007 forms a part of Indonesia's National Action Plan for Addressing Climate Change.[2] System wide monitoring will provide an assessment of overall changes in the area and progress being made towards the overall goal of rehabilitation and revitalisation. System-wide monitoring could also be valuable in assessing the impact of new policies (e.g. spatial planning policies, fire policies etc.).

2. Intervention Impact Monitoring – This level of monitoring will focus on monitoring at the intervention level. An intervention here is defined as a project that, if implemented successfully, will assist in the rehabilitation and revitilization of the EMRP and can include commercial (e.g. plantation development) and non-commercial projects as well as community initiatives. Monitoring of interventions will generally be led by the relevant project implementation agency but could receive support from the proposed Technical Facility (see Master Plan Technical Guideline No. 1) to ensure a common approach. Community initiatives could also be supported by the Technical Facility for implementation and monitoring as part of the community-based approach (see Master Plan Technical Guideline No. 3). The purpose of intervention impact monitoring is to understand the impact, negative and positive, of interventions in the area as a part of the adaptive management approach.

3. Progress and Compliance Monitoring – This level of monitoring will focus on two aspects: (i) *Progress Monitoring* to provide periodic, consolidated progress reports on project implementation within the EMRP area, and (ii) *Compliance Monitoring and Quality Assurance* to ensure that specific legal aspects within the EMRP area (such as land use permits, EIAs) and quality assurance have been carried out or issued when requested.

[2] www.adaptationlearning.net/profiles/country/files/IndonesiaNationalClimateChangeActionPlan_2007_English.pdf

2.2 Model of Change and Interventions

The starting point for the development of the monitoring framework and system is a clear understanding of the baseline conditions including the problems that need to be addressed, the proposed interventions and a model of change that describes how these interventions are expected to achieve the desired outcomes.

Problems and Issues

The existing conditions and problems of the EMRP area are defined in the Master Plan Main Synthesis Report. Briefly, these can be summarised as follows:

- Extensive degradation of a large part of an area of 900,000 ha of peat swamp forest occurred in the 1990s as a result of past logging, the construction of an extensive network of drainage canals and associated deforestation;
- Hydrological impacts include excessive flooding in certain areas during the wet season and low water tables during the dry season leading to drying of the surface peat;
- The loss of forest and lowered water tables during the dry season creates a fire-prone landscape that, combined with human activities, has led to extensive and damaging wildfires;
- High carbon emissions that contribute to global warming result from the decomposition of dry peat, and loss of peat through burning, leading to a lowering (subsidence) of the peat surface;
- Poor agricultural outcomes as a result of challenging bio-physical conditions, poorly functioning water management infrastructure, the use of basic farming practices and technology and a lack of supporting infrastructure and markets;
- Poverty amongst local communities and transmigrant settlers remains high as a result of the loss of natural resources, poorly functioning water management infrastructure and difficult conditions for agriculture;
- Innappropriate developments and projects, which may or may not be in accordance with the overall management goal.

Management Goal and Interventions

The goal of the Master Plan is to "*create long-term prosperity for the local population through the restoration of the area's ecosystems, developing appropriate infrastructure and services, and providing an enabling environment for increased productivity of agriculture*". The Master Plan considers this will be achieved through six main programs, which are shown in Table 2 with the exception of program 6 on institutional and capacity building.

Table 2 provides a logical framework of the Master Plan, linking main interventions and change with proposed performance measures for monitoring at both the level of an intervention and across the whole area.

Table 2: Main Master Plan programmes and Main Performance Measures for Monitoring.

Master Plan Program		Goal		Key Interventions and Change		Intervention Performance Measure		System-wide Performance Measure
1. Fire prevention and management	THE GOAL IS TO	Eliminate wildfire from the area	THROUGH	Strengthen institutions and systems and combine with knowledge and capacity for fire prevention and suppression	ASSESSING OUR WORK THROUGH	1. Fire management system monitoring 2. Fire monitoring 3. Fire policy impact monitoring	ASSESSING PROGRESS TO GOAL	1. Fire management system monitoring 2. Fire monitoring 3. Fire policy impact monitoring
2. Spatial management and infrastructure		Manage spatial development and build supporting infrastructure		Make a detailed spatial plan supported by systems to control spatial development		1. Compliance monitoring of development permits (plantations, mining) and infrastructure interventions (including EIA/AMDAL)		1. Assessing quality of detailed and district spatial plans and conformance to prov. Sp. Plan Master Plan.
3. Peat and forest rehabilitation and biodiversity, carbon and water conservation		Conserve existing peatland and forest resources and rehabilitate areas of degraded peatland		Raise water levels through canal blocking and water level control; rehabilitate peatland by reforestation, and conservation actions.		1. Hydrological monitoring 2. Subsidence monitoring 3. Ecological monitoring 4. Reforestation monitoring		1. Hydrological monitoring 2. Subsidence monitoring 3. Ecological monitoring 4. Land cover monitoring
4. Agricultural revitalization		Increase agricultural productivity through intensification and diversification of farm systems and limited development of new areas		Strengthen farm systems by improving land and water management, agricultural infrastructure and access to markets		1. Hydrological monitoring 2. Soil and environmental monitoring 3. Crop productivity monitoring 4. Fisheries monitoring 5. Farm systems monitoring		1. Hydrological monitoring 2. Soil and environmental monitoring 3. Crop productivity monitoring 4. Fisheries monitoring 5. Agricultural sector monitoring
5. Socio-economic and community development		Reduce poverty through socio-economic development linked to community empowerment		Community development programmes to develop institutions, participation and community finance; improvements in basic services, facilities and infrastructure; socio-economic development through land tenure security, market and local agribusiness development.		1. Community institutions monitoring 2. Community finance monitoring 3. Community facilities and service improvement monitoring 4. Land tenure monitoring 5. Socio-economic outcome monitoring		1. Community institutions monitoring 2. Community finance monitoring 3. Community facilities and service improvement monitoring 4. Land tenure monitoring 5. Socio-economic status monitoring

Proposed Models of Change

A 'model of change', or a hypothesis that defines the expected impact of interventions, is needed to (a) plan interventions and (b) define targets and thresholds and identify performance indicators. These, in turn, are needed to develop a system that allows monitoring of success of interventions. Models of change should be developed for each of the main interventions planned (see Table 2). An example is provided below for rehabilitation of degraded peatlands.

Peatland Rehabilitation Model of Change

Most interventions in recent years were implemented without a clear projection of exactly what effects were expected. An example is canal blocking, which aims to 'rewet' peatland areas. In most cases, there appears to have been no *a priori* quantification of the expected extent of the impact area or of whether the aim was to elevate groundwater levels year-round or to inundate areas in the wet season. Considering the complications of the hydrology of these degraded peatlands, with steep surface gradients towards canals and limited groundwater flow, both objectives are difficult to achieve over large areas. But knowing exactly what outcome is desired will help to plan interventions better in terms of location and design, and to measure their actual effects more precisely.

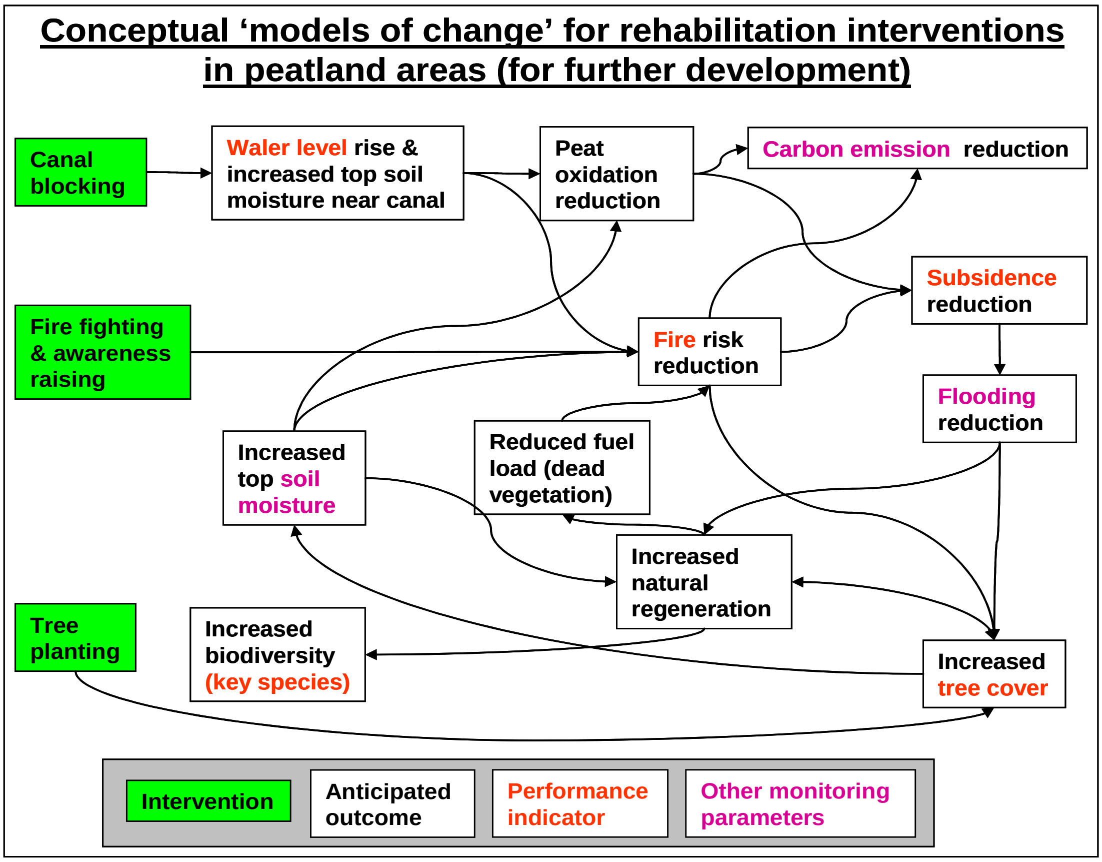


Figure 3: Tentative 'model of change' for interventions in peatland areas.

A flow chart with the most important 'model of change' relations for peatland rehabilitation is presented in Figure 3. This needs further refinement, as follows:

- The interrelations in the systems should be further detailed.
- Indicators and other parameters to be measured should be elaborated further.

- Targets and thresholds for indicator parameters should be clarified.
- Socio-economic factors, including interventions to improve agricultural use of peatland, need to be built into the model.

2.3 The Proposed Monitoring System

The monitoring system proposed by the EMRP Master Plan project aims to allow quantified assessment of intervention impacts (intervention level monitoring), providing a stronger basis for design or implementation projects and management adaptations where required, and an overall assessment of progress to the rehabilitation and revitalisation goal at the level of the whole EMRP area (system-wide monitoring). For each of the Master Plan components (see Table 2), main interventions components of the monitoring system for the EMRP area will be:

- **Standards for monitoring and evaluating rehabilitation and revitalisation activities** that will enable accurate assessment of key performance indicators and other parameters, preferably to be put in place before interventions are implemented so that post intervention results can be benchmarked against the pre intervention situations.
- **Guidelines for setting clear targets for interventions**, the basis being an understanding of expected positive effects and possible side effects.
- **Protocols for data collection and analysis methods** to provide quality control and an information service to support adaptive management.
- **Reference sites** to provide information on similar areas where interventions are not being implemented.
- **A methodology for baseline development that will be benchmarked** in areas that have been unaffected by the EMRP or by land use change and fire (e.g. CIMTROP Natural Laboratory in the upper Sg. Sabangau catchment)..

2.4 Performance Indicators and Other Parameters

The area of the EMRP is so large, the landscape so complex and the current and proposed land uses so varied that it is impossible, for logistical and financial reasons, to monitor every environmental variable in every location that may be important for determining the success of the 'Master Plan' implementation. Consequently, a number of 'indicators' that will provide a combination of direct and surrogate measures of hydrological, ecological, environmental and socio-economic change need to be identified and incorporated in monitoring systems, preferably after testing in pilot studies.

To allow real-time evaluation of whether or not targets are achieved, parameters need to be measured that can be interpreted in real-time. In the context of the current framework, these are called 'indicator parameters' that will provide a direct measure of the status of a system component crucial to the success of the intervention. Canal water depth, tree cover and subsidence are examples of indicator parameters since they can be measured relatively easily by non-experts over large areas and do not require further analysis to be interpreted.

By this definition, only a few parameters are good real-time indicators. Many other parameters are not as easily measured and/or harder to interpret, often in combination with other parameters, but add more in-depth understanding of the system processes than real-time indicators. A good example is peat soil moisture monitoring, which takes much processing time and expertise. So soil moisture is not a good real-time indicator, but it is important to monitor it in terms of understanding fire risk, decomposition processes and the actual meaning of 'groundwater depth' which is only an approximation of the depth of the unsaturated zone and may tell us little about soil moisture conditions.

2.5 Baseline and reference sites

In order to determine the extent to which targets have been achieved, it is necessary to know what might have happened without these interventions: the 'baseline' scenario. Three activities are needed to evaluate this: 1) monitoring of indicators should start prior to the intervention (ideally at least a year in advance for hydrological intervention), 2) 'baselines' need to be defined prior to interventions, and 3) reference sites must be selected in areas where no interventions take place, for comparison. Considering the spatial variability of peatland types, recent history and current land cover, it would be best to have a number of reference sites distributed over the EMRP and in adjacent areas. One way of achieving this would be to leave sections of intervention areas 'untreated', i.e. without tree planting and/or canal blocking.

2.6 Geographical Focus and Scale

The monitoring programme will be subdivided according to the different management zones defined in the Master Plan and at three different scales.

2.6.1 Management Zones

The monitoring programme should fit within the four major Management Zones and be formulated to address the priority objectives of each Zone:

1. ***Peatland Protection and Conservation Zone (Kawasan Lindung / Konservasi)***

The focus will be on hydrological and ecological monitoring. This zone will be sub-divided into two main areas:

a) **Conservation sub-zone** – The area currently with a good forest cover and only limited drainage infrastructure (mostly illegal logging canals / ditches) where conservation action is a priority.

b) **Rehabilitation sub-zone** – The area of degraded peatland with macro drainage infrastructure.

2. ***Development Zone (Kawasan Budidaya)***

The focus in this zone will be on hydrological monitoring of the performance of water management infrastructure, in terms on water level control and water quality control, and on performance of the agricultural systems within the four management units proposed for investment.

3. **Adapted Management Zone (Kawasan Budidaya Terbatas)**

The first step in developing monitoring programmes for the adapted management zone, i.e. the zone with peat depths between 1m and 3m, adjoining areas of deeper peat, is to determine the precise boundaries of the zone through peat depth surveys. The level of detail and accuracy of current peat depth data are insufficient for design purposes. The second step in these areas is to set up monitoring systems that allow assessment of the degree of impact that activities will have on the adjoining deeper peat areas. This requires monitoring of groundwater depth and subsidence rate. The need for adaptive management, and therefore for monitoring of real-time indicators, may be especially urgent here.

4. **Coastal Zone (*Kawasan Pesisir*)**

The focus of monitoring in this zone will need to be on the impacts of coastal fisheries (including conversion to brackish water fish ponds / *tambak*) on mangrove ecosystems, trends in productivity of such fisheries, and the success rate of mangrove protection/rehabilitation efforts.

2.6.2 Multiple Spatial Scales

Within each management zone, the monitoring system will focus on a series of three nested scales: (i) at the broad scale of the EMRP area / management zone (tens to hundreds of thousands of hectares), (ii) at the local / intervention scale (thousands of hectares) and (iii) at the site scale (several hectares). This will ensure that monitoring results are comprehensive across the EMRP area and sufficiently detailed to allow understanding of how effective interventions have been at both the local and site-specific scales.

Broad scale of the management zone (hundreds of thousands of hectares)

Remote sensing and secondary data analysis (e.g. permits and planned developments) will provide broad scale analysis of the management zone combined with extensive surveys where appropriate (e.g. biodiversity).

Local / intervention scale (thousands of hectares)

At the local or intervention scale, the focus will be on monitoring changes in areas where interventions are expected to have impacts. Reference sites will be established for comparison with intervention localities.

Site scale (several hectares)

At both reference and intervention localities, a number of monitoring sites will be established to (a) understand site specific factors and (b) assess variability between sites within localities.

2.7 Data Management

Although data management does not need to be part of a monitoring framework, strictly speaking, there is a clear relation that warrants its consideration when developing a monitoring system. Without proper data management and data exchange protocols, the value of monitoring will be seriously diminished.

2.7.1 Data inventory

Although many relevant available datasets for the EMRP area have been identified and some have been incorporated in the EMRP Master Plan, there will still be data that have not been identified. This should be done as a priority, to make sure followup projects will have access to the best possible database. A brief, easy to understand data inventory overview should be produced to allow all stakeholders to know precisely what has been measured already, and what has not. This inventory report should be updated regularly to include the new datasets being collected in the various projects now being prepared.

2.7.2 Data management

Standard platforms and protocols for data storage should be developed, to allow easy data access and exchange. Protocols for quality control and basic analyses are also needed. At present, no strict quality control standards are being applied by any of the organizations now collecting data in the EMRP area, be it Government, University or NGOs. This renders many datasets for the area of limited use, including rainfall data from BMG and PU, elevation data from Bakosurtanal, and groundwater depth data collected by several peatland rehabilitation projects. Apart from the database containing the actual data, a meta-database is also needed which provides standardized descriptions of database files in terms of data type, location, period, quality etc. To enhance transparency and accessibility to all stakeholders, it will be best to store data in Excel where possible, but to create a system of directories and file names that allows easy identification of files.

2.7.3 Capacity building

At present limited capacity exists, in the EMRP area and in most organizations preparing peatland rehabilitation projects, to take on the required tasks of data collection, data management, quality control, and analysis or protocol development. Developing the human capacity to improve this situation, during and beyond the planned projects, is an absolute requirement to project success. This is best done by on-the-job training and short technical courses on location.

2.7.4 Data management organizations and responsibilities

Organizations involved in relevant data collection and management include Government organizations that are responsible for routine data collection programmes (such as BMG with rainfall, PU with rainfall and river water levels, Bakosurtanal with elevation data), NGOs that collect data on a project basis (such as Wetlands International, BOS, CARE and WWF in the CKPP project), Indonesian University Departments and international scientists. Ideally, all these organization should be involved in some way in implementing a monitoring framework for the EMRP area, and understand how collaboration and improved data collection will benefit its management and rehabilitation.

2.8 Progress and Compliance monitoring

All projects contributing to conservation, rehabilitation and revitalization in the EMRP area should have clear objectives and measurable targets. The framework proposed here provides the tools by which success in achieving these targets can be monitored. It is expected that integration of monitoring systems developed by different projects and organizations will be required, not only to ensure consistency in methods and data quality but also because understanding of developments in each area will require information from other areas:

- For comparison: as reference sites and to distil ‘lessons learnt’ from experiences elsewhere.
- For improved knowledge of processes, i.e. research.

Moreover, there are also hydrological, ecological and socio-economic interdependencies in the actual execution of intervention projects in different areas: success or failure in one area can affect another.

It would therefore be sensible to have a ‘progress monitoring’ component linked to the technical monitoring system; a process by which progress, setbacks and obstacles in the different projects would be recorded. Apart from the benefits to the projects, this could also be a basis for internal progress evaluations and external audits that will presumably be required by all projects sooner or later. At some point, all donors funding peatland rehabilitation and carbon conservation projects will demand a level of accountability that requires progress monitoring.

Furthermore, a ‘compliance monitoring’ component may be needed to ensure that adverse developments inside or near rehabilitation areas do not affect the interventions. For example, drainage schemes should not be developed (by plantation owners or by PU) in the same peatland landscape where other stakeholders are trying to elevate water levels; similarly, access canals should not be opened in areas reserved for peat swamp forest conservation. Whilst progress monitoring deals with individual projects, compliance monitoring deals with developments controlled by Government agencies at the District, Provincial and National levels.

The protocols for progress monitoring and compliance monitoring should be established in communication with the relevant rehabilitation projects and with Government agencies, and may be refined for each individual project to best meet its (and its donors’) requirements. For instance, an REDD project aiming to avoid emissions will have different requirements from a rehabilitation project with a broader focus including biodiversity conservation/enhancement.

3 Towards the Development of Monitoring Protocols

The Master Plan defines four separate management zones: the protection zone (773,500ha), limited development zone (353,500ha), development zone (295,500ha) and coastal zone (40,000ha). This section of the report focuses on the development of monitoring protocols for each of the four management zones. For each management zone, a logical sequence should be followed to define the key performance indicators to be measured:

Step 1 - Management Objectives and Issues: The management objectives and issues for the management zone are defined.

Step 2 - Model of Change: A model of change is developed that defines how interventions influence the system to create the expected outcomes.

Step 3 – Performance Measure: The key performance measures / parameters are defined according to the main fields of (i) hydrology, (ii) ecology and environment, and (iii) social and economic aspects. Compliance and progress monitoring is also included.

Step 4 - Scale: The performance measures are assorted to a particular scale: system-wide or within an intervention area.

Step 5 - Key Performance Indicator (KPI): A specific and measurable KPI is defined, based on the performance measure of interest.

Step 6 - Methodology: Methodologies (protocols and tools) are developed to measure the indicators and which are compiled into an integrated monitoring methodology.

Step 7 - Feasibility and Cost: The integrated monitoring methodology is assessed in terms of its feasibility and cost with adjustments made.

Step 8 - Piloting: Piloting will be required as part of the development of monitoring protocols and tools before scaling up the monitoring system.

This process should be undertaken in collaboration with GOI and the relevant projects in the EMRP area to develop a single monitoring system for the area. It is recommended that full monitoring protocols are developed for each of the four management zones as the next step in the development of the monitoring system.

3.1 Management Objectives and Monitoring

Key aspects of the management objectives are outlined for each of the four management zones and their implications for monitoring.

3.1.1 Peat and Peat Swamp Forest Protection Zone

The key questions to be answered by monitoring in this Zone relate to the success of interventions to conserve or rehabilitate natural peat swamp forest and its functions.

There are two different types of areas within this zone, which require different management targets and monitoring objectives.

Forest and peat carbon conservation areas

Where there is still good or reasonably good forest cover on deep peat, and drainage is relatively low, the primary management objective is to prevent logging and encroachment of agriculture. Monitoring here will therefore focus on:

- Early detection of changes in land cover, including logging, canal/road construction and from fires. This should be done with a frequency that will allow rapid action to prevent further deterioration. Both ground surveys and remote sensing will be required.
- Monitoring trends in forest degradation, especially in forest that is already degraded, and recovery through natural succession.

Some well-protected forest conservation areas can act as ‘natural state’ reference sites for rehabilitation areas as well as other conservation areas that may be subject to high levels of disturbance. Here, the same parameters should be monitored as in the rehabilitation areas (including water depth, peat characteristics), with a focus on biodiversity aspects. Field monitoring frequency may be relatively low as no adaptive management may be needed.

Forest rehabilitation and peat carbon conservation areas

In the remainder of this zone, where there is very little or no forest cover remaining on deep peat, the primary management objective is rehabilitation of the peatland by rehabilitating hydrological functions and reforestation, which require a (major) reduction in fire frequency and extent, and higher water tables. A key requirement will be to ensure that people living in and near the peat areas can become prosperous without damaging the long-term sustainability of their livelihoods and peat swamp forest natural resources. As the Protection Zone is not open to development, compliance monitoring of development permits will need to focus on this area.

Monitoring should therefore focus on:

- Fire control, by determining if fire education and prevention measures are in place and are being implemented.
- Early detection of changes in land cover, especially for agriculture development and burnt areas.
- Early detection of drainage implementation and of damage to canal blockings.
- Monitoring of natural regrowth rates and types, as well as success of reforestation efforts.
- Peatland hydrological conditions with a focus on canal and groundwater depths.
- Subsidence, peat characteristics and carbon emissions.
- Socio-economic aspects including land tenure arrangements to ensure that conservation-community conflicts are effectively managed in a way that reduce threats of open access and unrestricted use of forest resources in the area and that communities can achieve beneficial long-term sustainable development outcomes.

3.1.2 Limited Development Zone

The monitoring requirements for this zone, which lies between the border of the Protection Zone and its hydrological boundary, where development of smallholder crops using controlled drainage is proposed, are those of both the Protection Zone and the Development Zone. Monitoring within the LDZ, where physical/agricultural conditions are more variable than in other Zones, is essential and because best management practices for this Zone have yet to be decided, defined and implemented. This may require a higher frequency of monitoring with faster data collection/processing procedures than may be necessary in the Protection Zone. Socio-economic aspects will be a high priority in this zone, which acts as a buffer between the Protection and Development Zones.

3.1.3 Development Zone

The primary management objective in the development zone is to optimize agricultural production and improve local livelihoods. The main current and potential impediments to agricultural development in these areas relate to the challenging biophysical conditions, land and water management, farming practices and technology, and access to markets. Flooding occurs in a number of places in the wet season.

Monitoring here will focus on:

- Hydrology and water management
- Soil and biophysical environmental aspects
- Agricultural productivity problems
- Farm systems and development in the broader agricultural sector
- Socio-economic developments

3.1.4 Coastal Zone

Most of the coastal zone with its mangrove forests is proposed for protection in the Master Plan. Some limited development of semi-intensive *tambak* is an appropriate land use on the western side of the Kahayan River near to its mouth. Monitoring in this area will focus mainly on the recovery of degraded mangroves, unwanted expansion of *tambak* into adjacent conservation areas, and further compliance with the Master Plan to avoid inappropriate development of this zone.

3.2 Performance Measures and Scale

A range of key performance measures that should be monitored in the EMRP area to determine the success of main interventions and achievement goals are presented in Table 2.[3] In total, twenty-one performance measures are proposed that if monitored will provide an assessment of progress towards the goal of rehabilitating and revitalising the EMRP area (Table 3).

3.2.1 System-wide monitoring requirements

Certain monitoring activities are required for all Management Zones and must therefore be co-ordinated at the EMRP-wide level to ensure availability to all projects as well as consistency and quality control. These include:

- Incidence of fire across the area and effectiveness of fire control and prevention policies;
- Level of compliance with existing legal spatial plans;

[3] A Performance Measure is defined here as the specific representation of an outcome relevant to the assessment of performance.

- Current status of peatland and forest resources;
- Certain hydrological parameters such as rainfall;
- Monitoring of land cover changes and flood extent
- Monitoring of the bio-physical and hydrological environment for agriculture across a range of reference sites;
- Monitoring of crop productivity and assessment of broad changes in the agricultural sector (new crops, adoption of new technologies etc.)
- Monitoring of progress in community empowerment, finance and other socio-economic factors.

3.2.2 Intervention monitoring requirements

For each intervention within the EMRP area, it is proposed that all projects have a core set of monitoring requirements and protocols so that comparisons can be made between projects and consolidated assessment of progress and reporting can be achieved. Each project can also develop other monitoring tools and indicators according to their own needs. The requirements for monitoring at the intervention level are shown in Table 3.

Table 3: The proposed requirements for the monitoring system.

Monitoring Programme Component	Performance Measure	Intervention	System-wide
1. Fire Management	1. Fire management system monitoring	✓	✓
	2. Fire monitoring	✓	✓
	3. Fire policy impact monitoring	-	✓
2. Spatial Management and Infrastructure	4. Compliance and quality assurance of spatial plans	-	✓
	5. Spatial development compliance monitoring including EIAs	✓	✓
3. Peat and forest rehabilitation and conservation	6. Peatland hydrological monitoring	✓	✓
	7. Peatland carbon emissions monitoring	✓	✓
	8. Peatland ecological monitoring	✓	✓
	9. Peatland reforestation monitoring	✓	✓
	10. Land cover monitoring	-	✓
4. Agricultural Revitalisation	11. Agricultural hydrological monitoring	✓	✓
	12. Agricultural soil and environmental monitoring	✓	✓
	13. Crop productivity monitoring	✓	✓
	14. Fisheries monitoring	✓	✓
	14. Farm systems monitoring	✓	✓
	15. Agricultural sector monitoring	-	✓
5. Socio-economic and Community Development	17. Community institutions monitoring	✓	✓
	18. Community finance monitoring	✓	✓
	19. Community facilities and service improvement monitoring	✓	✓
	20. Land tenure monitoring	✓	✓
	21. Socio-economic outcome monitoring	✓	✓

These monitoring requirements are arranged according to each specific management zone and the spatial scale of monitoring Table 4).

Table 4: Proposed Arrangement of Monitoring Performance Measures in the EMRP Area by Spatial Scale and Management Zone.

Scale	Master Plan Monitoring Component	Conservation / Protection Zone		Limited Development Zone	Development Zone	Coastal Zone
		With forest	*Without forest*			
System-wide / Mgmt Zone	Fire	1. Fire management system 2. Fire monitoring 3. Policy impact monitoring			2. Fire monitoring 3. Policy impact monitoring	
	Spatial Plan Compliance	4. Compliance and QA spatial plans: forest boundaries 5. Spatial Development Compliance Monitoring: non-forest use		4. Compliance and QA spatial plans 5. Spatial Development Compliance Monitoring: drainage requirements	4. Compliance and QA spatial plans 5. Spatial Development Compliance Monitoring	4. Compliance and QA spatial plans: mangrove protection 5. Spatial Development Compliance Monitoring: *tambak* expansion
	Peatland Rehabilitation	6. Hydrology 7. Carbon Emissions 8. Ecology: Biodiversity 10. Land cover	6. Hydrology 7. Carbon Emissions 8. Ecology: Succession 10. Land cover	6. Hydrology 7. Carbon Emissions 8. Ecology: Succession 10. Land cover	-	10. Land cover
	Agriculture	-	-	11. Agr. Hydrology 12. Soil and environment. 13. Crop productivity 14. Fisheries 15. Farm systems 16. Agriculture sector	11. Agr. Hydrology 12. Soil and environment. 13. Crop productivity 14. Fisheries 15. Farm systems 16. Agriculture sector	14. Fisheries 15. Farm systems 16. Agriculture sector
	Socio-economic	17. Community institutions monitoring 18. Community finance monitoring 19. Community facilities and service improvement monitoring 20. Land tenure monitoring 21. Socio-economic outcome monitoring				
Intervention area (project specific plus reference sites)	Fire	As above without policy impact monitoring			No monitoring required	
	Spatial Plan Compliance	No monitoring required				
	Peatland Rehabilitation	As above	As above with 9. Reforestation monitoring included	As above with 9. Reforestation monitoring included	-	-
	Agriculture	-	-	As above excluding agriculture sector	As above excluding agriculture sector	As above excluding agriculture sector
	Socio-economic	As above	As above	As above	As above	As above

In addition to these recurrent monitoring requirements, there are also a number of inventory needs (e.g. elevation and peat thickness) and other actions required to set a baseline.

3.3 Proposed Monitoring Protocols

For each of the proposed monitoring performance measures, a number of monitoring protocols and tools will need to be developed. This section of the report provides a brief summary of the proposed protocols and tools that will need to be developed for each of the five Monitoring Program Components.

3.3.1 Fire Monitoring

1. Fire Management System Monitoring

Why: A key task is the development of an effective Fire Management System in order to eliminate fires from the EMRP area. The development and performance of this system should be monitored.

What: A fire management system requires effective fire management institutions, a fire information system, a fire prevention capability, fire preparedness and fire suppression capability, and fire impact analysis.

How: A Fire System Assessment and Monitoring system needs to be established to assess progress in the development of the system and its performance (linked also to Fire Monitoring).

Where: The monitoring tool should be applied at both the level of project interventions as well as at the system wide level across the whole area (i.e. at national, provincial and district levels).

2. Fire Monitoring

Why: Reduction of fire risk, CO_2 emission and smoke from fire are objectives of all proposed interventions in the EMRP area, and monitoring is required to assess the effectiveness of the interventions.

What: Annual assessments of the area burn and number of fires (hotspot count); the depth of peat lost in fires is also important.

How: Fire monitoring can best be executed using remote sensing data supported by ground surveys. This can be infrared images to identify fire hot spots or visual spectrum products to determine the extent of burnt areas. The amount of peat lost can be estimateded from non-burning subsidence poles in the burned areas.

Where: Fire monitoring should cover the whole Conservation / Protection zone. Subsidence poles should be placed in areas susceptible to burning.

3. Fire Policy Impact Monitoring

Why: There are existing policies both nationally and at the sub-national level relating to fire. Broadly, the Regulation of the Governor of Central Kalimantan No 52/2008 bans burning in deeper non-coastal peat areas but allows burning outside of the dry season in coastal peat and non-peat areas. Burning by plantation companies and by the community is banned in the dry season. The effectiveness of this regulation and related policies needs to be monitoring and evaluated.

What: Fire detection by both remote sensing (see Fire Monitoring) and ground observation during the wet and dry seasons should be conducted in coastal peat, non-coastal peat and non-peat areas.

How: Remotely sensed hotspot data combined with ground detection over a specific period in wet and dry seasons. Observations should be analysed and combined with stakeholder interviews to assess the impact of this policy on burning practices.

Where: This monitoring activity will be conducted at the system-wide level of the whole EMRP area.

3.3.2 Spatial Planning and Compliance Monitoring

4. Compliance and Quality Assurance of Spatial Plans

Why: The Master Plan proposes the development of a detailed spatial plan for the EMRP area as a whole and updating of district spatial plans based on the revised provincial spatial plan and Master Plan. The production of these spatial plans should be assessed to ensure conformity with the provincial spatial plan and Master Plan. Quality assurance is needed to ensure that the specific nature of peat and lowlands has been taken into account in the production of these plans.

What: This activity is a one-off activity, dependent on the production of the spatial plans referred to above. Bappenas and the province should ensure that they are aware of and involved in the production of these spatial plans.

How: Cross checks should be made of the draft and final spatial plans and their compliance with the provincial spatial plan and Master Plan.

Where: This is a system wide activity.

5. Spatial Development Compliance Monitoring

Why: The province has a role in coordinating and controlling district governments. The Master Plan highlights that compliance monitoring to control spatial development and the approval of Environmental Impact Assessments (AMDAL) is required. Spatial development compliance monitoring should also include ensuring free, prior and informed consent by communities and that community rights are respected.

What: A number of inappropriate spatial developments have occurred and will occur in the future that can compromise the rehabilitation and revitalisation of the EMRP area. These include (a) issuance of development permits for plantations, mining and other land uses, (b) the creation of new canals and other drainage infrastructure and (c) the construction of new roads and other transportation infrastructure. These developments and their associated Environmental Impact Assessments (AMDAL) should be monitored on a regular basis to ensure corrective action can be taken.

How: A regular (monthly or quarterly) review with the districts of development permits issued should be undertaken as well as a review of proposed projects in annual development plans as part of the *Musrenbang*. This review should be incorporated into a spatial management system including updated GIS data. The Environment Agency can keep a record of AMDAL and ensure that guidelines for wetlands (and possibly new guidelines for peatlands) are followed, including the presence of expert witnesses at AMDAL hearings.

Where: This is a system-wide activity and should involve all four district governments in the EMRP area.

3.3.3 Peatland and Forest Monitoring

6. Peatland hydrological monitoring

The following hydrological parameters should be monitored: (a) rainfall, (b) canal water depth, (c) ground water depth and (d) soil moisture.

6A) Rainfall

Why: Rainfall is of particular importance to peatlands in the Conservation and Adaptive management Zones, because it affects all aspects of peatland degradation and rehabilitation: fire risk, peat decomposition and vegetation regrowth

What: Monitoring should provide spatially distributed assessments of daily rainfall. Owing to the variable nature of rainfall in the area, the spatial resolution should be in the order of 1,000 km^2 (100.000 ha) or less.

How: A spatially distributed daily rainfall assessment can be obtained from a combination of information from rain gauges and remote sensing data. Standard manual rain gauges (100 cm^2 orifice) should be installed at a sufficient number of locations (at least one every 100,000 ha) at a height of 1.5 m above the ground surface and clear of any obstacles (houses / trees) and should be measured daily at a fixed time in the morning (8:00 am) at each measurement location. Remotely sensed observed precipitation by the TRMM satellite (Tropical Rainfall Measuring Mission) is freely available through the internet with a temporal resolution of 3 hours and a spatial resolution of 28x28 km (or approximately 78,000 ha). These data can be used to interpolate between rain gauges, and for quality control purposes.

Where: To improve the assessment of the spatial rainfall variation it is necessary to add to the current BMG and PU monitoring networks rain gauges at Pulang Pisau, Kuala Kapuas and Mentangai. Furthermore, additional rain gauges should be installed in areas where interventions are planned or implemented to improve the accuracy of the rainfall data for these areas.

6B) Canal water depth

Why: Canal water depth directly influences the water table depth in the peatland along the canals, and thereby the rates of subsidence and CO_2 emission and the fire risk. In the long term canal water depths also define the limit for subsidence in the larger area draining into them. Canal blocking aims to increase canal water depth. Monitoring of canal water depth therefore serves as a first indication of the success of this conservation measure.

What: Canal water depth can be measured mostly with a daily or even weekly frequency. For some selected stations, 'diver' water level recorders with an hourly monitoring frequency may be used to provide information on the response time after rainfall events. In this case a rain gauge should be located close to the diver. For all locations where canal water depth is measured the canal cross section is needed as well to use the results in hydrological analysis and modelling.

How: Canal water depth can best be measured relative to the peat surface. Since the peat surface close to the canals is disturbed, the water depth should be measured relative to the peat surface level 50 m from the canal. Wherever possible, the canal water depth should be linked to a benchmark to obtain a water level relative to mean sea level.

Where: Canal water level measurements of the CKPP and EMRP MP project are focused on the north western part of Block A. Some monitoring also takes places in the North of Block C, by CIMTROP. New measurement locations are required wherever canal blocking is going to be implemented to assess the impact on canal water depth. Furthermore, additional canal water depth measurements are required in areas where interventions are planned or implemented to develop agriculture.

6C) Peat water table depth

Why: Hydrological rehabilitation of peatland aims to elevate the water table. Peat water table is an important indicator of the success of this rehabilitation measure and it is also crucial to determining the rates of subsidence and CO_2 emission and the fire risk. Furthermore, water table monitoring along a transect between two canals can be used to assess the hydraulic conductivity.

What: Water table depth can be measured with a weekly or two-weekly frequency.

How: Dip well tubes should be installed preferably with their lower end reaching the mineral soil underlying the peat to prevent movement and subsidence of the tube. Water table depth should be measured relative to the top of the tube and for each measurement the distance from the top of the tube to the surface level should be measured separately.

Where: Groundwater monitoring of the CKPP and Master Plan projects is focused on the north western part of Block A, while CIMTROP monitors groundwater in the northern part of Block C. Additional peat water table monitoring is required wherever interventions are being planned or implemented to raise water levels. Furthermore, transects of dip wells perpendicular to canals can provide information on the hydraulic conductivity and the extent of impact of hydrological rehabilitation measures.

6D) Peat moisture

Why: Peat decomposition (resulting in subsidence and CO_2 emission) is caused by aerobic bacteria that utilise peat organic matter as a metabolic substrate. Normally the water table depth is used as a measure of the oxidation/reduction (RedOx) potential of the soil. Foir a certain distance above the water table, however, some water remains in the peat and its pores reducing oxygen diffusion. Different types of peat have very different soil moisture retention characteristics, which will influence the relation between groundwater depth and peat decomposition.

What: Peat moisture monitoring may be limited to selected periods as long as a sequence of wet and dry periods is included, as the purpose will often be to establish a relation between peat moisture content in the unsaturated zone and the depth of the water table. The depth of the water table may then serve as a proxy measure for peat moisture.

How: For the purpose of monitoring peat moisture in a large number of locations, using a portable 'sounding' device and permanent access tubes is a suitable method. Access tubes (which are up to 2 metres in length) should be installed near dip wells where water table depth is measured. The sensor is lowered in the tubes at regular depth intervals.

Where: Peat moisture monitoring is needed for projects that aim to reduce greenhouse gas emission and subsidence. To assess peat moisture characteristics for different peat types, monitoring should focus on a number of locations within each area with a distinct type of peat. The locations therefore depend on the results of peat mapping (especially bulk density). Peat types are vertically distributed down profiles and will need to be assessed fully within locations.

7. Peatland Emissions Monitoring

The following should be monitored to assess carbon emissions from the peatland: (a) peat subsidence, (b) changes in peat characteristics, (c) gas emissions and (d) carbon losses in drainage water.

7A) Peat Subsidence

Why: Subsidence is a consequence of peatland drainage that reduces gradients and increases flood risk. Determination of the rate of subsidence can be used to measure the rate of carbon stock losses and therefore of CO_2 emissions (peat compaction may need to be taken into account). In the longer term subsidence monitoring can be used to assess the effectiveness of peatland rehabilitation measures.

What: The rate of subsidence should be measured annually in peatland locations that have been drained and/or affected by fires recently; more frequent measurements may reveal a seasonal pattern in subsidence rate.

How: Marker poles made of a long-lasting material are inserted through the peat and fixed firmly in the underlying mineral material. The difference between the surface level and the top of the pole is measured to calculate subsidence between consecutive measurements. PVC dip wells used for water table measurement, if firmly secured in the mineral subsoil, can also be used as subsidence markers for a number of years but they require regular maintenance and replacement. Laser altimetry also has great potential to be used over a large area.

Where: Since it is easy to combine with dip wells for groundwater monitoring, it is advised to measure subsidence at all these locations. Additional subsidence poles made of non-burning material could be installed in areas with a high chance of burning to determine the loss of peat due to fire.

7B) Changes in peat characteristics: bulk density and carbon content

Why: Peat characteristics are altered by decomposition occurring naturally and after drainage and by fire. The degree of decomposition influences future decomposition rate. The three characteristics that can be measured most easily and provide much useful information are bulk density, carbon content and ash content.

What: Benchmark measurements need to be made on samples collected from natural (undrained and unburned) peat swamp forest and in developed and degraded areas at different times since deforestation and/or fire. Monitoring needs to be repeated after future peatland clearance and fire.

How: Samples for bulk density should be taken in the field with minimal disturbance to the peat using, for example, a steel cylinder of approximately 10 cm height and 10 cm diameter. A pit has to be dug to take samples from different depths. Bulk density can be determined by weighing the sample after removing all water by drying for 24 hours in an oven at a temperature of 105°C. Carbon content can be determined according to the chemical standard methods using potassium-per-magnate. Ash content is determined by burning air dried samples at high temperatures.

Where: Bulk density and carbon content should be measured at different depths and at locations with different peat types and drainage history. Samples are needed especially close to subsidence markers to allow determination of carbon loss.

7C) Gas emissions

Why: Most of the carbon that is released during peat decomposition is transferred to the atmosphere as CO_2. Studies show that although there is a small rate of CH_4 emission from pristine waterlogged peat swamp forest there is virtually none from drained peatland, which may act as a sink. The rate of CO_2 emission from drained tropical peatland increases with the depth of the water table below the surface until about one metre. This relationship was believed to be linear but is now thought more likely to be a curved one. Measurement of the rate of CO_2 emissions will provide evidence for the success of hydrology rehabilitation projects.

What: Carbon released by peat decomposition is released mostly as carbon dioxide (CO_2) and partly as methane (CH_4). These gases seep up through the peat profile and escape at the surface.

How: Gases can be captured in gas chambers, and then analysed in the field or in the laboratory. The captured gas often originates from plant root respiration as well as peat decomposition. Separating the two is very complex and required well-considered experimental set-ups, but it is crucial to obtaining meaningful numbers.

Where: This type of monitoring is costly and requires highly specialized expert staff. It will therefore only be possible in selected projects with a strong focus on carbon emissions, such as REDD pilot projects.

7D) Carbon loss with discharge

Why: Organic carbon can be removed from by air or water. Estimation of atmospheric CO_2 emissions will be strengthened if the amount of organic carbon leaving the system with the water is also quantified. In the water flowing out of the area the organic carbon can be present in dissolved (DOC) or particulate (POC) form. The sum of these two is called total organic carbon (TOC). Measurements of concentrations of DOC and POC in open surface water (canals) together with discharge measurements are required to assess the flux of organic carbon flowing out of the system.

What: Fluxes of DOC and POC can be calculated from simultaneous discharge and concentration measurements. Concentrations of DOC and POC should be measured under different circumstances that can influence the concentration, such as the season, flow regime, rainfall pattern over the previous months and disturbance of the peat soil, e.g. by construction of canals and canal blockings.

How: Sampling and analysis for determination of DOC and POC concentrations should be carried out conform standard procedures. Timing of sampling is very important to include representative samples for different circumstances. To sample at several times during a peak runoff event, it might be necessary to have field staff spending days in the field at a location.

Discharge can be assessed from water level measurements if a rating curve is established. This requires a continuous water level measurement using a 'diver' water level recorder and discharge measurements over the whole range of water levels. Again it might be difficult to capture peak runoff events, but these are essential for the reliability of flow and flux estimates, since they form a significant part of total runoff. Velocity measurements can be carried out using a mechanical propellor device, an acoustic or electromagnetic device, or a simple floating stick. Discharge is then calculated from velocity and canal dimensions. The cross section of the canal should be measured accurately and repeatedly.

Where: To calculate the total flux of carbon flowing out of a peat dome, all canals flowing from the dome into the river should be measured as close to the river as possible. However, discharge cannot be calculated from a rating curve where the water level in the canal is influenced by the downstream river water level. In most cases it would therefore be preferable to locate the diver in each canal just upstream of the most downstream structure blocking the canal. Samples for DOC and POC should be taken at the same location as the discharge measurements, which can be just upstream, downstream or over the structure, wherever is easier to measure.

8. Peatland ecological monitoring

Both biodiversity and natural succession need to be monitored in the peatland areas to guide rehabilitation.

8A) Biodiversity

Why: The Master Plan Technical Report on Biodiversity Identifies six areas of high biodiversity, namely, Mawas Peat Swamp Forest (PSF), Kapuas-Kahayan PSF, Sebangau-Kahayan PSF, Sebangau south mangroves, Pantai Kiapak mangroves and riparian forest at the edge of Block C. Biodiversity monitoring should focus on these to assess the success of conservation, protection and rehabilitation measures.

What: Biodiversity monitoring should focus on (a) forest cover and condition in the remaining peat swamp forest and mangrove forest areas and (b) indicator species of conservation interest. The Technical Report on Biodiversity identifies 10 animal species (including primate, bird and fish species such as the orangutan, hornbills and *arowana*) and 3 plant species including *ramin* (*Gonystylus bancanus*).

How: A Forest Cover and Condition Survey should be completed every 2-3 years. Forest cover should be determined using remote sensing combined with ground truthing, while forest condition should be assessed in ground sample plots to measure forest structure and biodiversity. These sample plots could be made permanent as part of a Permanent Sample Plot network (PSP) across the EMRP area. Surveys could also include areas outside of the PSP network on an ad hoc basis.

Where: Biodiversity monitoring should be completed in the protection zone as a system-wide activity but can be done in partnership with organisations that have their own conservation interventions and existing monitoring systems (e.g. Yayasan BOS).

8B) Natural Succession

Why: Although more than half of the 920,000 hectares of peatland in the EMRP area is in a highly degraded state, there are signs of natural recovery through succession in many areas (see Master Plan Main Report and Technical Review No. 2 on Natural Succession in PSF in Central Kalimantan). At present, it is unknown to what extent the area as a whole can regenerate naturally although the potential is clearly there. The Main Master Plan Report also shows that reforestation can be one of the most expensive interventions there has been only limited success to date. Monitoring of succession is required to (a) determine where regeneration is occurring naturally and where it might require intervention assistance and (b) provide a better understanding of the patterns of natural succession across the area as part of developing the knowledge base for rehabilitation of the peat areas. This activity will therefore contribute to ensuring an effective use of limited resources for reforestation.

What: Natural succession should be monitored through the establishment of a network of Permanent Sample Plots (PSP) across a range of degraded habitat types in the EMRP peat area (these will therefore complement the proposed PSPs in the areas with natural forest cover). Within this network of PSPs, information on bio-physical conditions, species present, vegetation structure and recruitment into the population (seedlings, saplings and poles) should be collected. This will allow provisional maps of forest regeneration potential to be modelled for the EMRP area, which themselves can be verified by more extensive point sampling.

How: The network should be planned according to the availability of resources to regularly monitor natural regeneration as well as protecting the plots from disturbances such as fire and agricultural development. The design of the PSP network will need to capture intra-site variability as well as inter-site variability as a result of broader scale environmental changes (e.g. coastal versus inland peat) and environmental gradients in the area (e.g. distance from canals, rainfall gradient from north to south).

Where: Monitoring of natural succession should be a system wide activity but can be done in partnership with organisations that have their own reforestation interventions. The target area of interest is the broad area of degraded peatland that is to be protected in Management Units I-III.

9. Peatland reforestation monitoring

Why: Reforestation of peatland will be a part of most peatland rehabilitation efforts. At present, there is only limited information of what has succeeded and failed and why.

What: Within reforestation projects, a standard monitoring protocol should be applied that will allow comparison of results. This protocol should include basic information such a species planted, biophysical and environmental factors, silvicultural treatments (if any), and tree growth and mortality rates. Given the expense of reforestation, costs should be included as a matter of interest. Socio-economic factors including the level of community involvement (e.g. community nurseries, community planting etc.) should be included.

How: Standard procedures for monitoring tree growth and mortality can be applied. This monitoring can also be complemented by applied research, which will enable more understanding of the patterns emerging from the monitoring programme.

Where: This monitoring activity will occur within all areas where there are reforestation projects.

10. Land Cover Monitoring

Why: Rehabilitation of peat swamp forest is one of the objectives of the proposed interventions specified in the Master Plan. Repeated land use/land cover mapping will be used to assess the status of forest areas and the impact of rehabilitation measures and autonomous developments. Furthermore, changes in land use and land cover should reveal threats to the peatland rehabilitation, for example, illegal logging, construction of logging canals, roads or drainage canals for plantation crops.

What: Land cover/land use monitoring should provide maps with different categories of land use/land cover differentiating between different types and states of shrub and forest cover and between different types of agriculture. It would be advantageous to develop the legend from the one used in the Master Plan project to allow an assessment of land cover/land use changes since 2007. Frequent updating of the map would allow detailed analysis of land use/land cover change and the identification of successes, chances and threats. It would also be good to develop maps for past conditions, so a timeline of developments can be established (as part of 'Baseline' development).

How: SarVision mostly used ASAR radar satellite data to prepare the land use/land cover maps for 2007 and 2008 for the EMRP area. Additionally, ALOS-PALSAR radar data, SPOT and LANDSAT images and laser-altimetry data can be used. Ground surveys always remain necessary to validate remote sensing results.

Where: Remote sensing monitoring should cover the whole of the EMRP area plus surroundings (certainly the Sebangau area). Specific assessments could focus on smaller areas, e.g. for an assessment of degradation and/or improvement of forest state.

3.3.4 Agricultural Revitalisation Monitoring

Monitoring of agricultural revitalisation should be conducted across the farm systems of the EMRP area. An Integrated Agricultural Monitoring System should be developed to ensure a clear understanding of changes in the agricultural system are captured and understood. This could also be linked to the Socio-Economic Monitoring as presented in 3.3.5. The main performance measures to be monitored are discussed below.

11. Agricultural Hydrological Monitoring

11A) River Levels

Why: River water level is the main factor determining flooding, drainability and potential for tidal irrigation, which are important in determining land suitability for agriculture and in hydrological analyses and modelling.

What: River water levels should be monitored along the main Rivers: Kahayan, Kapuas, Barito, the smaller Sabangau and some of the streams in Blocks A and E, such as Mentangai and Mengkatip. River cross sections are needed at the same locations. Monitoring along the Barito is especially urgently needed as this is where flooding and drainability problems are most severe.

How: Manual monitoring is required, but can be enhanced with automatic monitoring (divers) at selected locations.

Where: Monitoring by PU of river water levels in and around the EMRP area is limited to the Kahayan River in Palangka Raya. The CKPP and Master Plan projects have installed some 10 additional automatic monitoring stations using divers. Monitoring at these locations needs to be continued, especially where the main rivers enter the coastal plain. New monitoring stations need to be added where there are specific question in relation to agricultural management and flooding.

11B) River Discharge

Why: To assess water levels within the EMRP area it is necessary to quantify the discharge from the upstream catchments of the main rivers Kahayan, Kapuas and Barito where they enter the area. Without this information no reliable assessment of river hydrology within the area can be made.

What: Measurement of discharge of the main rivers on the upstream boundary of the EMRP area.

How: Water level can be measured continuously with a diver. Discharge can be calculated from the water level after a rating curve is established. For the rating curve discharges should be measured for a wide range of water levels. Discharge measurements can be carried out using a mechanical mill or an acoustic or electromagnetic device. The cross section of the river should be measured accurately and repeatedly.

Where: PU monitors water level continuously with an autograph at the Kahayan River in Palangka Raya. The cross section is measured in principle annually and discharges a few times per year. However, due to budget constraints these measurements have not been carried out in the last few years. It is advised to install a diver at this location to monitor water level automatically and to continue with annual cross section measurements and regular discharge measurements. For the Kapuas and Barito rivers the CKPP and Master Plan projects have installed divers near the upstream boundary of the EMRP area. Monitoring at these stations needs to continue and rating curves and cross sections remain to be established.

11C) Water levels in agricultural areas

Why: Accurate knowledge on water levels in agricultural areas is required for design of the hydraulic lay-out and infrastructure and to assess the potential threat of flooding and saline intrusion and the possibilities for drainage and irrigation. The water levels can be used to prepare a hydraulic model, which can provide detailed insight in water level and flow under different conditions. Detailed insight is only possible if a DEM with a high resolution and a high accuracy is available.

<u>What:</u> Water level measurements by divers and manual gauges. Divers in tidal areas are needed to measure with a half-hourly frequency to catch detailed information on tidal dynamics. In other areas the frequency can be hourly. Manual staff gauges should be read at least twice (preferably 3 times) per day every day at the same time. To use the water level information for modelling it is necessary to measure the cross section of the canal at the same location. Furthermore, all measurements should be linked through benchmarks to MSL.

<u>How:</u> Divers and staff gauges need to be installed in the canal so that they can cover the complete range of water levels. Where required a number of staff gauges can be placed at the same location at different heights. Each diver location should be accompanied by a staff gauge, ensuring a continuous dataset should the diver malfunction.

<u>Where:</u> Water level measurements are required in all main canals in Development and Adaptive Management zones where enhancement of agricultural production is planned. Water level stations should be located at different distances from the river to assess the extent and damping of impact from river water levels in relation to the local topography.

11D) Water quality in agricultural areas

<u>Why:</u> Two aspects of the water quality affect agricultural production: salinity and excessive acidity. Salinity is the result of intrusion of seawater, while acidity originates from oxidation of sulphate present in the soil. Monitoring of these two components is essential for planning, design and implementation of interventions to enhance agricultural production.

<u>What:</u> Measurements of salinity and acidity can be made instantly with pH/EC meters during measurement campaigns. Measurement campaigns should be planned to cover different seasons and different stages of the daily and bimonthly tidal cycles. Better insight of temporal variation can be obtained by using a diver for combined continuous measurement of pH and EC with water level. Measurement frequency could then be hourly or half-hourly in areas with a strong tidal influence.

<u>How:</u> pH meters and EC meters are standard equipment. Continuous measurements can be obtained using special ceramic divers resistant to saline and acid conditions and able to monitor water level, pH and EC simultaneously.

<u>Where:</u> For each scheme one or two divers could provide enough information on temporal variation, while campaigns should cover all canals.

12. Agricultural soil and environmental monitoring

<u>Why</u>: Improving soil quality and the biophysical environment for crop growth is a key goal in improving agricultural productivity and in the land reclamation process. Progress with this as a result of natural processes and interventions should be monitored to assess the likely contribution of soil and bio-physical conditions as a limiting factor to agricultural productivity.

What: Within the major farms systems identified in the master plan and in a variety of contrasting locations, the physical and chemical properties of the soil should be assessed using standard procedures. Farms where these measurements are made can be set up as a permanent monitoring network for this purpose.

How: A specific protocol will need to be designed working closely with agricultural extension workers, research institutes and farmers. The results of the monitoring should be brought as close as possible to the farmers themselves, potentially those a farmer field school approach as a means of helping farmers adapt their farming practices.

Where: This monitoring should be applied as a system-wide activity and in areas with interventions to improve agriculture. This will be especially important in the development zone linked closely to hydrological and water quality monitoring.

13. Crop productivity monitoring

Why: Increasing crop productivity remains a major strategic goal of the Master Plan as a means of rehabilitating and revitalising the area. Productivity of specific crops should be monitoring as part of the system-wide monitoring work building on existing data collected through current monitoring work by the Agricultural Offices and National Statistics Agency (BPS).

What: For the main farm systems and their primary associated crops in the EMRP area, agricultural production should be monitored across the whole area and at the field level.

How: At the level of the whole EMRP, data on crop area and productivity in different areas will be needed to produce an estimate of overall production building on existing monitoring approaches. At the field level, crop productivity can be measured through close cooperation between agricultural extension workers, research institutes and farmers.

Where: This monitoring should be applied as a system-wide activity and in areas with interventions to improve agriculture. This will be especially important in the development zone linked closely to hydrological and water quality as well as soil and environmental monitoring.

14. Fisheries Monitoring

Why: The livelihoods of many communities in the EMRP area, in particular Dayak communities, is dependent to some extent on fisheries. The Master Plan Technical Report on Fisheries provides more information on this and highlights the need for interventions and monitoring to support this.

What: Fisheries monitoring protocols will need to be developed for each of the main fisheries in the EMRP area (capture fisheries, freshwater aquaculture, cage culture, *beje* fisheries, ornamental fisheries, *tambak*). Data collection including stock assessments, catch data at landing sites, marketing data and the impact of hydrology and land use on fish populations should be included in the monitoring protocols.

How: Standard approaches for fisheries monitoring should be applied expanding on existing data collection. These should be closely linked to the fishing communities as part of the adaptive management approach and as a means of improving management of the area's fisheries.

Where: Fisheries monitoring is required in the main fisheries areas (see Master Plan Technical Report for more details).

15. Farm systems monitoring

Why: The Master Plan highlights that the main unit of organisation of agriculture is the farm and that successful interventions can be best developed by taking a farm systems approach. The farm system is defined as a population of individual farms that have broadly similar resource bases, enterprise patterns, household livelihoods and constraints. Monitoring changes in farm systems will provide information on the extent to which agricultural interventions are succeeding and whether natural uptake of new technologies and enterprise patterns is occurring.

What: A specific Farm Systems Monitoring protocol for each of the main farm systems in the EMRP area will need to be produced.

How: A specific farmer-centred approach is the most appropriate means of monitoring farm systems as a means of helping farmers analyse changes in their own farm and understand new innovations in the farm system overall that are occurring.

Where: This monitoring should occur across the whole EMRP area and in areas with

16. Agricultural sector monitoring

Why: Farms and farming exist within a context of changing policies, demand and prices at the national and international levels that influence farmers and the agricultural sector overall. Agricultural sector monitoring is required to ensure that farmers have good information on changes and policy makers are informed of these and their impacts on the EMRP agricultural sector.

What: Changes in the agricultural sector in general and broadly within the EMRP area should be monitored to assess (a) the changing context of policies, demand and prices in the sector, (b) how this affects the sector overall in the EMRP area and (c) how farmers are coping (linked to farm systems monitoring).

How: A agricultural research institute could be tasked with producing a regular sector summary based on international and national trends combined with monitoring in the EMRP area.

Where: This activity would be conducted across the whole EMRP area.

3.3.5 Socio-economic and Community Development Monitoring

17. Community institutions monitoring

Why: The lack of effective community institutions was identified as a constraint to socio-economic development in the EMRP area. Interventions are proposed in the Master Plan to strengthen village institutions, including the development of a community-based approach, which will need to be monitored to assess the success of interventions.

What: The monitoring of community institutions should focus on (a) the existence of specific institutions (e.g. community and sub-district forums, community-based implementation teams, community-based forest management groups) and (b) community / member views on their performance. This will require a predominantly participatory approach to monitoring.

How: A simple record of the existence of specific community institutions can be made through a simple proforma completed by facilitators. Community views on their performance, needs for strengthening and success and lessons learnt from interventions will need to be completed through participatory monitoring and evaluation processes. Specific protocols for villages in different socio-economic contexts should be developed combined with training of facilitators to undertake this.

Where: This should be done for all villages as part of the community-based approach to rehabilitation and revitalisation of the EMRP area.

18. Community finance monitoring

Why: The approach to community-based implementation proposes that financial resources are made available to communities as (a) general grants for community infrastructure (e.g. water supply etc.) and (b) specific grants for rehabilitation and revitalisation, possibly through existing mechanisms such as the PNPM. Monitoring of this finance and the outcomes for the community and environment should be completed to guide further development of this.

What: Monitoring should focus on (a) the level of finance made available to communities, (b) the appropriate use of funds, (c) the outcomes of funding and (d) community perceptions to the value of these resources.

How: Financial flows to communities can be tracked through basic tracking of financial disbursements and the proper accounting and completion of social accountability processes without complaints. The outcomes of funding can be monitored quantitatively in terms of number and type of community projects and qualitative assessments can be completed as part of the Participatory Monitoring an Evaluation.

Where: This will be completed by interventions in all villages where community-based grants are provided in the EMRP area.

19. Community facilities and service improvement monitoring

Why: Improvements in the delivery (quality and quantity) of basic services such as health and education and provision of basic facilities such sources of clean potable water were identified as needed by the Master Plan. Interventions should focus on improving access and quality of services and facilities and the impact of these should be monitored and assessed.

What: Monitoring should focus on (a) the accessibility of basic services and community facilities and (b) the quality of services and facilities and (c) public satisfaction with these. These should be aligned to specific standards set by government.

How: Assessing the accessibility of basic services can build on existing data collection by government. The quality of services and facilities and public satisfaction will need to be assessed through qualitative sampling instruments. A baseline survey should be completed.

Where: Baseline monitoring should be completed across the EMRP area. Specific interventions from government and others should use standardised protocols to allow comparison and consolidated reporting between interventions.

20. Land tenure monitoring

Why: Land tenure remains a constraint to the long-term rehabilitation and revitalisation of the EMRP area. Many local farmers and landowners do not have legal title to their land and/or rights associated with state forest land that they may consider their property. This is particularly important given the number of new plantation licences in the area, the future delineation of new forest boundaries based on the revised provincial spatial plan and the possible flow of revenues from carbon finance. In the MRP transmigrant communities, there is a uncertainty over legal ownership rights following the departure of roughly half the transmigrant families moved there. There is a need for interventions to resolve these land tenure issues, which will require monitoring.

What: Monitoring of land tenure issues will basically involve creating a database of land tenure issues and conflicts. This database would include basic information on location of the land, the issue and status of resolution. Such a database can be used to monitor progress in the resolution of land tenure issues and action required. Qualitative monitoring should also be conducted to assess constraints and complaints as a means of securing final resolution of these issues.

How: Monitoring of land tenure issues is not straight forwards and a number of strategic decisions will need to be made. One approach would involve soliciting communities to lodge formal notice of land tenure issues in their village lands and to then monitor the resolution of these. The risk with this is that this may invite opportunistic claims and/or unnecessarily raise expectations. Alternatively, monitoring protocols for interventions in areas with known land tenure issues can be designed. The Department of Forestry and National Land Agency (BPN) will be the key government agencies in this and the approach to monitoring will need to be developed according to initiatives to address land tenure issues.

Where: Land tenure monitoring will be required in areas with land tenure issues. Current knowledge of he extent of these is incomplete but it could involve many villages in the area.

21. Socio-economic outcome monitoring

Why: Improving the socio-economic welfare of people living in the EMRP area is a key objective of the Master Plan and the rehabilitation and revitalisation program. Progress towards this goal will need to be monitored.

What: The Master Plan takes a livelihoods approach to socio-economic development whereby livelihood outcomes in terms of food security, income and prosperity are analysed in terms of the capital assets of households, the livelihood strategies of households and the context of vulnerability in which they live. Broadly, socio-economic is proposed to focus on broad quantitative issues such as measures of poverty that are currently measured by government as well as more qualitative aspects such as household assets, livelihood strategies and food security.

How: There are a number of quantitative and qualitative approaches to measuring socio-economic welfare. Quantitative approaches should be based on existing government instruments such as the various surveys conducted by the National Statistics Agency (BPS) such as SUSENAS. Specific questions of interest in terms of the rehabilitation and revitalisation of the EMRP area could be added to survey instruments applied in the EMRP area. Qualitative monitoring could take (a) a community-based approach as part of the participatory monitoring and evaluation and/or (b) a ‘sentinel household’ approach where a certain number of households in different parts of the EMRP area provide a permanent sample in which trends and changes can be followed.

Where: Socio-economic monitoring should be conducted across the whole EMRP area and as part of interventions that have impact on socio-economic welfare.

3.4 Monitoring in the Limited Development Zone

The management requirements for the Limited Development Zone are highly dependent upon effective monitoring. At the present time, the Limited Development Zone is seeing increased development and drainage canals being constructed. The canals create a system of open drainage in this zone, so that water loss from the deeper and shallow peats is accelerated. Although this drainage allows the removal of excess water for certain crops in the wet season, it means that in the dry season water levels will be relatively low. As a result, high levels of peat loss through oxidation and as a result of increased fire risk are expected. The Master Plan proposes that controlled drainage is introduced into this area to allow removal of excess water in the wet season but maintain water levels during the dry season.

Introducing such water control into the EMRP area will be a challenging task that will require careful monitoring. Monitoring in this zone will require a combination of peatland and agricultural monitoring with a specific focus on the hydrology of the zone. One aspect that will apply to all Limited Development Zone locations is that it will be necessary to closely monitor the impacts of activities adjoining the Protection Conservation Zone (which will be negative: drainage, fire and encroachment), and of impacts of activities in the Protection Zone on the adjoining Limited Development Zone (which should be positive: fewer fires, lower peak flows, higher baseflow).

3.5 Key Performance Indicators and Means of Verification

For each of the twenty-one requirements described above, which are linked to key outputs defined in the Master Plan, a possible Key Performance Indicator (KPI) and means of verification are defined and presented in Table 5. These KPIs are intended to convey headline statements regarding the status of rehabilitation and revitalisation in the EMRP area and are not an exhaustive list of indicators for what is a complex program. It would be mandatory for specific interventions to report on these indicators using standard monitoring protocols to allow consolidated reporting of overall progress, although individual projects would be expected to develop their own detailed monitoring systems and indicators according to their individual needs.

Table 5: Proposed Key Performance Indicators and Means of Verification for Rehabilitation and Revitalisation of the EMRP Area.

Monitoring Program Component	Performance Measure	Key Performance Indicator (KPI)	Means of Verification
1. Fire Management	1. Fire management system	1. An effective fire management system and policy is in place	Fire system assessment tool
	2. Fire monitoring	2. The number of fires and area burnt	Remote sensing and ground truthing of fires
	4. Fire policy impact monitoring	3. Number of 'illegal fires' occurring	Remote sensing and ground truthing of fires
2. Spatial Management and Infrastructure	4. Compliance and QA of spatial plans	4. Number of spatial plans not in compliance	Expert review of spatial plans
	5. Compliance monitoring	5. Number and % of developments not in compliance	Expert review of spatial permits and EIAs
3. Peat and forest rehabilitation and conservation	6. Peatland hydrology	6. Area with raised water levels and height raised	Various
	7. Carbon emissions	7. Total emissions per year	Various
	8. Peatland ecology	8. Area with biodiversity value and regenerating forest	Surveys, PSPs and remote sensing
	9. Reforestation	9. Area and % of planted area with growth and survival rates higher than target values	Growth and mortality monitoring
	10. Land cover monitoring	10. Area of land cover in relation to targets	Remote sensing
4. Agricultural Revitalisation	11. Agricultural hydrological monitoring	11. Area of farmland with effective water management	Water management monitoring protocols
	12. Agricultural Soil and environmental monitoring	12. Area and % of soil and environmental samples in target range	Soil and environmental monitoring protocol
	13. Crop productivity monitoring	13. Total production and productivity of key crops	Crop monitoring
	14. Fisheries	14. Total production and productivity relative to sustainable yield	Fisheries monitoring protocols
	15. Farm systems monitoring	15. Number and area of farms with improved farming system	Farm system monitoring protocols
	16. Agricultural sector monitoring	16. % farmers reporting positive feedback	Participatory monitoring and evaluation
5. Socio-economic and Community Development	17. Community institutions monitoring	17. Number and % of villages with effective institutions	Participatory monitoring and evaluation
	18. Community finance monitoring	18. Total finance and project outputs	Community grant monitoring tool
	19. Community facilities and service improvement	19. Number of villages with facility and service improvements (and type)	Participatory monitoring and evaluation
	20. Land tenure monitoring	20. Number of land tenure resolutions	Participatory monitoring and evaluation
	21. Socio-economic outcome monitoring	21. Poverty rate	Socio-economic survey

3.6 Inventory and Baselines

A number of attributes need to be measured as part of an inventory as a basis for detailed planning and setting of baselines.

3.6.1 Priorities for Inventory

Elevation

Why: Accurate and reliable elevation information is required for understanding the natural system and for planning and design of a number of interventions. Specific use of elevation information is expected to support the following:

1. Preparation of an improved overall DEM of the EMRP area with a spatial resolution of 100 m as a basis for hydrological analysis and modelling.
2. Detailed assessment of topography around canals to support design of canal blocking structures;
3. Detailed assessment of topography in zones where agriculture is to be developed/enhanced with the aim to support design of hydraulic infrastructure dealing with flooding, drainage, salinity and tidal irrigation;
4. Assessment of subsidence by analysis of the difference between elevation data from different years.

What: Each of the above described items requires a specific horizontal and vertical resolution of the elevation data. A more detailed description of the requirements and potential of a specific technique is presented in a separate Master Plan note (Van der Vat et al, 2009). A system of benchmarks has been put in place during the CKPP and Master Plan projects. However, the elevation of the benchmarks is not known with enough accuracy. Accurate DGPS elevation measurements of the benchmarks is needed urgently.

How: Elevation analysis should combine information from different sources, such as:

- Ground surveys using water levellers or freeboard measurements along canals
- DGPS measurements
- Laser-altimetry from a helicopter or small airplane.

It is essential to link measurements to MSL. This can be done by linking to the Bakosurtanal benchmark in Banjarmasin or by linking to a benchmark near the mouth of the rivers where MSL can be established from the tidal analysis carried out as part of the Master Plan (Hooijer et al, 2008). Preferably both methods are combined.

Where: The location of the elevation measurements depends on the different use of the data. preferably an overall DEM of the EMRP area is combined with more detailed DEMs for specific areas.

Peat thickness

Why: Peat thickness is used in the Master Plan and Indonesian Legislation to determine the boundary between zones where different activities are planned or allowed. Peat thickness ultimately defines the amount of carbon stored in the peat and is therefore of importance to calculate avoided emissions. Furthermore, subsidence and groundwater dynamics depend on peat thickness. More accurate determination of peat thickness distribution is essential for rehabilitation planning.

What: The Master Plan includes a peat thickness map prepared from data available currently. A more accurate and reliable map can be produced as more data becomes available.

How: Peat thickness should be established by boring using special equipment to take small soil samples at the end of the bore hole. The bore hole should be deepened until the mineral subsoil is found. Surveyors may use different definitions to classify soil as either peat or mineral. This should be standardised.

Where: Additional peat thickness surveys are required in all parts of the EMRP where peat protection and conservation interventions are planned to be able to determine the carbon store and estimate potential subsidence and emission losses.

Drainage systems

Why: Drainage systems consist of canals and hydraulic structures such as weirs and gates constructed for the regulation of inflow and outflow of water. The largest drainage system in the area is formed by the drainage canals in Blocks A, B, C and D and their inlet structures as constructed in 1996-98 when the EMRP was being implemented. Most structures have been demolished and not all canals were completed according to design. Connections between canals are sometimes missing. For peat conservation and protection interventions such as canal blocking it is essential to know the current status of the EMRP drainage system. In the south of Block C and D older and smaller drainage systems exist.

What: An inventory needs to be made of all canals and structures and their current state. A large number of canals have been surveyed in the framework of the CKPP and Master Plan projects. A more complete map of the drainage system has to be prepared, especially where canals connect and where canal construction was not completed.

How: The Master Plan database provides a starting point for the inventory. Additionally, all structures that still exist need to be visited and dimensions need to be measured relative to MSL (using improved benchmarks). For canals not yet surveyed the width of the canal should be measured every few hundred metres as well as the depth at three locations in the canal relative to the surface level.

Where: Improved knowledge of the drainage system is required for all areas where intervention (both in peat conservation and agricultural development) are planned and / or implemented.

3.6.2 Establishment of Baselines

The following should be considered as a priority for detailed assessment as part of establishing a baseline. A number of these can use secondary and primary data presented in the Master Plan and are indicated as such.

1. **Fire monitoring of previous years** - Hot spot and burnt area data exists as secondary data although a more detailed assessment can be completed as has been done for Block C (Hoscilo et al. 2008).
2. **Spatial development compliance** – Overlays of existing developments and permits have been made in the Master Plan. These can be updated based on

the revised provincial spatial plan and more detailed information on new canals and proposed infrastructure developments to act as a baseline.

3. **Peatland Hydrology** - Canal water depth, peat water table depth and peat moisture will require the deployment of an extended hydrological monitoring system. This will allow improved modeling of the peatland hydrology using the SOBEK model produced during the Master Plan.
4. **Carbon Emission Estimates** - Preliminary figures for oxidation are presented in the Master Plan Technical Report on Subsidence. Fire emissions can be better estimated using laser altimetry (Lidar) data to detect past fire scars and improved peat and hydrology data will allow more accurate emissions estimates, especially when combine with gas emissions measurements and data on carbon losses in discharges.
5. **Peatland Ecology: Biodiversity** – The results of a preliminary survey are presented in the Master Plan Technical Report on Biodiversity. An improved baseline could be produced through (a) survey work on forest structure in Block E and the mangrove forests in the south and (b) survey work targeting key indicator species.
6. **Peatland Ecology: Natural Succession** – There is limited data on patterns of natural succession across the area. The establishment of a series of permanent sample plots in degraded areas will allow the setting of a baseline for future monitoring.
7. **Land Cover** – An analysis of land cover has been completed in 2008, which can act as a baseline for future land cover monitoring. This land cover analysis would benefit from additional ground truthing.
8. **Agricultural Hydrological Monitoring / Agricultural Soil and Environmental Monitoring** – There is very limited hydrological data in agricultural areas except for ad hoc studies. The establishment of an effective monitoring system should be seen as a priority and will enable the setting of a baseline.
9. **Crop Productivity** – The Master Plan presented secondary data on agricultural productivity. These data can be used as a baseline but it is considered wise to verify these through field check if possible to ensure consistency.
10. **Fisheries Monitoring** - There is very limited fisheries data except for ad hoc studies. The establishment of an effective monitoring system should be seen as a priority and will enable the setting of a baseline.
11. **Farm Systems Monitoring** – There is no existing baseline but ad hoc studies and local knowledge can be used to assist in this. The establishment of an effective monitoring system should be seen as a priority and will enable the setting of a baseline.
12. **Agricultural Sector Monitoring** – An initial agricultural sector report should consider past trends and be used to set the historical context to the agricultural sector in the EMRP area.
13. **Community Institutions** – A number of reports produced by CKPP and others using PRA can be used to establish a baseline in a sample of villages.

Expansion of a community-based approach to rehabilitation and revitalisation can be used to establish a baseline (see Master Plan Technical Guideline No. 3).

14. **Community Finance –** The baseline can be set based on existing programs such as the PNPM.
15. **Community Facilities and Services –** Existing data from sectoral agencies as reported in the Master Plan regarding access to facilities and services could assist in establishing a baseline. It is recommended that these data are reviewed and verified in more detail. A baseline survey on public satisfaction and priorities could be conducted as part of the socialisation of the Master Plan.
16. **Land Tenure** – There is limited comprehensive data on land tenure issues in the area. An initial baseline and assessment of the issues could be conducted through (a) compilation of documentation and cases reporting to government and non-government organisations, (b) inventory of land tenure issues as part of the socialisation of the Master Plan and/or (c) implementation of Rapid Land Tenure Assessments in the area.
17. **Socio-economic Monitoring** – A socio-economic baseline can be set using secondary data collected by government and the National Statistics Agency. These should be subject to verification. A qualitative baseline can be set using (a) existing data from organisations that have conducted socio-economic surveys such as CARE Indonesia, (b) through community-based processes either during the socialisation of the Master Plan or initiation of community-based approach and/or (c) on the establishment of a sentinel monitoring system.

3.7 Analysis and Reporting

The tasks of analysis and reporting are critical steps in ensuring that information collected through monitoring activities are effectively communicated to decision makers and program managers. Standard approaches to analysis are therefore required to enable comparisons and consolidated reporting of progress with interventions.

At the system-wide level, much of the monitoring work will be done independently of direct project interventions in the area. This will require the support of the proposed Technical Facility to lead on the technical aspects of establishing and managing the monitoring program of work including working with stakeholders to establish monitoring standards, guidelines for implementation (which can be updated based on monitoring results) and monitoring protocols for data collection and analysis. Monitoring results from projects can be integrated with system-wide monitoring results to produce consolidated half-yearly and annual progress reports in the rehabilitation and revitalisation of the EMRP area.

4 Conclusions and Next Steps

A Common Monitoring Framework is presented in this report as a first step in the establishment of developing an effective monitoring system for the rehabilitation and revitalisation of the EMRP area. It provides a rationale and direction to the development of this system and sets out key attributes to be monitored. Such a system is considered an essential component of the implementation of Inpres 2/2007.

The proposed framework presented here will need to be reviewed and agreed amongst stakeholders with improvements made based on this process to produce a final Common Monitoring Framework. This final monitoring framework should be accompanied by defined and agreed standards for monitoring and provide guidelines to projects on objective setting and intervention level monitoring as part of the integrated monitoring in the EMRP area. Once this has been completed, specific monitoring protocols and tools can be developed for the defined performance measures at both the system-wide and intervention levels.

These protocols and tools will need to be assessed in terms of their cost and feasibility for application. Simple approaches are preferred, although in some cases such as hydrological monitoring this might require significant investment in developing a monitoring network. A key principle in the development of the monitoring system and program is that it should be rooted in local organisations with government leadership. This also means that long-term sustainability in terms of financial resource requirements as well as developing human resources to manage the system will need to be addressed.

In order to advance this, it is proposed that the province forms a technical team to develop the monitoring framework and system. This working group should be given a certain period in which to complete the task of completing the finalisation of the monitoring framework, guidelines and draft protocols for piloting. Technical support from the Netherlands and other donors may be available to assist this process.

Annex 1: The RAMSAR Approach to Wetland Inventory, Assessment and Monitoring

The Ramsar Convention has developed tools for the inventory and assessment of wetlands and monitoring their ecological character. These are described in the various Handbooks for the Wise Use of Wetlands (Ramsar, 2007). The *Framework for Wetland Inventory* (Ramsar Secretariat, 2007) provides a 13-step structured framework, supported by guidance on each step, for planning a wetland inventory, as a prerequisite to wetland management and monitoring (Ramsar, 2007a, b). These steps are listed in Table 1 together with explanations.

This planning framework applied to the EMRP should be supported by examples of successfully applied standardized inventory methodologies from different regions, guidance on determining the most appropriate remotely-sensed data for a wetland inventory and for determining land use and land use change, a summary of different widely-used wetland classifications, and a standard metadata record for the documentation of the inventory. The Ramsar *Framework* identifies a set of core (minimum) data fields for biophysical and management features, which should be collected, depending upon the specific purpose (Table 2).

The *Framework for Wetland Inventory* recognizes that wetland inventory has multiple purposes, including:

a. Listing particular types, or even all wetlands in an area
b. Listing wetlands of local, national and/or international importance
c. Describing the occurrence and distribution of wetland taxa
d. Describing the occurrence of natural resources such as peat, fish or water
e. Establishing a baseline for measuring change in the ecological character of wetlands
f. Assessing the extent and rate of wetland loss or degradation
g. Promoting awareness of the value of wetlands
h. Providing a tool for conservation planning and management; and
i. Developing networks of experts and cooperation for wetland conservation and management.

Table 1. Structured framework for planning a wetland inventory (Ramsar, 2007b)

Step	Guidance
1. State the purpose and objective	State the reason(s) for undertaking the inventory and why the information is required, as the basis for choosing a spatial scale and minimum data set.
2. Review existing knowledge and information	Review the published and unpublished literature and determine the extent of knowledge and information available for wetlands in the region being considered.
3. Review existing inventory methods	Review available methods and seek expert technical advice to: a) choose the methods that can supply the required information; and b) ensure that suitable data management processes are established.
4. Determine the scale and resolution	Determine the scale and resolution required to achieve the purpose and objective defined in Step 1.
5. Establish a core or minimum data set	Identify the core, or minimum, data set sufficient to describe the location and size of the wetland(s) and any special features. This can be complemented by additional information on factors affecting the ecological character of the wetland(s) and other management issues, if required.
6. Establish a habitat classification	Choose a habitat classification that suits the purpose of the inventory, since there is no single classification that has been globally accepted.
7. Choose an appropriate method	Choose a method that is appropriate for a specific inventory based on an assessment of the advantages and disadvantages, and costs and benefits, of the alternatives.
8. Establish a data management system	Establish clear protocols for collecting, recording and storing data, including archiving in electronic or hardcopy formats. This should enable future users to determine the source of the data, and its accuracy and reliability. At this stage it is also necessary to identify suitable data analysis methods. All data analysis should be done by rigorous and tested methods and all information documented. The data management system should support, rather than constrain, the data analysis. A meta-database should be used to: a) record information about the inventory datasets; and b) outline details of data custodianship and access by other users.
9. Establish a time schedule and the level of resources that are required	Establish a time schedule for: a) planning the inventory; b) collecting, processing and interpreting the data collected; c) reporting the results; and d) regular review of the program. Establish the extent and reliability of the resources available for the inventory. If necessary make contingency plans to ensure that data is not lost due to insufficiency of resources.
10. Assess the feasibility & cost effectiveness	Assess whether or not the program, including reporting of the results, can be undertaken within the current institutional, financial and staff situation. Determine if the costs of data acquisition and analysis are within budget and that a budget is available for the programme to be completed.
11. Establish a reporting procedure	Establish a procedure for interpreting and reporting all results in a timely and cost effective manner. The report should be succinct and concise, indicate whether or not the objective has been achieved, and contains recommendations for management action, including whether further data or information are required.
12. Establish a review and evaluation process	Establish a formal and open review process to ensure the effectiveness of all procedures, including reporting and, when required, supply information to adjust or even terminate the program.
13. Plan a pilot study	Test and adjust the method and specialist equipment being used, assess the training needs for staff involved, and confirm the means of collating, collecting, entering, analysing and interpreting the data. In particular, ensure that any remote sensing can be supported by appropriate "ground-truth" survey.

Table 2. Core (minimum) data fields for inventory of biophysical and management features of wetlands (Ramsar, 2007a)

Biophysical features
- Site name (official name of site and catchment)
- Area and boundary (size and variation, range and average values)
- Location (projection system, map coordinates, map centroid, elevation)
- Geomorphic setting (where it occurs within the landscape, linkage with other aquatic habitat, biogeographical region)
- General description (shape, cross-section and plan view)
- Climate – zone and major features
- Soil (structure and colour)
- Water regime (periodicity, extent of flooding and depth, source of surface water and links with groundwater)
- Water chemistry (salinity, pH, colour, transparency, nutrients)
- Biota (vegetation zones and structure, animal populations and distribution, special features including rare/endangered species)

Management features
- Land use – local, and in the river basin and/or coastal zone
- Pressures on the wetland – within the wetland and in the river basin and/or coastal zone
- Land tenure and administrative authority – for the wetland, and for critical parts of the river basin and/or coastal zone
- Conservation and management status of the wetland – including legal instruments and social or cultural traditions that influence the management of the wetland
- Ecosystem benefits/services derived from the wetland – including products, values, functions and attributes and, where possible, their relevance to human well-being

- Management plans and monitoring programs – in place and planned within the wetland and in the river basin and/or coastal zone

Metadata record for wetland inventory and monitoring

It is important to establish a publicly-accessible and standardized metadata record for the various inventories undertaken. Metadata has many elements that can include information describing the age, accuracy, content, currency, scale, reliability, lineage, authorship and custodianship of an individual dataset. Recording and describing this information enables data to be easily located, identified and understood and managed. It also enables data to be used more efficiently and effectively. The metadatabase stores descriptions of the data, not the actual data itself and should be viewed as the mechanism that links all of the data descriptions together to provide a comprehensive description of the dataset. Where possible, the data fields should be populated with values representing established international standards, to ensure consistency and quality in the data entry. By identifying the fields required for the metadatabase and recommending the parameters and file formats, the metadatabase could be produced on a range of standard platforms, while using standardized parameters should assist with the transfer of data between platforms.

The ecological character of a wetland

As stated earlier, the Ramsar Convention has adopted the ‘Wise Use’ approach to wetland management, a key feature of which is the ‘Ecological Character’ of the wetland against which changes brought about by management, restoration and impacts can be measured. Wetlands that are targeted for conservation and restoration should be managed so as to maintain or restore their ecological character and in so doing retain or rehabilitate those essential ecological and hydrological functions that ultimately provide its products, functions and attributes. Ecological character is therefore an indication of the 'health' of the wetland that should be measured against a baseline for subsequent monitoring to detect any changes to these ecological and hydrological attributes. Changes to ecological character outside the natural variations may signal that uses of the wetland, or externally derived impacts on it, are unsustainable and may lead to degradation of natural processes and thus the ultimate breakdown of its ecological, biological and hydrological functioning. In addition to ecological character the economic and socio-economic values of the site and cultural values associated with the site need to be considered.

Under the Ramsar Convention "ecological character" of a wetland is defined as "the combination of the ecosystem components, processes and benefits[4]/services that characterise the wetland at a given point in time" and change in ecological character is "the human-induced adverse alteration of any ecosystem component, process and/or ecosystem benefit/service of the wetland".

An effective survey and monitoring programme is a prerequisite for assessing whether or not a wetland has undergone a change in its ecological character and should enable full consideration of the values and benefits of the wetland when the extent and significance of the change is being assessed. Monitoring should establish the range of natural variation in ecological parameters at each site, within a given time frame. Change in ecological character occurs when these parameters fall outside their normal range. Thus, in addition, to monitoring, an assessment of the extent and significance of the change is required taking into account the appropriate conservation status of each wetland.

In the case of wetland restoration to re-establish the ecological character that existed *prior* to a particular date, a new baseline needs to be established for assessing any future change. Information should also be given concerning the target state that any restoration is aiming at. It is recognized that, for many sites, the baseline data needed to allow changes in ecological character to be detected will not be known at present, nor be readily available.

Designing wetland restoration programmes

The restoration of wetlands cannot replace the loss of natural wetlands but restoration can play an important role in addressing degraded wetlands, which have lost, or are losing, their values and functions through change in ecological character. Although there is increasing interest in wetland restoration and opportunities are widespread, efforts to restore wetlands are still sporadic, and there is a lack of general planning at the national level. Individuals and organizations interested in wetland restoration often work in isolation and without the benefit of experience gained on other projects.
The difference between the two terms "restoration" and "rehabilitation" is not clear and the Ramsar Convention has not attempted to provide precise definitions of them. While it might be said that "restoration" implies a return to pre-disturbance conditions and "rehabilitation" implies an improvement of wetland functions without necessarily returning to pre-disturbance conditions, these words are often used interchangeably both within Ramsar documentation and within conservation literature. The Ramsar *Principles and Guidelines for Wetland Restoration* use the term "restoration" in its broadest sense, which includes both projects that promote a return to original conditions and projects that improve wetland functions without necessarily promoting a return to pre-disturbance conditions.

Further guidance on tools and methods, including case studies, for wetland restoration, has been developed by the Ramsar Scientific and Technical Review Panel and is available on the restoration pages of the Ramsar Web Site at http://ramsar.org/strp/strp_rest_index.htm. The approach to

[4] Within this context, ecosystem benefits are defined in accordance with the Millennium Assessment definition of ecosystem services as "the benefits that people receive from ecosystems".

monitoring the success of ‘restoration’ of the EMRP will depend greatly on the nature of the restoration activities that are planned and the management thereafter. Ramsar provides ‘Principles’ that should be followed in wetland restoration projects so that their success or otherwise can be monitored subsequently.

1. Wetland restoration should fit within a clearly defined national framework of programmes and priorities based on a national inventory of wetlands for restoration.
2. A clear understanding and statement of goals, objectives, and performance standards for wetland restoration projects is a critical part of restoration success.
3. Careful planning will limit the possibility of undesirable side effects.
4. Natural processes and existing conditions should be considered during project selection, design, and development. Where possible, ecological engineering principles should be applied in preference to methods requiring hard structures or extensive excavation.
5. Currently available restoration techniques almost never lead to conditions that match those of pristine natural ecosystems.
6. Whenever possible, the minimum acceptable scale for wetland restoration planning should be at the catchment level.
7. Wetland restoration should consider water allocation principles and the role that restoration can play in maintaining ecological functions of wetlands.
8. Wetland restoration should be an open process that involves local community stakeholders as well as stakeholders who will be affected by a project even though they may be geographically distant from the project, for example those living well downstream.
9. Restoration requires long-term stewardship, including ongoing management and *monitoring.*
10. Wetland restoration planning should incorporate, where practicable, knowledge of the traditional resource management that contributed to the shaping of the landscape. Incorporation of traditional environmental knowledge, management and sustainable harvesting practices by local people should be an integral component of restoration.
11. The principles of adaptable management (Ramsar Secretariat, 2007) should be applied to restoration projects. As a project develops, modifications may be necessary to accommodate unforeseen developments and take advantage of newly acquired knowledge or resources.
12. Restoration interventions should be coupled with measures to raise awareness and influence the behaviours and practices that led to the degradation of the ecosystem, in order to ensure that the causes, as well as the effects, of degradation are addressed.
13. Restoration plans should include training programmes to ensure that construction and rehabilitation activities are undertaken in an appropriate manner. Consideration should be given to first developing and implementing a pilot project to test and refine the restoration methods.
14. Monitoring should focus on performance standards that are linked to project objectives. Effective monitoring programmes should consider that all ecosystems undergo constant change and development and should account for both temporal and spatial variability.
15. If performance standards are not met, careful reconsideration of the project is necessary. It may be that original goals, objectives, and performance standards are not feasible, in which case they should be reconsidered.
16. If performance standards are satisfied, the project can be considered successful. However, ongoing stewardship and monitoring will be necessary to maintain the success. Also, stakeholders should re-examine the project from time to time to determine if they are still satisfied with the performance standards used to assess success (i.e. to determine if meeting performance standards equates to their sense of successful restoration). If stakeholders are not satisfied with the project outcomes even after performance standards have been met, it may be necessary to begin the entire process again.

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